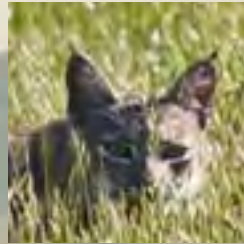
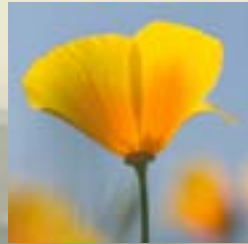


*A Bold Plan to Protect  
the Bay Area's  
Last Wild Places  
and Working Lands*



# The Conservation Lands Network

**San Francisco Bay Area  
Upland Habitat Goals Project Report**

**BayAreaLands.org**

*Think Big. Connect More.*



# **The Conservation Lands Network**

**San Francisco Bay Area  
Upland Habitat Goals  
Project Report 2011**

### **Citation**

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### **Additional Copies and More Information**

This report, accompanying technical documents, and related tools for conservation practitioners are available online at [www.BayAreaLands.org](http://www.BayAreaLands.org).



The Bay Area Open Space Council is a collaborative of member organizations actively involved in permanently protecting and stewarding important parks, trails and working lands in the ten-county San Francisco Bay Area.

# Preface

This report presents the approach, methods, conclusions, and recommendations of the San Francisco Bay Area Upland Habitat Goals Project, a five-year science-based study to identify the most essential lands needed to sustain the biodiversity of the San Francisco Bay Area.

The project identified the types, amount, and distribution of habitats – the Conservation Lands Network – and the ecological processes needed to sustain healthy and diverse populations of plants, fish, and wildlife in the nine county Bay Area. The Conservation Lands Network is a mosaic of existing protected lands, additional lands to support irreplaceable rare and endemic species, and vast tracts of intact common vegetation types. The network design prioritized ecological integrity and watershed functions to ensure resilience to environmental disturbance.

The Conservation Lands Network is a guide to help conservation practitioners, policymakers, regulators, funders, and landowners make informed investments in biodiversity conservation.

The website for the Conservation Lands Network, [www.BayAreaLands.org](http://www.BayAreaLands.org), makes the project information readily accessible. It includes the Conservation Lands Network Explorer, an online tool that allows the user to draw the boundary of an area of interest and explore the natural resources found on the property. The website also contains the downloadable Conservation Lands Network GIS Database, this report and its appendices, detailed maps, and background material.

## Report Audience and Use

The purpose of this report is to document the scientific approach used to develop the Conservation Lands Network; it is intended to be comprehensible to scientists, land managers, and other interested readers with or without science backgrounds. The report presents the methodology, assumptions, focus team decisions and recommendations, viability factors, management recommendations, data gaps, and references for additional information. More detailed methodology descriptions can be found in Appendix B (*Data and Methods*).

Because the Conservation Lands Network, web-based tools, and recommendations can be found on the project's website, [www.BayAreaLands.org](http://www.BayAreaLands.org), this report is not required reading before using the Conservation Lands Network. However, users are strongly encouraged to be familiar with guidelines for interpreting the results of the Conservation Lands Network before making conservation investment decisions. These guidelines are described in Chapter 11 and are available on the project website.

## Acknowledgements

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With support from a number of visionary funders, the Conservation Lands Network was created over a period of five years thanks to the efforts of dozens of experts who committed their time and talent. The participants on the Steering Committee, Focus Teams, Public Outreach Group, and the peer reviewers provided critical guidance and expertise. Without their hard work and dedication, this project would not have been possible.

The Bay Area Open Space Council would especially like to thank the Gordon and Betty Moore Foundation and California State Coastal Conservancy for providing significant financial support and crucial technical expertise. The early commitment, ongoing advice, vision, and enthusiasm from Amy Hutzler, Program Manager of the San Francisco Bay Program at the Coastal Conservancy, and Gary Knoblock, Program Officer with the San Francisco Bay Area Program at the Gordon and Betty Moore Foundation, were invaluable.

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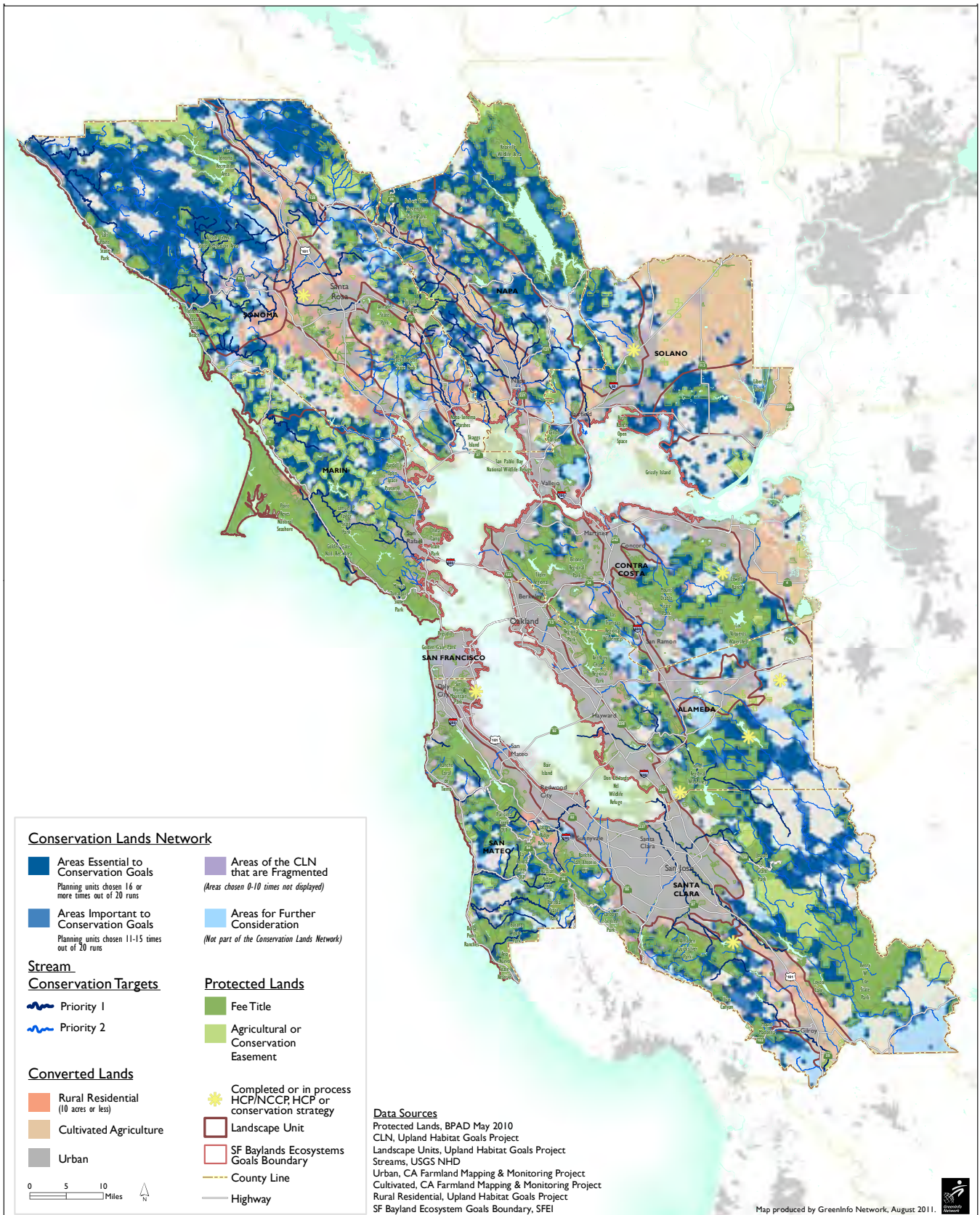
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**Figure A ■ The Conservation Lands Network 1.0.** A high-resolution, zoomable version of this map is available at [www.BayAreaLands.org](http://www.BayAreaLands.org).



# Executive Summary

## **Bay Area Upland Habitat Goals Project Tools for Biodiversity Conservation**

The Upland Habitat Goals Project has created a series of tools for conservation practitioners:

**Conservation Lands Network** – The configuration of Bay Area habitats and linkages needed to meet biodiversity conservation goals.

**Report** – Documentation of the project data, methodology, conclusions, and recommendations.

**CLN Explorer** – A web-based interactive mapping tool that can be used to produce Biodiversity Portfolio Reports for user-defined areas.

**GIS Database** – All publicly available datasets used for the analyses.

These tools will be updated; current versions are available at [www.BayAreaLands.org](http://www.BayAreaLands.org).

The San Francisco Bay Area is one of the most special places on Earth. It is one of only five regions worldwide with a Mediterranean-type climate, and supports large numbers of species found nowhere else. The natural beauty and innovative business sector have attracted a large human population, making the region a biodiversity hotspot. The threats facing the Bay Area are unprecedented, from budget cuts to poorly planned development to a changing climate. Every day, clean water for fish, wildlife, and humans dwindles as streams are constrained, polluted, and dewatered. Habitat and linkages vital for healthy wildlife populations are degraded or lost. Ranchers, whose vast grasslands and oak woodlands are integral to conserving biodiversity, are forced to cash out and move on.

At the same time, the push for sustainable communities at the state, regional, and local levels is similarly unprecedented, offering promise that the Bay Area's high quality of life will not only continue, but flourish. The region's economy depends on the high quality of life that comes from healthy, functioning ecosystems providing clean water, beautiful vistas, locally grown foods, resilience to a changing climate, and open space for world-class recreation.

In response to these threats and opportunities, the Bay Area Open Space Council initiated the San Francisco Bay Area Upland Habitat Goals Project to create a collaborative, science-based vision for conserving the region's irreplaceable landscapes. Inspired by the groundbreaking Baylands Ecosystem Habitat Goals, the project developed the Conservation Lands Network (Figure A) that identifies the types, amounts, and distribution of habitats needed to sustain diverse and healthy ecosystems in upland habitats beyond the baylands. This is the culmination of five years of work by 125 experts representing resource and regulatory agencies, conservation nonprofits, consulting firms, universities, and landowners.

The Conservation Lands Network is not a list of specific parcels, but represents a mosaic of interconnected habitats. Fortunately, the Bay Area is well on its way to making this vision a reality. The Conservation Lands Network builds on the considerable investment in conservation made to date – nearly 1.2 million acres and counting. Approximately 970,000 acres of protected lands form the spine of the Conservation Lands Network, comprising 44% of the total network. The Conservation Lands Network is a guide for making conservation investments, supporting collaborative conservation planning, and helping protect biodiversity throughout the region.

The development of the Conservation Lands Network marks the completion of a trilogy of ecosystem planning efforts covering the continuum of habitat types from the bottom of the Bay to tidal wetlands and grassland transition zones to the upper watersheds. The Upland Habitat Goals Project joins the Baylands Ecosystem Habitat Goals, in the process of being updated, which covers the historic tidelands around the Bay, as well as the recently completed San Francisco Bay Subtidal Habitat Goals Project, which establishes priorities for submerged habitats. Together, these three projects will guide the conservation of the natural resources that make the Bay Area such a unique place.

## Guidelines for interpreting the Conservation Lands Network

The Conservation Lands Network is dynamic. As the distribution of conservation targets, protected lands, and threats change over time, so will the ideal configuration of areas to conserve. The most up-to-date GIS datasets and Conservation Lands Network maps can be found online at [www.BayAreaLands.org](http://www.BayAreaLands.org).

Areas outside of the Conservation Lands Network may have high conservation value. Surveys of a property of interest may reveal extraordinary biological resources not captured in the current Conservation Lands Network datasets.

Ground truthing is essential. Even the best available data is inconsistent and incomplete; conservation decisions must include site visits and surveys.

## Accessing the Conservation Lands Network

From the project's inception, a primary goal of the Bay Area Open Space Council was to make the Conservation Lands Network easy to use and readily accessible via the Internet. The website ([www.BayAreaLands.org](http://www.BayAreaLands.org)) and especially the Conservation Lands Network Explorer, a web-based interactive mapping tool, make this goal a reality. The CLN Explorer lets the user draw a line around an area of interest (or upload parcel boundaries) and review a vegetation map, protected lands, priority streams, and whether the area falls within the Conservation Lands Network. A user can also create a Biodiversity Portfolio Report for the property that summarizes biodiversity attributes including vegetation type acreages, fine filter conservation targets, landscape unit(s), climate information, and the property's contribution to the conservation goals.

## Approach and Methodology

The Conservation Lands Network was developed collaboratively by scientists and resource managers representing more than 43 agencies, conservation nonprofits, universities, environmental consulting firms, and landowners. The project used the best available data, supplemented by expert opinion, to articulate shared conservation goals for the region and identify a network of conservation lands to meet those goals.

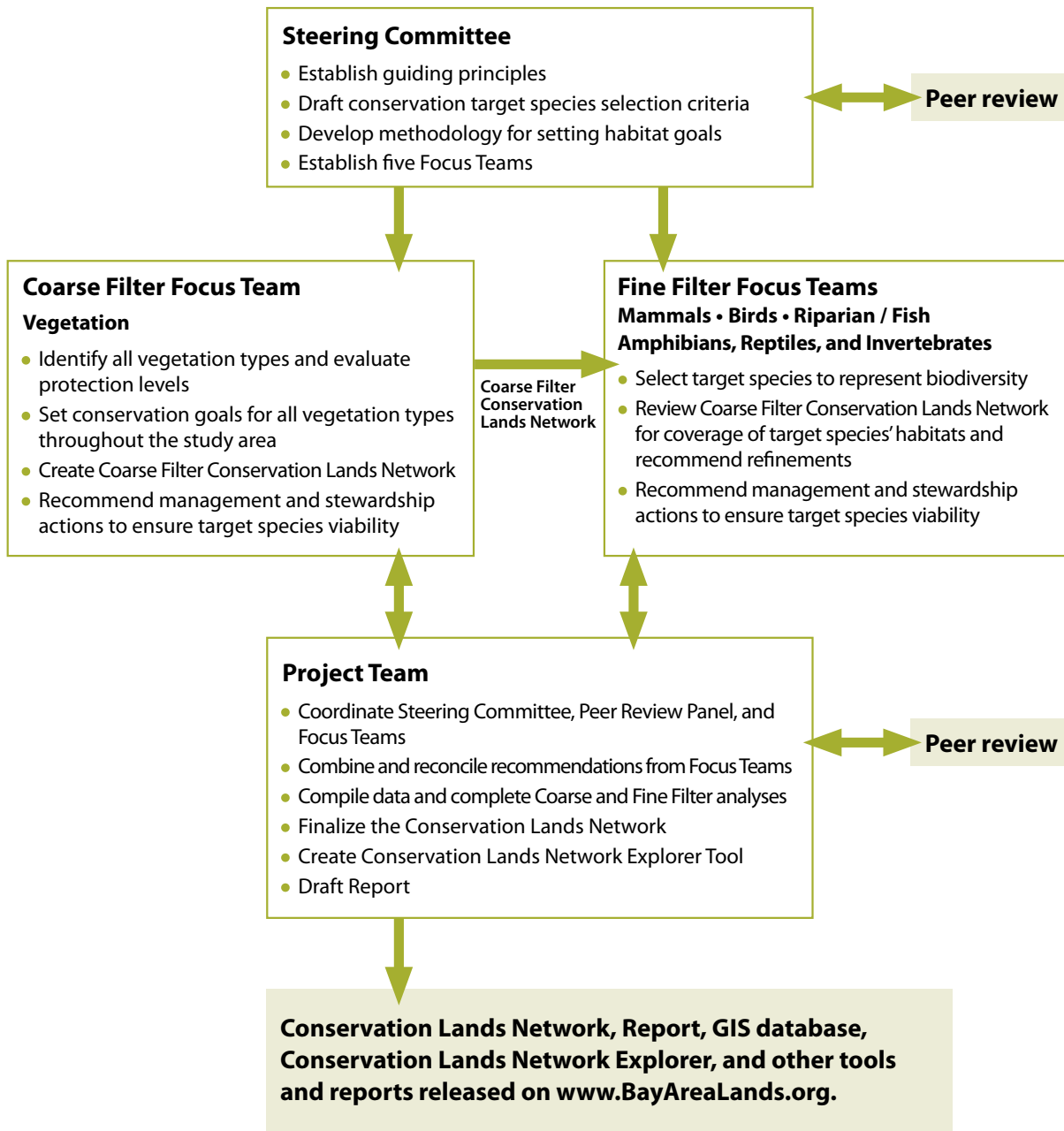
The Steering Committee and focus teams followed a two-step coarse filter/fine filter approach to conservation planning (Figure B). After defining 29 landscape units to capture geographic variations in the region, the team used a coarse filter or vegetation representation analysis to inventory all natural vegetation types in each Landscape Unit, and then – considering existing protection levels – established protection goals for each Landscape Unit. Conservation planning software combined the vegetation type conservation goals with numerous other variables (e.g., population density, distance to roads) to define the boundaries of the Coarse Filter Conservation Lands Network.

The fine filter focus teams then refined the Coarse Filter Conservation Lands Network during the fine filter analysis, identifying nearly 500 conservation targets of plants, mammals, fish, amphibians, reptiles, and invertebrates, and adjusting the network configuration to incorporate sufficient habitat for these target species. The teams also identified important habitat elements such as streams and riparian areas, unique soil types, and ponds as fine filter conservation targets.

Acknowledging the vital role of good stewardship to biodiversity, focus team members also addressed factors that shape ecological processes and directly affect target species viability – climate change, connectivity, floods, drought, nitrogen deposition, invasive plants and animals, grazing, disease, ecological succession, and fire. While the Conservation Lands Network is designed to support healthy, functioning ecosystems, specific management actions may still be necessary to maintain ecosystem functions.



**Figure B ■ The Conservation Lands Network Planning Process.** Led by guiding principles and methodology established by the Steering Committee, the project followed a peer-reviewed, two-step coarse filter / fine filter process to develop the Conservation Lands Network.



## The Conservation Lands Network 1.0

The resulting Conservation Lands Network 1.0 (Figure A) encompasses interconnected habitats with irreplaceable rare and endemic species as well as vast tracts of intact common vegetation types necessary for biodiversity conservation. It meets the conservation goals for the vast majority of nearly 1,000 vegetation type and fine filter targets, explicitly includes stream and riparian areas, and is relatively well connected. Because goals are met for species and habitats across their geographic ranges, the Conservation Lands Network has built-in resilience to climate change.

The Conservation Lands Network includes three categories of varying levels of significance. A fourth category indicates areas that should be considered for addition, pending further research.

### 1. Areas Essential to Conservation Goals (darkest blue)

The lands in this category support high-value conservation targets and/or are adjacent to existing protected lands. These lands serve vital functions in any network configuration, and attaining the conservation goals will be difficult without them.

### 2. Areas Important to Conservation Goals (medium blue)

These lands have high conservation suitability and are generally adjacent to Areas Essential to Conservation Goals and protected lands. There is more flexibility in this category, as areas with similar conservation values not currently included in the Conservation Lands Network may also meet the goals.

### 3. Areas of the Conservation Lands Network that are Fragmented (light purple)

These odd-shaped lands include conservation targets but have suffered substantial human impacts (intensive agriculture, urban, suburban or rural residential development). Special care is needed with these lands because the location and viability of the conservation targets may be compromised by map scale, incomplete or inaccurate data, and/or ecological degradation.

### 4. Areas for Further Consideration (light blue)

These are areas where additional lands should be added to the Conservation Lands Network (usually for connectivity), but more information is required to identify the lands with the highest biological values. Specific decisions in these areas can be made only with better data and finer-scale planning.

The Conservation Lands Network 1.0 is a work in progress, developed using the best available data. It is dynamic; it will change as additional lands are protected and as new data are incorporated. The most recent datasets and current Conservation Lands Network maps can be found at [www.BayAreaLands.org](http://www.BayAreaLands.org).

Courtesy Sonoma Land Trust / Stephen Joseph Photography





## Charting the Course: Implementing the Conservation Lands Network

Implementing the Conservation Lands Network means continuing and expanding the extraordinary collaboration and coordination of conservation actions that have made the Bay Area a leader in open space protection. By using the Conservation Lands Network as a guide, conservation practitioners, planners, policymakers, regulators, funders, and landowners can make knowledgeable conservation investments and planning decisions that take a step closer to attaining the mutual goal of conserving the region's diverse natural resources.

The following actions chart the course toward meeting the challenge of implementing the Conservation Lands Network.

### 1. Use the Conservation Lands Network as a guide.

The Conservation Lands Network and supporting tools – the Conservation Lands Network Explorer, the GIS Database, and other information at [www.BayAreaLands.org](http://www.BayAreaLands.org) – can be used by everyone to guide conservation actions such as selecting lands for purchase, conservation easements, or mitigation, establishing stream buffers, restoring habitat on rangelands, or incorporating resource lands into land use plans.

### 2. Create incentives for landowners.

The Conservation Lands Network is composed of both public and private lands. Working lands – both public and private – support biodiversity and are an important component of the Conservation Lands Network. It is essential to keep these lands in production. The sale of conservation easements by range and forestland owners can ensure operational viability while the lands continue to support invaluable habitat. Other voluntary programs offer technical and financial resource assistance to improve habitat on private lands. Supporting and expanding programs offered by the Natural Resources Conservation Service, US Fish and Wildlife Service, CAL FIRE, and the California Department of Fish and Game – as well as property tax relief programs like the Williamson Act – are vital to conserving biodiversity.

### 3. Support sound stewardship and adaptive management.

Identifying and conserving key habitats are only the first steps toward conserving biodiversity. Stewardship and adaptive management monitoring are equally crucial to maintain and restore the ecological processes and functions on which biodiversity depends.

### 4. Save our streams.

Streams are integral to ecosystem health and provide habitat for fish, mammals, birds, and other species. Riparian areas are especially important in an era of climate change offering cool, shady areas as temperatures increase, and linking lower with higher elevations giving plants and animals room to shift their ranges. Creating, restoring, and protecting riparian habitat buffers and stream channels are critical. Comprehensive, multi-stakeholder watershed plans have proven to be very effective for restoring riparian ecosystems.

### 5. Integrate into public policy.

Public policies are important tools for biological diversity conservation. The Conservation Lands Network offers a “greenprint” that should be incorporated into land use, watershed, transportation, and special planning processes such as the Sustainable Communities Strategy to focus development away from essential habitat. Protective policies – including those addressing stream buffers, forest and agricultural practices, and non-point source runoff – should be consistently enforced and coordinated among local and regional agencies.

## 6. Fund what works and create new funding sources.

Continued funding for successful programs is vital. The San Francisco Bay Program of the California Coastal Conservancy, California Wildlife Conservation Board, California State Parks, regional open space and park districts, and federal programs like the Land and Water Conservation Fund have created many of the open space lands enjoyed today. Consistent and increased funding is also needed for landowner incentive programs such as the Williamson Act, and those administered by the Natural Resources Conservation Service, CAL FIRE, US Fish and Wildlife Service, UC Cooperative Extension, and the California Department of Fish and Game. These important programs offer technical and financial assistance to farmers, ranchers, and forestland owners interested in improving habitat on their lands. In addition, new sources of consistent funding – especially for stewardship, management, and adaptive management strategies – need to be created.

## 7. Update and adapt: Conservation Lands Network 2.0.

Keeping the Conservation Lands Network current is imperative for success. New lands will be conserved, more accurate data will be gathered, and research will advance conservation planning concepts. The Critical Linkages: Bay Area and Beyond project is already developing detailed linkage data that will be integrated into the Conservation Lands Network and the Conservation Lands Network Explorer, and climate change research is underway that will also be applied to future versions.



Cait Hutnik / LightofMorn.com





## **Interpreting the Conservation Lands Network**

The establishment of upland habitat goals for the San Francisco Bay Area is a big step forward for strategic biodiversity conservation. Those interested in applying the goals are encouraged to review the approach used by the Upland Habitat Goals Project to understand how its findings are best translated to on-the-ground conservation. Chapter 11 provides a full discussion of how to interpret the Conservation Lands Network to guide conservation actions.

### **Key guidelines for interpreting the Conservation Lands Network**

**The Conservation Lands Network is dynamic.** The Conservation Lands Network is an analysis based on the distribution of conservation targets, protected lands, and threats – all of which change over time. As these elements change, so will the ideal configuration of areas to conserve. Some areas will be protected while others are developed; research and monitoring will offer new data and insights. The Conservation Lands Network is a work in progress, and it will be revised periodically. Consult [www.BayAreaLands.org](http://www.BayAreaLands.org) for the most up-to-date GIS datasets and Conservation Lands Network maps.

### **Areas outside of the Conservation Lands Network may have high conservation value.**

Although a property of interest may fall outside of the Conservation Lands Network, a site visit and biological survey may reveal extraordinary biological resources not evident in the current Conservation Lands Network Database.

**Ground truthing is essential.** The Conservation Lands Network offers users a first look at the natural resources that may be found in an area of interest. However, the project is regional in scope, covering 4.3 million acres, and while the best available data were used, they are inconsistent and incomplete. Users must visit sites of interest and conduct biological surveys to verify results from the Conservation Lands Network and its reports.

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This entire report (with appendices) is available at [www.BayAreaLands.org/reports](http://www.BayAreaLands.org/reports)

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## CHAPTER

# 1

# Introduction



Cait Hutnik / LightOfMorn.com

The San Francisco Bay Area is part of the California Floristic Province, one of only five regions in the world with a Mediterranean-type climate, and is noted for a high diversity of endemic species. Conserving this biodiversity requires the conservation of large blocks of interconnected habitat and the ecological processes and functions that support species richness. Healthy ecosystems offer numerous ecological services such as clean water and air, flood protection, and buffering against predicted impacts of climate change. Science has proven many times over the truth in John Muir’s famous quote, “When we try to pick out anything by itself, we find it hitched to everything else in the Universe.”

The Bay Area is a leader in open space protection – 1.2 million acres have been permanently protected throughout the Bay Area, and the region’s high quality of life is frequently attributed to, in part, its natural beauty and accessibility to open space. Still, the region lacked a shared, scientifically informed vision for the protection of our natural resources – a vision that allows strategic and efficient conservation actions.

The Bay Area Open Space Council, a collaborative of land protection and stewardship organizations working throughout the ten-county San Francisco Bay Area, has undertaken the San Francisco Bay Area Upland Habitat Goals Project, producing the first regional plan for conserving the Bay Area’s biological diversity. The project employed a collaborative scientific process to identify the types, amount, linkages, and distribution of habitats needed to sustain diverse and healthy communities of plant, fish, and wildlife resources.

The successful and continuing implementation of the Baylands Ecosystem Habitat Goals offered inspiration and a model to the Bay Area Open Space Council to undertake a similar project for upland habitats beyond the Bay’s edge. Completed in 1999 by a consortium of public agencies and conservation organizations, the Baylands project focused on the protection and restoration of historic tidelands around the Bay. Since that time, the Baylands Goals attracted \$200 million in implementation funding in the Proposition 50, the Water Quality, Supply and Safe Drinking Water Projects Bond passed in 2002 and contributed to the protection of more than 45,000 acres of wetlands. This effort demonstrated that when scientists and land managers are brought together to create a scientific vision for conservation, conservation practitioners, decision makers, and funders will respond by assisting with implementation.

The Upland Habitat Goals Project identified a Conservation Lands Network (CLN) composed of both public and private lands. It builds from the existing protected lands and adds other areas important to biodiversity that should be conserved. Conservation can be accomplished using a variety of means, including outright purchase or conservation easement acquisition, cooperative agreements with private landowners or other voluntary incentive programs, and land use policies. Working lands provide valuable habitat, and the project places a high priority on keeping ranch and forest lands in production. The CLN is intended to serve as a guide to help conservation practitioners, policymakers, regulators, and funders make informed decisions about investments in biodiversity conservation that support the shared goal of healthy ecosystems throughout the Bay Area.

It is critical to the Bay Area Open Space Council and the project funders that conservation practitioners and others have ready access to the recommendations,



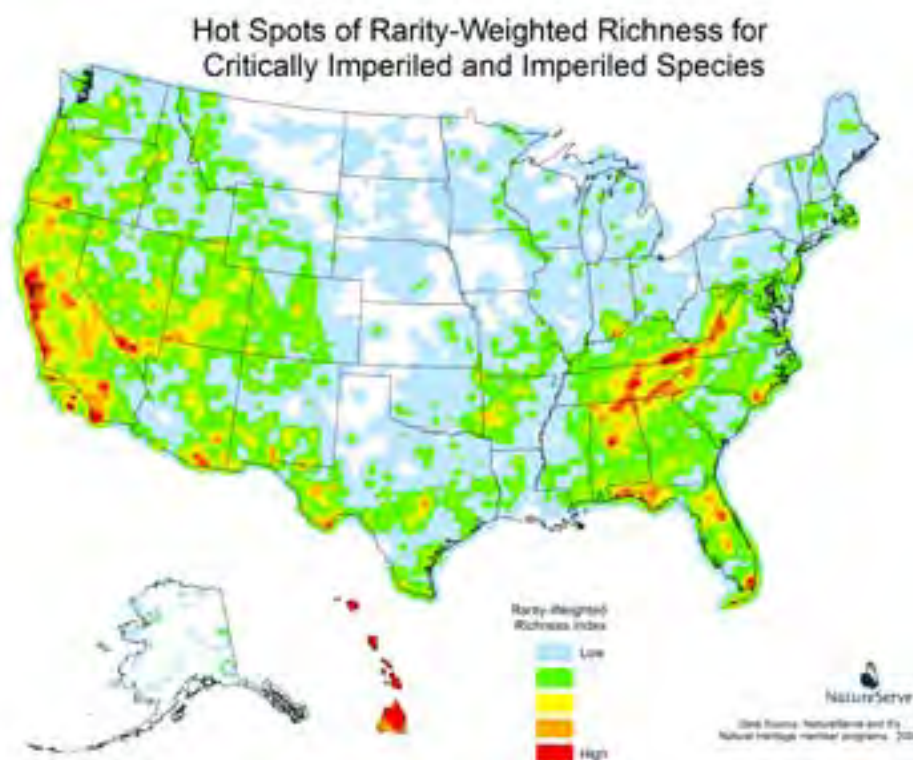
methodology, and data sources used in the project. The project website, [www.BayAreaLands.org](http://www.BayAreaLands.org), fulfills this commitment with maps, data sources, reports, meeting summaries, best practices for applying the recommendations, and – most significantly – the Conservation Lands Network Explorer. This online tool, accessible to all users regardless of GIS skill level, can be used to inform conservation decisions. Users can explore biological resources within a property or area of interest, see how those resources fit into the Conservation Lands Network, and assess the area’s contribution toward reaching the goals. Chapter 11 offers guidance on how to interpret and best apply the CLN recommendations.

This report describes the methodology, conservation goals, implementation strategies, research needs, and stewardship recommendations that will help protect or restore the ecological processes so vital to sustaining diverse and healthy natural communities. The Upland Habitat Goals Project Report, Conservation Lands Network Explorer, and GIS Database are designed to inform conservation strategies and management policies of public resource agencies, nonprofit conservation organizations, landowners, local government, elected officials, and private foundations seeking to conserve, enhance, and restore the biological diversity of upland habitats.

## Bay Area Biodiversity Threatened

The Mediterranean-type climate of the California Floristic Province is renowned for a large number of endemic species. Conservation International, The Nature Conservancy, and others have identified California, including the Bay Area, as a biodiversity hotspot: a region with high biological diversity coupled with extensive habitat loss ([www.biodiversityhotspots.org](http://www.biodiversityhotspots.org) – see Figure 1.1). Similarly, the Center for Biological Diversity cites the Bay Area as one of the six most important biodiversity hotspots in the country ([www.biologicaldiversity.org/campaigns](http://www.biologicaldiversity.org/campaigns)).

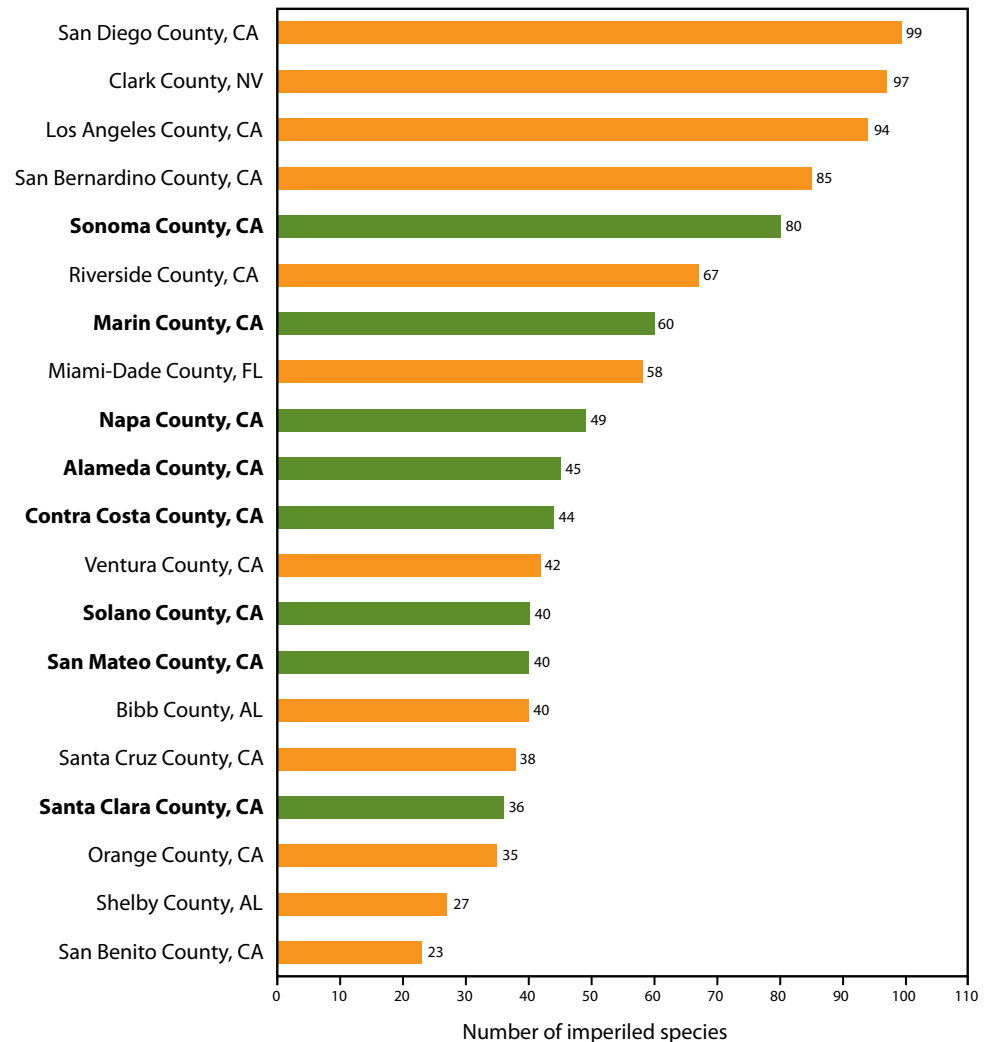
**Figure 1.1 ■ Biodiversity Hotspots in the United States.** Map from NatureServe. 2008. NatureServe’s Central Databases. Arlington, VA. USA.





In 2005 Smart Growth America, National Wildlife Federation, and NatureServe released *Endangered by Sprawl: How Runaway Development Threatens America's Wildlife* (Ewing *et al.* 2005). Examining the fastest-growing metropolitan regions within the US, the report identified 20 counties across the nation with the largest number of imperiled species. Eight of those 20 counties are in the Bay Area (Figure 1.2).

**Figure 1.2 ■ Endangered by Sprawl.** Imperiled species by county, for the top 20 counties among the nation's 35 fastest-growing metropolitan areas. Eight of the counties (shown in green) are within the Upland Habitat Goals Project study area. Adapted from Ewing *et al.* 2005.



Similarly, Greenbelt Alliance's 2006 report, *At Risk: The Bay Area Greenbelt* reviewed planning documents and proposed developments to identify more than 400,000 acres in the Bay Area that are at high or medium risk of development in the next 30 years. The lands classified as low risk on the map in Figure 1.3 represent an opportunity to conserve large tracts of interconnected landscapes that are essential to conserving healthy ecosystems. Conservation of these landscapes, many of which are working forests and ranches, may be accomplished by conservation easements or voluntary landowner agreements, allowing the properties to remain in production and private ownership.

**The biological significance of this region coupled with the continuing threat of development means that the time is right to identify lands for conservation.**



2. Develop a science-based process for establishing habitat goals that draws upon the expertise of scientists, resource managers, landowners, and other conservation practitioners from a broad array of entities with the common goal of conserving biodiversity.
3. Develop an analytical framework and compile data that:
  - Identifies the biological values associated with upland habitats and larger landscapes. Uses consistent and comprehensive data for the entire region where available.
  - Inventories current habitats and includes a historical baseline to evaluate habitat loss and restoration potential. (Funding was not available for such an evaluation.)
  - Supports development of alternative conservation area designs and scenarios that include processes and functions necessary to preserve ecosystem functions.
  - Relies on existing data as much as possible but generates new data to the extent funding is available. (Funding was not available for biological inventories.)
  - Incorporates more detailed datasets for particular species or geographic areas where available.
  - Is readily accessible via the Internet to local, regional, state, and federal agencies and nonprofit conservation organizations, city and county planners, and other conservation practitioners.
  - Can be updated incrementally by qualified individuals following metadata information requirements as new data becomes available.
4. Combine physically practical and financially feasible recommendations along with a more visionary approach where possible.
5. Respect, and incorporate where possible, the habitat goals of local, regional, state, and federal resource agencies and nonprofit conservation organizations, including habitat conservation plans.
6. Recognize the role some forms of agriculture and private landowners play in providing and protecting wildlife habitat.
7. Identify and recommend additional specific research needs for both the short- and long-terms.
8. Provide an overview of tools for successfully implementing the goals.
9. Review and recommend stewardship and management practices required for viability of biodiversity conservation targets.
10. Facilitate the implementation of the goals by widely distributing the final recommendations to encourage conservation practitioners to use the report as a guide, land use planners to incorporate the recommendations in land use plans and policies, and increase the amount of funding available to permanently protect key habitats and linkages. Audiences include public resource and regulatory agencies, nonprofit conservation organizations, landowners, environmental consultants, land use planners, public and private funders, and elected officials.
11. Develop the organizational capacity to develop, maintain, and update the GIS Database and track progress toward accomplishing the goals as funding allows.

With the exception of those requiring additional funding, the objectives were accomplished by a planning process that involved a diverse array of scientists and land managers in all phases of data compilation and analysis, and an extensive outreach component that engaged additional stakeholders.

## Products of the Upland Habitat Goals Project

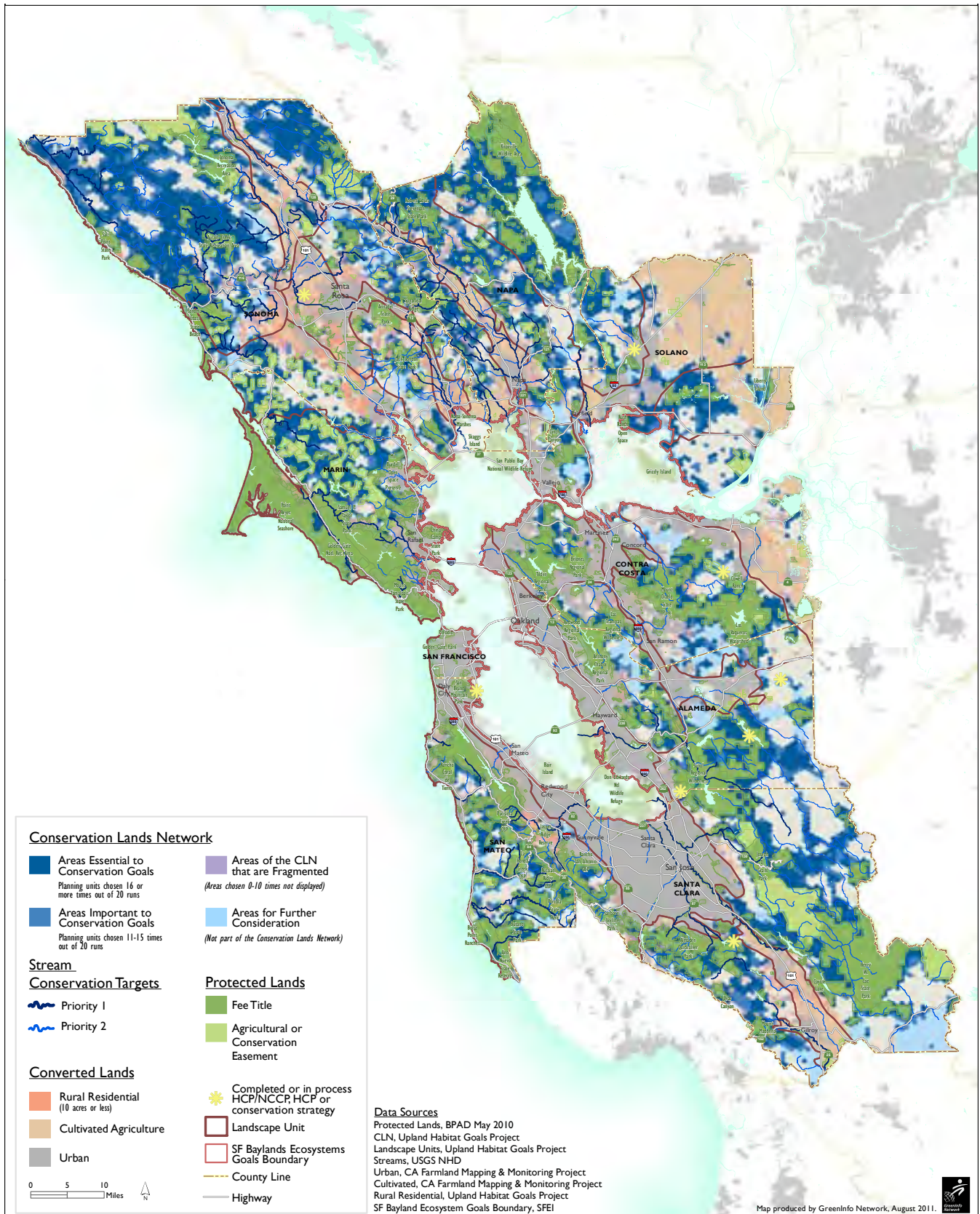
All of these products are available online at [www.BayAreaLands.org](http://www.BayAreaLands.org).

The Upland Habitat Goals Project developed the following resources to provide transparency and access to the project's data and methodology and ensure implementation of the recommendations. The project's final products – the report, Conservation Lands Network, website, database, and CLN Explorer – make the Conservation Lands Network and recommendations readily available regardless of a user's GIS skill level.

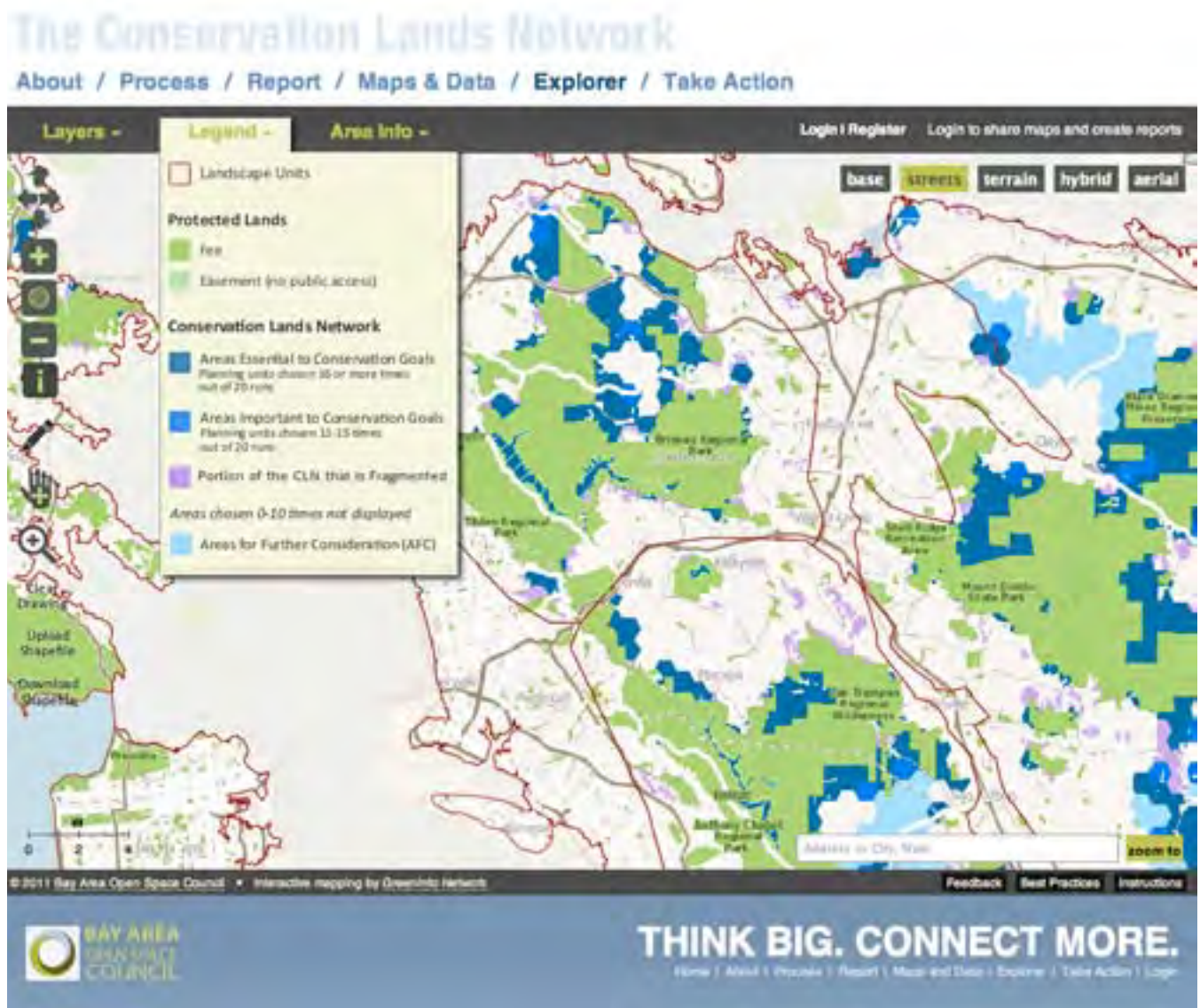
1. **Conservation Lands Network.** This map (Figure 1.4) illustrates interconnected lands in the nine Bay Area Counties that represent the mosaic of habitats and linkages needed for biodiversity conservation. The Conservation Lands Network includes lands already protected as well as those proposed for conservation; it is not a list of priority properties.
2. **Conservation Lands Network Explorer.** This web-based interactive mapping tool (Figure 1.5) offers ready access to the Conservation Lands Network data and recommendations. A conservation practitioner or land use planner can outline a property or area of interest to display a Biodiversity Portfolio Report detailing the property's vegetation types, conservation suitability, proximity to or inclusion in the Conservation Lands Network, presence of conservation targets, and a host of additional information.
3. **Report.** This report is available in hard copy (in limited numbers) and as a download from [www.BayAreaLands.org](http://www.BayAreaLands.org). The report describes the methodology, conservation targets, focus team recommendations, goals, Conservation Lands Network, implementation strategies, stewardship recommendations, and data gaps.
4. **Conservation Lands Network GIS Database.** A fully integrated GIS Database is also available for those interested in conducting their own detailed analyses for a specific subregion. All publicly available datasets used for the analyses have been organized in intuitive directories with consistent symbology, and are available for download in ESRI's ArcGIS format from the project's website, [www.BayAreaLands.org/gis](http://www.BayAreaLands.org/gis).
5. **Website ([www.BayAreaLands.org](http://www.BayAreaLands.org)).** The project website includes the Conservation Lands Network Explorer, the GIS Database with metadata, a downloadable version of this report, maps, and summaries from all the Steering Committee and Focus Team meetings. It also contains a description of the project, data and methods, results and recommendations, maps, contact information, and much more. The website is the best source of the current version of the Conservation Lands Network, which will be updated periodically.
6. **Analytical Framework.** The project's conservation planning analytical framework is applicable to smaller jurisdictions for finer-scale planning. The Open Space Council has made the planning tools and expertise accessible to those who are interested in fine-scale planning.
7. **Updates and Biennial Report Card.** As new data become available, and as additional lands are conserved or lost to development, the Conservation Lands Network will be updated. The Open Space Council intends to update the Conservation Lands Network periodically, and to produce a biennial report card that will measure progress toward meeting the goals.



**Figure 1.4 ■ Conservation Lands Network.** Building from existing protected lands, the Conservation Lands Network captures the types, amounts, and distribution of habitats needed for biodiversity conservation.



**Figure 1.5 ■ Conservation Lands Network Explorer.** This web-based interactive mapping tool offers ready access to the Conservation Lands Network data and recommendations. It can be found at [www.BayAreaLands.org/explorer](http://www.BayAreaLands.org/explorer).



## Geographic Scope

The Upland Habitat Goals Project geographic scope (Figure 1.6) covers the nine-county Bay Area, beginning at the inland edge of the baylands (historic tidelands) that were included in the San Francisco Baylands Ecosystem Habitat Goals Project, and extending to the outer county boundaries.

The study area corresponds to the jurisdictions of the Bay Area Open Space Council and the San Francisco Bay Program of the Coastal Conservancy, a primary funder of habitat protection and restoration in the region. (It should be noted that in 2009, Santa Cruz County was added to the Open Space Council's region, but it was not part of the Upland Habitat Goals Project. Santa Cruz County completed its own conservation planning process – *Conservation Blueprint* – that will be incorporated into CLN Explorer.)

**Figure 1.6 ■ Geographic Scope of the Upland Habitat Goals Project.** The project covers the nine counties of the Bay Area, but excludes historic tidelands that were the focus of the Baylands Ecosystem Habitat Goals.



Although the project's boundaries are political rather than ecological, they include a range of unique habitats and capture critical connections between the three ecoregions that intersect here – the Central Coast, North Coast, and the Central Valley. Landscape-scale factors and linkages to areas outside of the study area but vital to species viability are incorporated into the Conservation Lands Network.

## Project Participants

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The Baylands Ecosystem Habitat Goals Project is successful, in part, because of the diverse array of scientists who participated in that project. They proffered their expertise to fortify the project's scientific integrity, and – in the process – became vested in its implementation. Hoping to replicate this success, the Upland Habitat Goals Project included a similarly broad group of resource managers and scientists from public agencies, nonprofits, universities, and consulting firms – beginning in 2004 by convening an Advisory Committee of 13 resource managers and scientists to guide the approach and structure of the project. The participants provided a broad and deep range of scientific input, and their continued support is integral to the implementation of the CLN.

### Advisory Committee

Virginia Boucher, University of California, Davis, UC Reserve System  
Ann Buell, California State Coastal Conservancy  
Dick Cameron, The Nature Conservancy  
Janice Gan, California Department of Fish and Game  
Geoff Geupel, PRBO Conservation Science  
Rainer Hoenicke, PhD, San Francisco Estuary Institute  
Rick Hopkins, Live Oak Associates, Inc.  
Kathleen Brennan Hunter, Sonoma County Agricultural Preservation & Open Space District  
Jeff Kennedy, University of California, Davis, Information Center for the Environment  
Mischon Martin, Marin Open Space District  
Brad Olson, East Bay Regional Park District  
Don Rocha, Santa Clara County Parks and Recreation Department  
Cindy Roessler, Midpeninsula Regional Open Space District

In 2005, the Advisory Committee transitioned into a larger Steering Committee that provided direction and guidance to the Project Team on all aspects of the project.

### Steering Committee

Morpheus Anima, USDA Natural Resources Conservation Service  
Laura Baker, California Native Plant Society  
Kim Batchelder, Sonoma County Agricultural Preservation and Open Space District  
Tina Batt, California Rangeland Trust  
Virginia Boucher, University of California, Davis, UC Reserve System  
Ann Buell, California State Coastal Conservancy  
Dick Cameron, The Nature Conservancy  
Josh Collins, PhD, San Francisco Estuary Institute  
Jill Demers, San Francisco Bay Bird Observatory  
Melanie Denninger, California State Coastal Conservancy  
Wendy Eliot, Sonoma Land Trust  
Darren Fong, US National Park Service  
Keenan Foster, Sonoma County Water Agency  
Janice Gan, California Department of Fish and Game  
Geoff Geupel, PRBO Conservation Science  
Janet Hanson, San Francisco Bay Bird Observatory  
Marla Hastings, California State Parks  
Nadine Hitchcock, California State Coastal Conservancy  
Rainer Hoenicke, PhD, San Francisco Estuary Institute  
Terry Huff, USDA Natural Resources Conservation Service  
Laura Kindsvater, PhD, Save the Redwoods League  
Kirk Lenington, Midpeninsula Regional Open Space District

#### **The Steering Committee and Project Team**

began meeting regularly in February 2006. With the establishment of the focus teams and peer review panels, the project eventually engaged more than 125 scientists and resource managers from throughout the Bay Area. The work done over the subsequent four and a half years is described in this document and at [www.BayAreaLands.org](http://www.BayAreaLands.org).



Mischon Martin, Marin County Open Space District  
Lech Naumovich, California Native Plant Society  
Ryan Olah, US Fish and Wildlife Service  
Paul Ringgold, Peninsula Open Space Trust  
Tom Robinson, Sonoma County Agricultural Preservation and Open Space District  
Don Rocha, Santa Clara County Parks and Recreation Department  
Sandra Scoggin, San Francisco Bay Joint Venture  
Cyndy Shafer, California State Parks  
Kim Squires, US Fish and Wildlife Service  
Beth Stone, East Bay Regional Park District  
Diana Strahlberg, PRBO Conservation Science  
Darrel Sweet, California Rangeland Trust

Day-to-day management of the project was handled by the three-member Project Team.

### **Project Team**

Ryan Branciforte, Director of Conservation Planning, Bay Area Open Space Council  
Nancy Schaefer, Project Manager, Land Conservation Services, Consultant to Bay Area Open Space Council  
Stuart B. Weiss, PhD, Science Advisor, Creekside Center for Earth Observation, Consultant to Bay Area Open Space Council

## **Partner Outreach**

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Following the successful model of the Baylands Ecosystem Habitat Goals, the Upland Habitat Goals Project actively sought involvement and input from numerous conservation practitioners to improve the quality of the results and engage those who are in a position to implement the recommendations. With input from the Steering Committee and technical assistance from the National Park Service Rivers, Trails and Conservation Assistance program, a Partner Outreach Plan (Appendix A) was developed to identify key audiences and corresponding messages. Key audiences included public agencies, nonprofit conservation organizations, environmental consulting firms, universities, private landowners, environmental regulators, city and county land use planners, public and private funders, and elected officials. The Public Outreach Group provided invaluable assistance shaping messages and outreach materials.

### **Public Outreach Group**

Marcia Brockbank, San Francisco Estuary Project  
Elizabeth Byers, Communications Consultant  
Rosemary Cameron, East Bay Regional Park District  
Barbara Rice, National Park Service Rivers, Trails and Conservation Assistance Program

More than 125 scientists and resource managers representing more than 43 public resource and regulatory agencies, conservation nonprofits, universities, environmental consulting firms, and landowners participated in the goal-setting process. The project team gave presentations and held meetings with more than 30 individuals representing additional resource agencies and organizations, landowners, and funders not directly involved in the goal-setting process.

A second outreach phase, Public Outreach and Implementation, coincides with the release of this report. The second phase emphasizes those who can help implement the goals via land or conservation easement acquisition, habitat restoration, landowner habitat incentive programs, policy protections, or funding for such actions. Key audiences are public resource and regulatory agencies, nonprofit conservation organizations, landowners, land use and transportation planners, public and private funders, and elected officials.



Stuart B. Weiss

## Conservation Planning and Stewardship

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Conserving biodiversity involves two key steps. The first step is to identify habitats to be conserved – the focus of the Upland Habitat Goals Project. The second step is stewardship – articulating, funding, and employing sound stewardship practices that sustain the ecological processes and functions essential for species viability. Simply holding a large tract of land in public ownership will not meet biodiversity objectives if the managing entity is unable to fund invasive species control and endemics are crowded out.

Many public agencies and conservation organizations want to implement sound stewardship practices, but have difficulty procuring operations and management funding. This chronic lack of management funds is a significant funding gap that must be closed to successfully conserve biodiversity. In support of good stewardship, the Upland Habitat Goals Project highlights stewardship requirements for many of the target species, and notes references for specifics. A consistent source of stewardship funding is essential for achieving the goals of the Conservation Lands Network.

## Upland Habitat Goals and Other Planning Efforts

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The Upland Habitat Goals Project is one of several habitat planning processes in the region. It is the last of a trilogy of ecosystem planning efforts that includes the Baylands Ecosystem Habitat Goals and the San Francisco Bay Subtidal Habitat Goals Project. These three projects cover the continuum of habitat types from the bottom of the Bay to tidal wetlands and grassland transition zones to the upper watersheds. The most relevant planning efforts and the relationship to the project are discussed here.

**San Francisco Baylands Ecosystem Habitat Goals (1999).** The Baylands Habitat Goals project covers the historic tidelands of San Francisco, San Pablo and Suisun Bays and was the inspiration for the Upland and Subtidal Habitat Goals Projects. See [www.sfei.org/documents/baylands-goals](http://www.sfei.org/documents/baylands-goals).

**San Francisco Bay Subtidal Habitat Goals (2010).** The recently released Subtidal Habitat Goals Project report articulates goals and restoration recommendations for six submerged habitat types found in San Francisco Bay. See [www.sfbaysubtidal.org](http://www.sfbaysubtidal.org).

**California Wildlife: Conservation Challenges (California Department of Fish and Game, 2007).** California's Wildlife Action Plan ([www.dfg.ca.gov/wildlife/WAP](http://www.dfg.ca.gov/wildlife/WAP)) was completed as a requirement to receive funding from the federal State Wildlife Grants Program enacted by Congress in 2000. The plan divides the state into nine regions, with the San Francisco Bay Area split among three – North Coast-Klamath, Central Coast, and Central Valley-Bay Delta. The document addresses three main questions:

1. What are the species and habitats of greatest conservation need?
2. What are the major stressors affecting California's native wildlife and habitats?
3. What are the actions needed to restore and conserve California's wildlife, thereby reducing the likelihood that more species will approach the condition of threatened and endangered?

The Upland Habitat Goals Project fulfills the report's recommendation to develop multi-county regional habitat conservation and restoration plans.

**San Francisco Bay Joint Venture.** The Joint Venture utilized the Baylands Goals recommendations to write *Restoring the Estuary: A Strategic Plan for the Restoration of Wetlands and Wildlife in the San Francisco Bay Area*, which is focused on wetlands and waterfowl. The plan sets acreage goals for bay habitats, seasonal wetlands, creeks and lakes. In 2004, the Joint Venture broadened its focus to include habitats for all birds and will undertake updates to its plan to incorporate more detailed information on seasonal wetlands and addressing climate change. See [www.sfbayjv.org/strategy.php#implementation\\_strategy](http://www.sfbayjv.org/strategy.php#implementation_strategy).

**Conservation Blueprint for Santa Cruz County (2011).** Santa Cruz County, added to the Bay Area Open Space Council's boundary in 2009 and not included in the Upland Habitats Goals Project, has embarked on a comprehensive, county-wide conservation planning process called the Conservation Blueprint for Santa Cruz County. The Blueprint, under the guidance of the Land Trust of Santa Cruz County, has taken a multi-benefit approach to conservation incorporating biodiversity, water resources, working lands (forest, farm, and ranch), recreation, and healthy communities. The data and recommendations from the Blueprint will be added to CLN Explorer. See [www.conservesantacruz.org](http://www.conservesantacruz.org).

**Green Vision 2025 (2008).** The Upland Habitat Goals Project is informing two additional Bay Area planning efforts. The first is Green Vision 2025, a collaboration between the Open Space Council, Greenbelt Alliance, Association of Bay Area Governments, and the California State Coastal Conservancy to advance the conservation of open space lands. After many regional meetings of open space agencies and organizations, Green Vision issued the report *Golden Lands, Golden Opportunity: Preserving Vital Bay Area Lands for all Californians* in 2008. The report states the case for conserving lands with scenic, historic, recreational, habitat, archaeological, and agricultural values. The Conservation Lands Network provided the foundation for the wildlife habitat recommendations in the report. See [www.OpenSpaceCouncil.org](http://www.OpenSpaceCouncil.org).

**FOCUS.** The second collaborative planning effort informed by the Upland Habitat Goals Project, FOCUS is led by the Association of Bay Area Governments in partnership with the Bay Conservation and Development Commission, Metropolitan Transportation Commission, the Joint Policy Committee, and the Bay Area Air Quality Management District. FOCUS is a voluntary, incentive-based regional development and conservation strategy promoting compact land use patterns. Using the CLN and Golden Lands report, the Bay Area Open Space Council has helped FOCUS identify Priority Conservation Areas. FOCUS is a unique collaboration for the Bay Area Open Space Council with non-traditional partners from the planning community, and is bringing attention to the development side of the conservation issue. See [www.BayAreaVision.org](http://www.BayAreaVision.org).

**California Rangeland Conservation Coalition Focus Area Prioritization (2007).** The Coalition, a partnership of ranchers, environmentalists, and government agencies, recognized the dual significance of rangeland to ranching industry and biodiversity, and completed a planning exercise that prioritized rangelands (Figure 1.7). The rangeland study area overlaps with that of the Upland Habitat Goals Project. See [www.carangeland.org/images/Rangeland\\_Coalition\\_Map.pdf](http://www.carangeland.org/images/Rangeland_Coalition_Map.pdf).



John Woodbury



**Habitat Conservation Plans and other Conservation Strategies.** The Bay Area is home to several Habitat Conservation Plans (HCPs), including the first in the nation – the HCP for San Bruno Mountain. So far, the Bay Area has only one approved Habitat Conservation Plan/Natural Communities Conservation Plan (HCP/NCCP) – the East Contra Costa County Habitat Conservation Plan. The Santa Clara Valley HCP/NCCP and the Altamont Pass Wind Resources Area HCP/NCCP are in the planning phase.

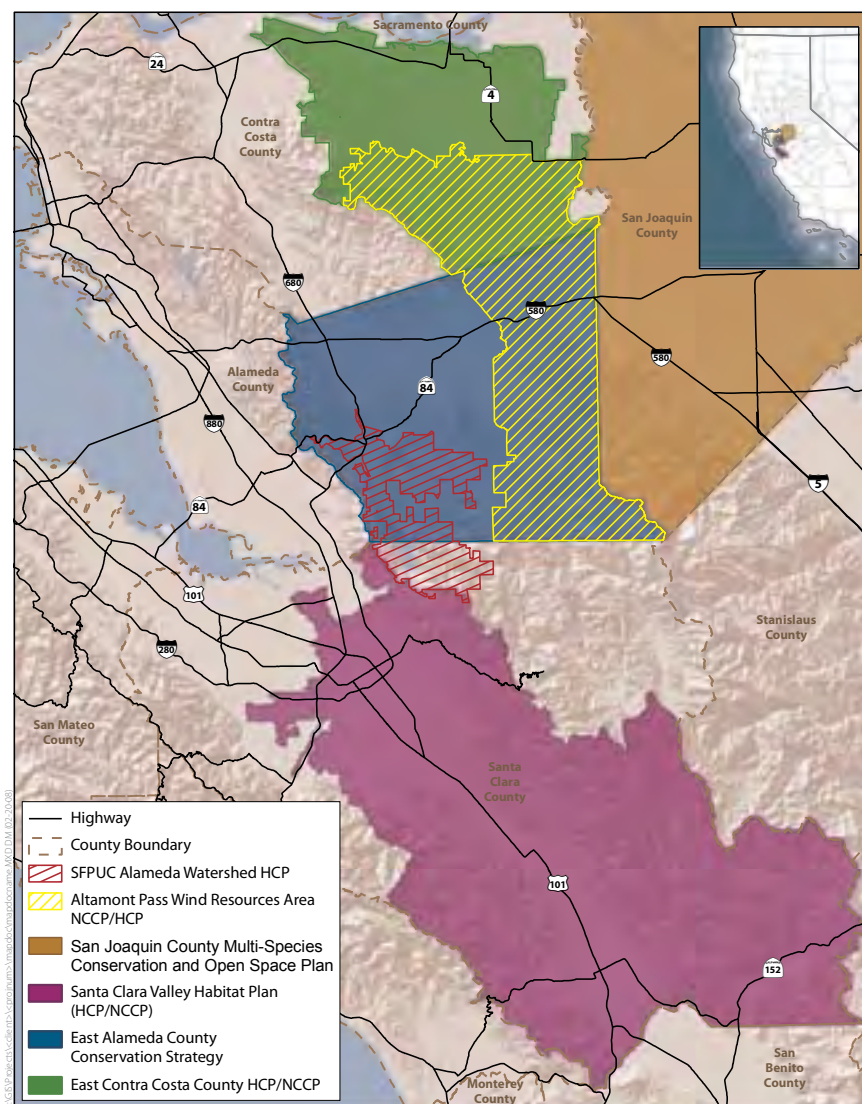
In addition, Alameda County is preparing a conservation strategy for the eastern portion of the county. In the North Bay, the Santa Rosa Plain Conservation Strategy was completed in 2005. The Solano County Water Agency is preparing an HCP for the county, and the San Francisco Public Utilities Commission is developing an HCP for its lands in the Alameda Creek Watershed.

HCPs and HCP/NCCPs conduct detailed, fine-scale analyses for areas significantly smaller than the Upland Habitat Goals Project and should be reviewed alongside the Conservation Lands Network. Where the maps differ, HCP maps – especially those of approved HCP/NCCPs – should be used to guide local conservation action.

Figure 1.8 illustrates areas covered by the most recent HCPs.

**Figure 1.8 ■ Scope of Major Conservation Plans in the East and South Bay.**

Figure created by ICF International.





## CHAPTER

# 2

# Upland Habitats Past and Present



Lech Naumovich Photography

## Upland Habitats Defined

In the Upland Habitats Goals Project, the term *upland habitats* refers to all habitats, including riparian areas and wetlands, from the inland edge of the baylands to the outer boundaries of the nine Bay Area counties. The project's geographic scope is complementary to that of the Baylands Ecosystem Habitat Goals, which cover the historic tidelands, and the San Francisco Bay Subtidal Habitat Goals, which focus on submerged habitats.

## Vegetation of the Bay Area

From towering redwood and Douglas-fir forests, to evergreen hardwood forests, rolling oak woodlands, impenetrable hillsides of chaparral, semi-desert grasslands on the fringe of the Central Valley, and unique specialized habitats such as vernal pools, serpentine barrens, and closed-cone conifer forests, the diversity of vegetation in the Bay Area is exceptional. Vegetation structure, or physiognomy, is a function of local climate and water balance accentuated by the region's semi-arid Mediterranean-type climate with its cool rainy season and long dry season. Water is at a premium, and where water is more available, vegetation has greater productivity and biomass.

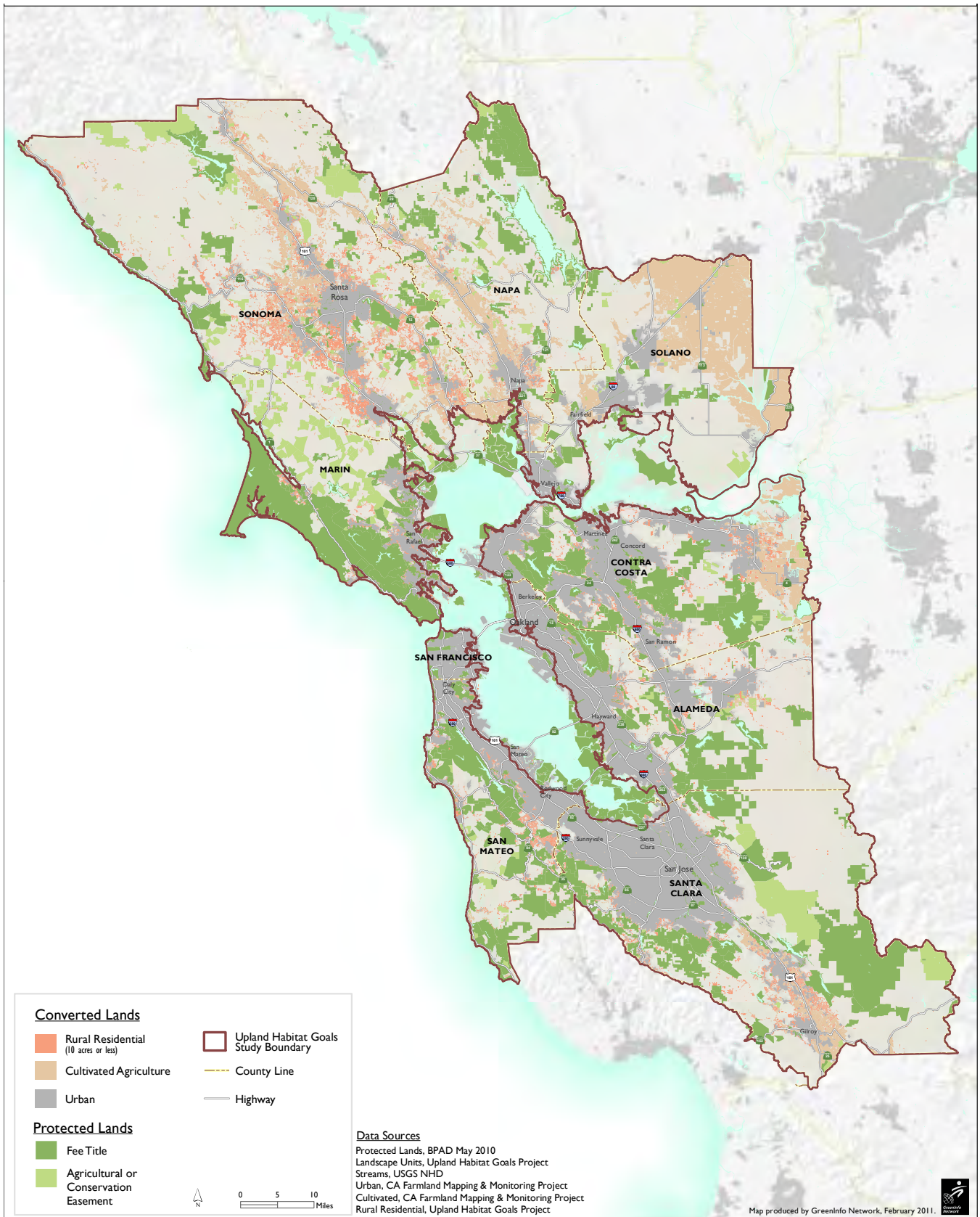
Local mosaics of contrasting vegetation types, such as moist redwood forest, coastal scrub, semi-arid chaparral, and grasslands within a matrix of coastal evergreen forests, reflect steep climatic gradients at multiple scales – coastal to inland, valley to mountain, north-slope to south slope, and ridgetop to valley bottom. Furthermore, climate intersects with geology and soils, and natural and anthropogenic disturbance regimes drive dynamic vegetation shifts through time (Barbour *et al.* 2007).

According to the *Jepson Manual* (Hickman 1993), more than 3,000 plant species occupy these varied environments, loosely organized into communities comprised of innumerable local combinations of species (Sawyer *et al.* 2009; Thorne *et al.* 2009). In addition to this richness, the Bay Area is home to numerous endemic species with limited geographic ranges – sometimes only a few square miles or less. This spatially complex and dynamic vegetation mosaic is the foundation of Bay Area biodiversity, and is therefore central to the conception and design of the Conservation Lands Network.

## Land Uses in the San Francisco Bay Area

The nine counties of the Bay Area total approximately 4.3 million acres (exclusive of the Bay and baylands). Of this total, roughly 1.24 million acres have been converted from natural land cover to other land uses with approximately 720,000 acres in urban/suburban development, 370,000 acres in cultivated agriculture, and 150,000 acres in rural residential uses (parcels less than 10 acres in size). Conservationists have protected 1.2 million acres for open space, natural resource, and agricultural values, but not all protected lands retain their natural land cover.

**Figure 2.1 ■ Map of Land Uses in the San Francisco Bay Area.** Approximately 1.24 million acres of habitat have been lost, degraded, or fragmented due to conversion to urban, rural residential, and cultivated agricultural uses.





## Vegetation Past

The Bay Area landscape has changed dramatically in the past 250 years. Understanding these changes offers insights into the dynamics of upland habitats today. Pre-European vegetation was heavily influenced by dense populations of Native Americans who manipulated large parts of the landscape through fire and other disturbances for thousands of years (Anderson 2005). Native ecosystems were continuous from the bayshore to the mountains, and across the flat valleys. Colonization by the Spanish in the 1700s, followed by the Gold Rush in the mid-1800s, resulted in dramatic changes to the landscape. Native American populations were decimated, introduced plants and overgrazing transformed grasslands, hunting drastically reduced wildlife populations, forests were felled, wetlands drained, valley bottoms cultivated, and urban centers established.

Historical ecologies of the Santa Clara and Napa Valleys (Grossinger *et al.* 2008a, 2008b) paint a very different picture of the historic distribution of vegetation. The loss of valley floor habitats in and around active floodplains – mosaics of riparian woodlands, freshwater wetlands, vernal pools, and oak savannahs – has been especially severe across the region. Most valley bottoms had been converted by the early 20th century. The loss of old-growth forests was also almost complete, and early conservation efforts beginning in the late 19th century were focused on protecting remaining old-growth redwood stands.

After World War II, explosive growth led to conversion of agricultural lands on the valley floors to urban and suburban uses. This produced nearly continuous urbanization, suburban sprawl into the smaller valleys and hills, and massive transformation of creeks and rivers for flood control and water supply. In the 1960s, concern over sprawl and diminishing open space led to the establishment of a vigorous land conservation community in the Bay Area (Walker 2007), which has since conserved more than a million acres. In addition, more than two million acres of unprotected lands remain as open space today, due to remoteness, ruggedness, land use regulations, and economic factors.

A baseline for vegetation from the 1930s is captured by the Wieslander Maps ([hvtm.berkeley.edu](http://hvtm.berkeley.edu)), a series of maps compiled by the US Forest Service for the forested regions of California including much (but not all) of the Bay Area. Ongoing analysis will document changes in vegetation over the past 80 years (J. Thorne pers. comm. 2010), and will eventually be evaluated for implications to the Conservation Lands Network.



Scott Hein

## Vegetation Present

Today, open space in Bay Area upland habitats (both protected and unprotected), consists of approximately 360,000 acres of conifer forest, 400,000 acres of evergreen hardwood forests, 500,000 acres of oak woodlands, 1,015,000 acres of herbaceous vegetation types (primarily annual grasslands), and 390,000 acres of shrublands, as illustrated in Figure 2.2. In addition, nearly 100,000 acres of various serpentine vegetation types support unique species mixes and high endemism. These habitats are spread across the region where numerous small and large mountain ranges create islands of native vegetation that are tenuously linked across developed valleys.

**Figure 2.2 ■ Remaining Acreage of Upland Habitats in the San Francisco Bay Area.**

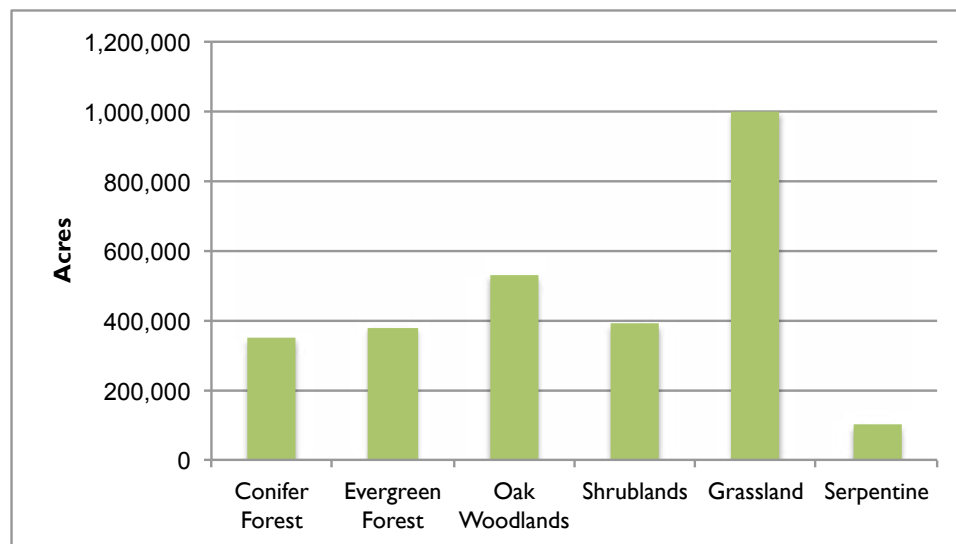


Figure 2.3 presents the broad groupings of vegetation types along with the specific vegetation types included in each grouping and the remaining acreage for each.

The impacts of development on biodiversity are severe, ranging from outright destruction of habitats, to fragmentation and interruptions of ecological processes. Not surprisingly, the Bay Area supports 97 listed endangered or threatened species (CNDDDB 2010), many of which are known from no place else, as well as numerous other species that might be listed based on rarity and threat.

However, many largely intact ecosystems remain across the region and continue to maintain high plant and vegetation diversity. These ecosystems support large animals highly valued by the public including mountain lions, tule elk, black bear, and bald eagles, along with most of the smaller mammals, birds, reptiles, amphibians, and invertebrates native to the region. Streams, although highly altered and degraded, still nurture remnant populations of salmon, steelhead, and less well-known native fishes.

Today's remaining upland habitats and the species they support are pressured by demands of an increasing population. The needs and opportunities for effective land conservation and ecological restoration are immense.

## Data Gaps

While an historical ecology study for the Bay Area would be the most informative, an analysis of the digitized and ortho-rectified Wieslander maps would be a great first step toward understanding the loss of vegetation types – at least since the 1930s.

**Figure 2.3 ■ Remaining Acreage for Upland Habitat Goals Vegetation Types** (protected and unprotected).

Vegetation Type	Remaining Acreage	Vegetation Type	Remaining Acreage
<b>Coniferous Forests</b>	<b>364,143</b>	<b>Oak Forests / Woodlands and Other Woodlands</b>	<b>502,064</b>
Bishop Pine Forest	7,224	Black Oak Forest / Woodland	4,193
Coulter Pine Forest	266	Blue Oak / Foothill Pine Woodland	32,516
Douglas-Fir Forest	163,145	Blue Oak Forest / Woodland	191,358
Grand Fir Forest	216	Canyon Live Oak Forest	7,154
Knobcone Pine Forest	6,755	Coast Live Oak Forest / Woodland	213,052
Mixed Conifer / Pine Forest	430	Interior Live Oak Forest / Woodland	8,923
Monterey Cypress Forest	91	Juniper Woodland and Scrub	197
Monterey Pine Forest	1,958	Oregon Oak Woodland	37,876
Ponderosa Pine Forest (Non-Maritime)	11,521	Valley Oak Forest / Woodland	6,795
Pygmy Cypress Forest	106	<b>Riparian Forests</b>	<b>13,801</b>
Redwood Forest	172,431	Central Coast Riparian Forests	13,704
<b>Hardwood Forests</b>	<b>404,492</b>	Sycamore Alluvial Woodland	97
California Bay Forest	48,913	<b>Serpentine Variants</b>	<b>96,375</b>
Montane Hardwoods	327,514	McNab Cypress	9,677
Tanoak Forest	28,065	Sargent Cypress Forest / Woodland	2,955
<b>Herbaceous</b>	<b>1,015,391</b>	Serpentine Barren	1,149
Barren / Rock	6,654	Serpentine Conifer	8,095
Coastal Salt Marsh / Coastal Brackish Marsh	1,880	Serpentine Grassland	16,632
Coastal Terrace Prairie	870	Serpentine Hardwoods	16,863
Cool Grasslands	72,283	Serpentine Knobcone Pine	457
Dune	771	Serpentine Leather Oak Chaparral	39,386
Hot Grasslands	269,259	Serpentine Riparian	135
Moderate Grasslands	143,794	Serpentine Scrub	1,026
Native Grassland	1,165	<b>Shrublands</b>	<b>388,313</b>
Permanent Freshwater Marsh	2,361	Chamise Chaparral	91,771
Warm Grasslands	516,149	Coastal Scrub	90,173
Wet Meadows	205	Mixed Chaparral	15,139
		Mixed Montane Chaparral	145,329
		Semi-Desert Scrub / Desert Scrub	45,901
		<b>Totals</b>	<b>2,784,579</b>



# Approach and Methodology



Stuart B. Weiss

## Biodiversity Defined

As the field of conservation biology has evolved, so too has the definition of biodiversity. Initially defined simply as the variety of species, biodiversity has been expanded to include the numbers of organisms, the interactions among these organisms, and how they array themselves in the physical environment (Noss 1990, Redford and Richter 1999).

The Upland Habitat Goals Project embraces this latter, broad definition, and developed a methodology designed to incorporate the elements of composition, structure, and function of biodiversity.

The international Convention on Biological Diversity defines biodiversity even more broadly (Figure 3.1).

**Figure 3.1 ■ The Dimensions of Biodiversity from the Convention on Biological Diversity** (Global Biodiversity Outlook 1, 2001).

### Biodiversity

This term is used by the Convention to refer to all aspects of variability evident within the living world, including diversity within and between individuals, populations, species, communities, and ecosystems. Differences in pest resistance among rice varieties, the range of habitats within a forest ecosystem, or the global extinction of species of lake fish, all illustrate different aspects of biological diversity. The term is commonly used loosely to refer to all species and habitats in some given area, or even on the Earth overall.

## The Conservation Planning Process

Conservation planning is the systematic process of identifying areas important for conserving biological diversity. The result of this planning process is a network of lands that best conserves all elements of biodiversity within the planning area.

Conservation planning typically involves the following steps (Groves 2003):

1. Identify conservation targets.
2. Compile information and identify data gaps.
3. Analyze existing protected lands for their contribution to biodiversity goals.
4. Set goals for conservation.
5. Evaluate the viability and ecological integrity of conservation targets.
6. Design a network of conservation lands to meet the goals.

Conservation planning is not a linear process. Several steps can occur at the same time and numerous feedback loops can require revisions to identified conservation objectives as monitoring results or other new data become available. The Upland Habitat Goals Project will be revised every two years so that newly conserved areas, updated human impacts, and other new data – as well as advances in the conservation planning process itself – are factored into the configuration of the Conservation Lands Network, recommendations, and tools.

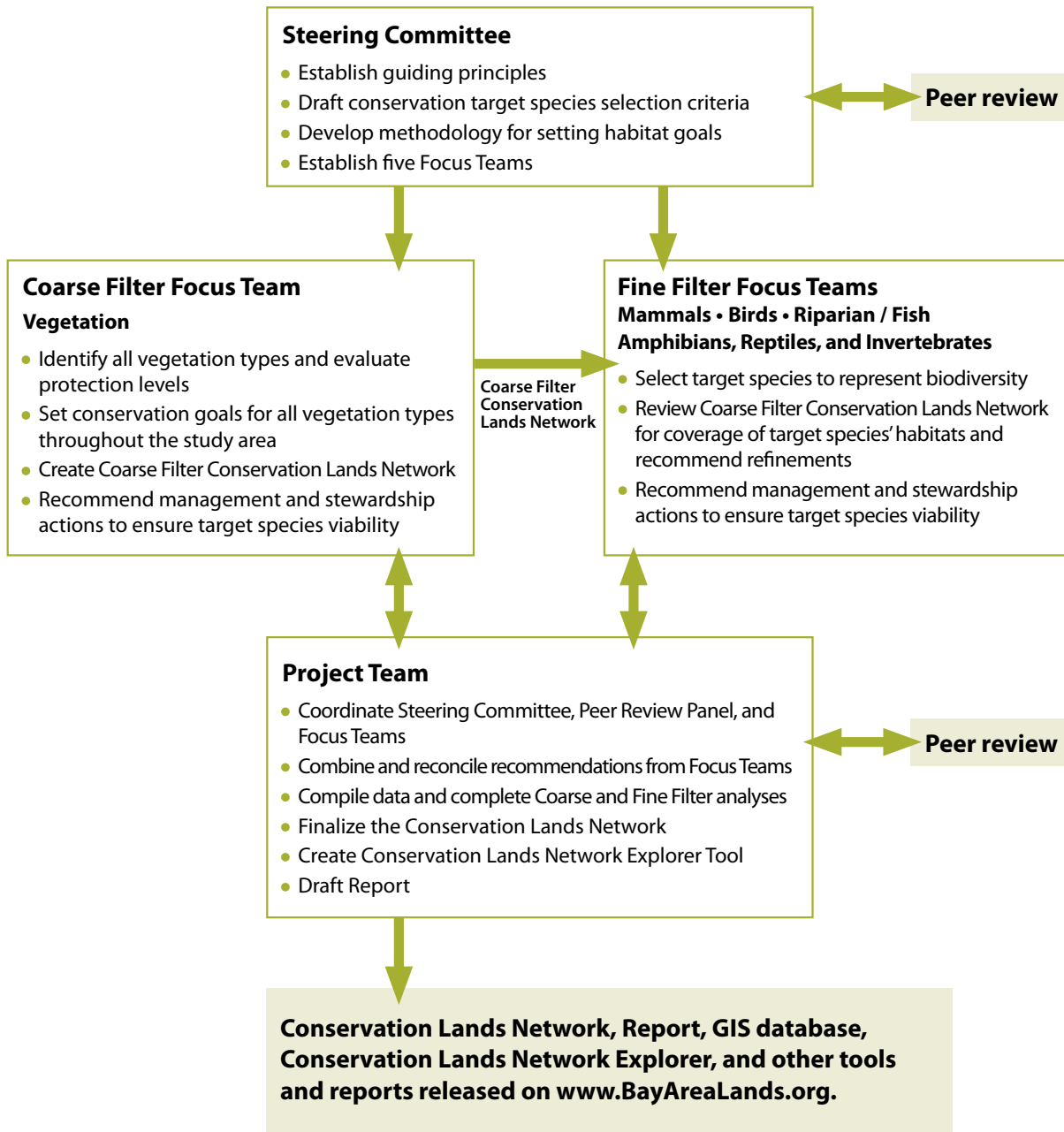
The Upland Habitat Goals Project incorporates the basic principles of the coarse filter/ fine filter approach to conservation planning (Noss 1987, Groves 2003), as illustrated in Figure 3.2. The coarse filter phase comprised a vegetation representation analysis (or gap analysis) that inventoried all vegetation types, established percentage conservation goals for each vegetation type, evaluated the extent of protection afforded by existing protected lands, and then calculated acreage goals for each vegetation type based on the gaps in protection. Conservation planning software (called Marxan) combined the vegetation type conservation goals with numerous other variables (e.g., population density, distance to roads) to define the boundaries of the Coarse Filter Conservation Lands Network. The underlying assumption of the coarse filter gap analysis is that if sufficient acreage of all vegetation types is preserved, then the majority of biodiversity elements will also be preserved.

To capture species that may not have been covered by the coarse filter analysis, a fine filter analysis was used to refine the Coarse Filter Conservation Lands Network. Focus team experts selected fine filter conservation target species including plants, mammals, fish, amphibians, reptiles, invertebrates, and abiotic elements such as unique soil types, streams, and ponds. The configuration of the Coarse Filter Conservation Lands Network was adjusted to incorporate sufficient habitat for these target species.



Stuart B. Weiss

**Figure 3.2 ■ The Conservation Planning Process.** The Upland Habitat Goals Project used a coarse filter/fine filter approach to identify the Conservation Lands Network.



In order to successfully conserve biodiversity, the selection of conservation areas must integrate the concepts of representation, resilience, and redundancy (Scott 1999). Representation means that selected conservation areas should represent all the biological features and the range of environmental conditions under which they occur. Resilience refers to the conservation targets' viability in light of the impacts or disturbance that may occur. Resilience is, in part, a function of redundancy, a principle requiring a conservation target to be conserved throughout its range and the range of environmental conditions where it occurs.

## Project Scale

The Upland Habitat Goals Project is a broad-brush approach to biodiversity conservation across nine Bay Area counties covering roughly 4.3 million acres. The project set regional and subregional (landscape unit) habitat conservation goals, identified unique high-value areas, and shaped a Conservation Lands Network from existing protected lands and unprotected areas to meet the conservation goals. Importantly, CLN Explorer and GIS Database provide a decision support system for conservation actions throughout the region. These actions are placed in a regional context, providing a first look at site biodiversity potential, but are not intended to support detailed site-specific planning where surveys are required to evaluate restoration potential. Chapter 11 (*Interpreting the Conservation Lands Network*) provides guidance for translating the Conservation Lands Network to action.

Although conservation planning is best geared to an ecologically cohesive unit or ecoregion, the nine-county Bay Area lies inconveniently at the intersection of three ecoregions as defined by The Nature Conservancy – the Central Coast, North Coast, and the Central Valley. To compensate for this inconsistency, the Upland Habitat Goals Project looked beyond the study area borders when selecting areas to conserve by considering wildlife corridors extending outside the boundary and protected lands outside of, but adjacent to the planning area. Figure 3.3 shows the intersection of the ecoregions and the project study area.

### Figure 3.3 ■ Ecoregions within the Upland Habitat Goals Project Study Area.

The Upland Habitat Goals study area intersects three of The Nature Conservancy's Ecoregions.





The project's analyses are based on planning units of 100ha hexagons (247.1ac). By design, these hexagons cut across parcel boundaries, precluding the project from targeting specific parcels. An entire hexagon was selected for inclusion in the CLN if as little as 10% of it was protected land, or if it contained a high-value target such as riparian vegetation. In cases where the remainder of the hexagon was comprised of Urban, Rural Residential, and/or Cultivated Agriculture lands (collectively, Converted Lands), these developed lands were "clipped out" of the Conservation Lands Network, so that elements of biological diversity were retained in the CLN, and CLN acreage calculations include only the targeted habitats. If such a hexagon did not include Urban, Rural Residential or Cultivated Agriculture lands, it remained in the Conservation Lands Network even though only a small portion of it may include lands that are protected or of high value

## Peer Review

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To ensure the scientific integrity of the planning process, the draft Study Design and Methodology was peer reviewed by a Peer Review Panel of conservation planning experts. The final methodology of the Upland Habitat Goals Project incorporates their recommendations.

### Methodology Peer Review Panel

James Bartolome, PhD, University of California, Berkeley  
Grey Hayes, PhD, Elkhorn Slough Coastal Training Program  
Adina Merenlender, PhD, University of California, Berkeley  
Mark Reynolds, PhD, The Nature Conservancy  
James Thorne, PhD, University of California, Davis  
Mike White, PhD, Conservation Biology Institute

A second Peer Review Panel provided comments on the draft final report.

### Report Peer Review Panel

Frank Davis, PhD, University of California, Santa Barbara  
Lisa Micheli, PhD, Pepperwood Preserve  
James Thorne, PhD, University of California, Davis

## Upland Habitat Goals Methodology

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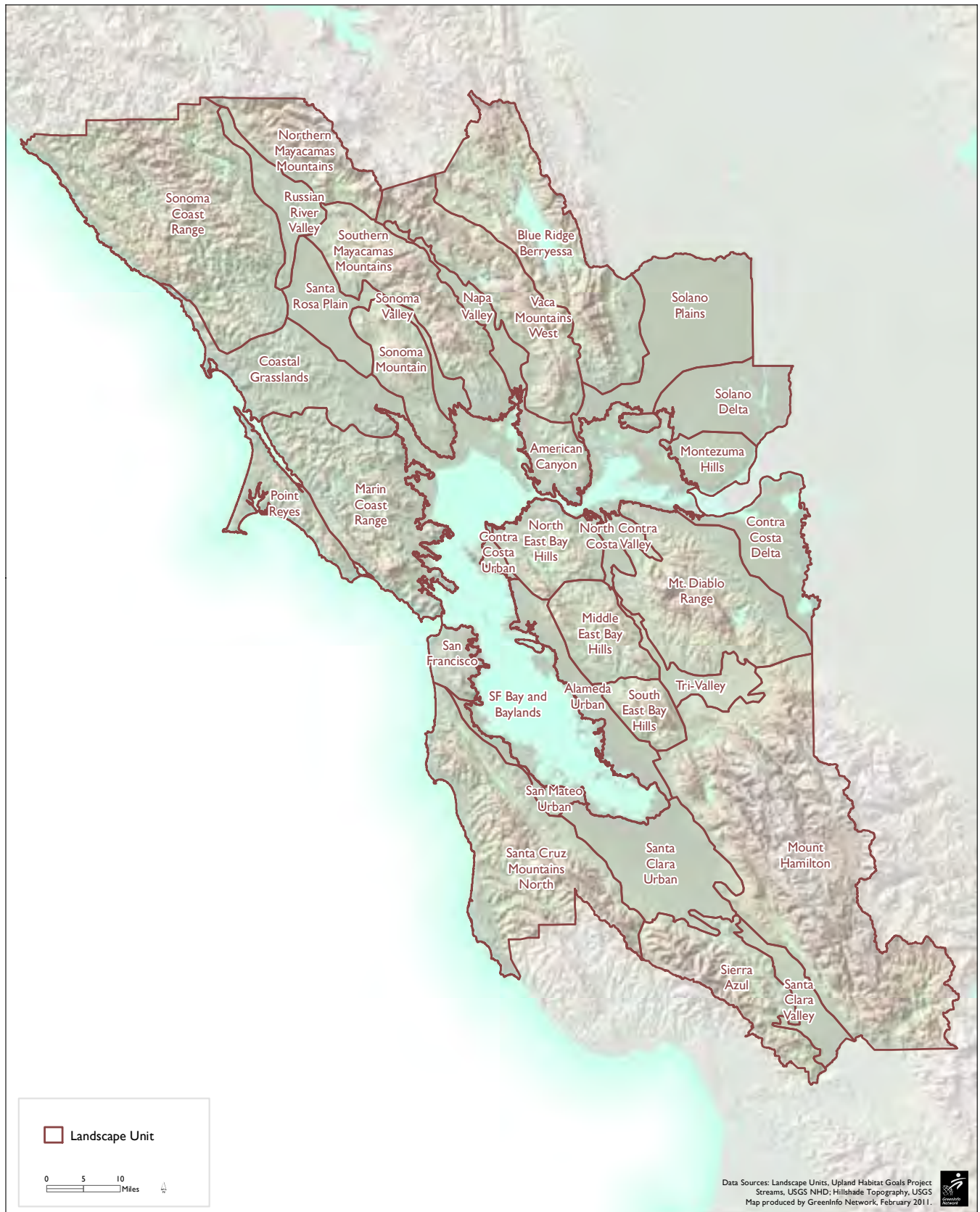
The Upland Habitat Goals Project Team, with input from the Steering Committee and Peer Review Panel, devised the following methodology for this project.

### 1. Define Landscape Units.

It is essential for a conservation plan to protect target species in all environments where they occur – across latitudes, elevations, aspects, *etc.* – to build in redundancy and resilience. For example, blue oak should be protected in the farthest western reaches where it is found as well as in the East Bay where it is quite abundant. Capturing such geographic stratification is likely to capture genetic variability and provides multiple representations of conservation targets, both of which bolster resilience in the event of major habitat loss, rapid climate change, or other disturbance.

The Upland Habitat Goals Project integrated geographic stratification by defining subregions referred to as landscape units (Figure 3.4). Goals were established for each vegetation type within each landscape unit where it occurs, thereby incorporating much of the ecological variability within a vegetation type along regional climatic and biogeographic gradients. The initial conservation network design, therefore, was done within each landscape unit to identify local networks with high ecological integrity. The second step in the network design focused on maintaining linkages between landscape units.

**Figure 3.4 ■ Landscape Units of the San Francisco Bay Area Upland Habitat Goals Project.** The study area was divided into 34 geographically coherent landscape units that followed major physiographic features, primarily mountain ranges and intervening valleys.





The nine-county San Francisco Bay Region was divided into 34 landscape units. In delineating the landscape units, the emphasis was on creating geographically coherent units, but limiting landscape units to a reasonable number (approximately 30) to keep the analysis tractable. Demarcation of the landscape units followed major physiographic features, primarily mountain ranges and intervening valleys. Discrete mountain ranges such as Mt. Diablo, Sonoma Mountains, Southern Mayacamas, and Marin Coast Range each became individual landscape units. Where discrete valleys do not exist, major highway corridors were used to subdivide mountain ranges, as in the cases of the East Bay Hills landscape units (Highway 24, I-580, and I-680), Santa Cruz Mountains Landscape Unit (Highway 17), and American Canyon Landscape Unit (Highway 12). Major valleys such as Napa, Sonoma, and Santa Clara were delineated manually using slope and topography derived from the USGS 10m Digital Elevation Models.

The urban plains around the Bay were divided into four landscape units labeled **urban** – San Mateo, Alameda, Contra Costa, and Santa Clara – and excluded from the coarse filter analysis that led to the initial draft Coarse Filter Conservation Lands Network. However, because streams are important conservation targets and traverse urban areas, the project recommends the protection and restoration of stream conservation targets along their entire length including within the urban landscape units. A fifth landscape unit excluded from the study area is the San Francisco Bay and Baylands, because the baylands are covered by the Baylands Ecosystem Habitat Goals Project, and the submerged tidelands are the focus of the San Francisco Bay Subtidal Habitat Goals Project.

Protected areas within the San Francisco Bay and Baylands Landscape Unit and adjacent to the Upland Habitat Goals Project boundary were reviewed for connections to the Conservation Lands Network. Similarly, the CLN was reviewed at the outer county boundaries, and adjusted to ensure connections to protected areas adjacent to, but outside of the study area.

Watersheds were considered as an option for designating distinct geographic units, but were not selected for several reasons. Watersheds are delineated by ridgelines, but upland areas are better defined by entire mountain ranges. Watersheds also often extend across natural physiographic features such as mountains with valleys, and thus do not capture important components of integrity within these distinct areas. However, the Riparian/Fish Focus Team members selected watersheds as the logical geographic unit for reviewing coverage for fish and stream conservation targets by the Coarse Filter Conservation Lands Network.

## 2. Compile Information and Identify Data Gaps.

As part of the planning process, the Upland Habitat Goals Project compiled numerous public and private datasets, ranging from vegetation types and species occurrence to roads and jurisdictional boundaries. A full listing of datasets used in the project can be found in Appendix B (*Data and Methods*, Chapter 3).

The first data gap encountered was the lack of a consistent vegetation map for the nine-county study area. This gap was resolved with the development of the Coarse Filter Vegetation Map described in Chapter 4 (*Coarse Filter: Vegetation*), but a more accurate, detailed, and current vegetation map continues to be an information gap.

A second significant data gap is occurrence data for target species throughout the study area. The California Natural Diversity Database (CNDDDB) was employed for many species, but its shortcomings are well known. It is not a comprehensive survey of rare plants and animals. CNDDDB focuses on areas with active Natural Communities Conservation Plans/Habitat Conservation Plans and other priority areas defined by the Department of Fish and Game ([www.dfg.ca.gov/biogeodata/cnddb](http://www.dfg.ca.gov/biogeodata/cnddb)). Biologists submit occurrence records on a voluntary basis for occurrences on public lands or private lands where they are allowed access. The lack of CNDDDB records does not mean that an area does not contain species of special concern.

Although CNDDDB is incomplete, it provides verified occurrences for a wide variety of species and presents a useful starting point for fine filter targets. Consensus was reached

with focus team experts that CNDDDB is the best available data and should be used, but supplemented with additional data whenever possible. The University of California Museum of Vertebrate Zoology (MVZ) and the Department of Fish and Game California Wildlife Habitat Relationship (CWHR) databases were also used to supplement CNDDDB. CNDDDB was filtered by spatial accuracy, date, and presumed extant occurrences so that only high quality records were considered.

All publicly available datasets used for the analyses or those generated by the project are included in the Conservation Lands Network GIS Database. This database uses intuitive directories and consistent symbology, and is available for download in ESRI ArcGIS format from the project's website ([www.BayAreaLands.org/gis](http://www.BayAreaLands.org/gis)). A subset of these data layers is included in the Conservation Lands Network Explorer online mapping tool.

### 3. Identify Protected Lands.

An important step in the conservation planning process is identifying existing protected lands and evaluating the contribution of those lands to biodiversity values based on the level of stewardship provided by the managing entity. The Bay Area is unique in that the Bay Area Open Space Council works with GreenInfo Network to maintain the comprehensive Bay Area Protected Areas Database (BPAD), a GIS layer updated annually (Figure 3.5). The BPAD includes open space that is owned in fee or easement by a public agency or a private, nonprofit land trust and is held primarily for open space purposes. The database includes public golf courses, but excludes private golf courses, city halls, active military bases, and other lands held in public ownership but not for open space purposes.

The number and acreage of regulatory easements – easements created by land use or regulatory actions – are unknown; this data gap warrants further research. The BPAD, while extensive, includes very few regulatory easements, leaving the database incomplete.

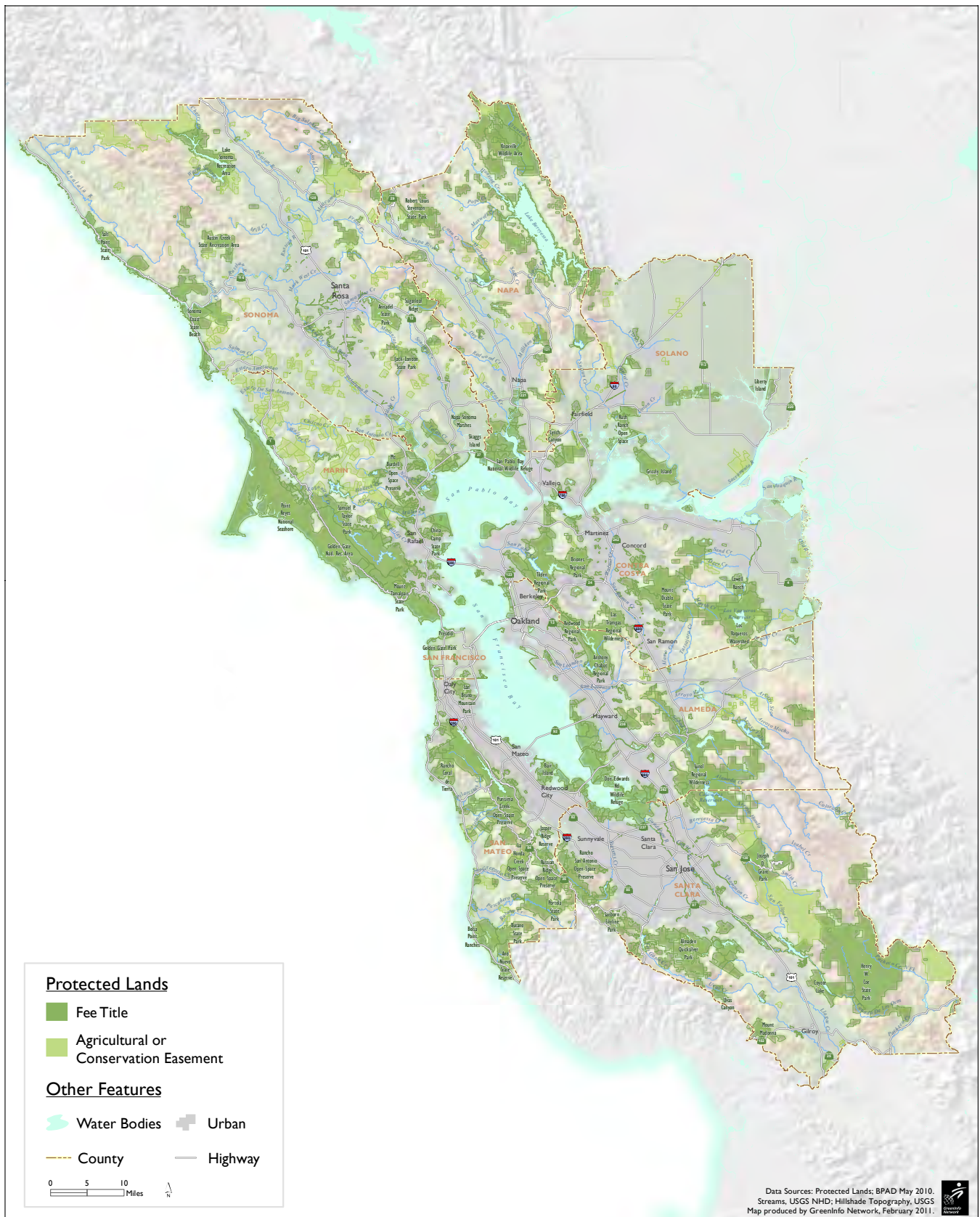
The second task of evaluating the stewardship of protected lands and thus the contribution to biodiversity conservation is a complicated one and was not completed for the project. The classification of stewardship levels is typically done by assigning values to protected lands based on the level of protection from conversion of the natural land cover and an operational management plan mandating the protection of the natural cover (Davis *et al.* 1998, Stoms 2000). There are several classification systems that could be applied, such as the California Gap Analysis Program (GAP) management categories, but the diverse ownerships and management objectives (often within the same regional park) make such a task highly labor intensive with only a marginal enhancement in the quality of the inputs for the site selection software.

In lieu of a stewardship analysis, the project team modified the BPAD prior to the analysis by removing protected lands that could be readily identified as having little or no contribution to biodiversity such as cemeteries and golf courses. Additionally, the BPAD includes lands with easements protecting cultivated agriculture. These lands provide foraging areas for some species such as raptors and waterfowl, but have been converted from the natural cover and are not appropriate for inclusion in the CLN. Department of Conservation Farmland Mapping and Monitoring Program data were used to identify cultivated agricultural lands, including those with easements, and these areas were assigned very low conservation suitability scores to reduce the probability of their selection by Marxan, the site selection software.



Kathy Switky

**Figure 3.5 ■ Bay Area Protected Lands (2010).** The Bay Area Open Space Council and GreenInfo Network maintain the comprehensive Bay Area Protected Areas Database (BPAD). This GIS layer includes open space that is owned in fee or easement by public agencies and nonprofit conservation organization for open space purposes. The data are updated annually.



#### 4. Select Coarse Filter Conservation Targets.

In *Drafting a Conservation Blueprint*, Craig Groves (Groves 2003) describes conservation targets as:

*...those features or elements of biodiversity that planners seek to conserve within a system of conservation areas. These targets may be biologically based features, such as species and communities, or they may be environmentally derived targets (based on such factors as soils, climate, geology, and elevation) that serve as surrogates for biological features. Some types of conservation targets have legal standing under various laws. For example, under the Endangered Species Act, some subspecies and distinct populations are legally recognized and protected.*

Using the Target Selection Criteria established by the Steering Committee (Figure 3.6), coarse and fine filter experts selected target species to represent major species groups for each of the focus teams. This figure also describes how these criteria were met by the targets that were chosen.

Consistent with the coarse filter / fine filter approach to conservation planning and the conservation target selection criteria, the project team selected vegetation type targets first. Every vegetation type in every landscape unit was identified as a conservation target (556 targets in total), ensuring that all habitats in the region are represented in the CLN. The Vegetation Focus Team then assigned a Rarity Rank of 1, 2, or 3 to each coarse filter target. A Rarity Rank 1 denotes a very rare vegetation type, while Rarity Rank 3 indicates common species. Rarity ranking is explained in greater detail in Chapter 4.

#### Figure 3.6 ■ Upland Habitat Goals Project Conservation Target Selection Criteria and Application.

1. Targets should include different levels of biological organization (populations, species, ecological communities, and ecological systems). The use of vegetation types defined by physiognomy (forest, woodland, shrublands, herbaceous) and dominant species (or some description of composition, e.g., Mixed Montane Chaparral) intrinsically captures some of the higher levels of biological organization. Fine filter targets, such as plants, mammals, birds, and specific stands of old-growth redwood, capture the lower levels.
2. Target species requirements should cross spatial scales from regional (millions of acres) to local (ten to thousands of acres). Some vegetation types extend over tens of thousands of acres or more within landscape units, while others are highly restricted in area. At one extreme, conservation targets such as mountain lion have individual home ranges greater than 10,000 acres, and habitat for subpopulations extends over hundreds of thousands of acres, requiring linkages between landscape units and to the rest of California. Conversely, highly localized target species, such as Bay Checkerspot Butterfly and certain rare plants, exist in areas ranging from less than 10 acres to several thousand acres.
3. All habitats in the region should be represented through target selection. The vegetation representation analysis (coarse filter) selects all vegetation types as conservation targets, and sets goals for each vegetation type in every landscape unit where it occurs.
4. Targets should include rare and special status species as well as common species. Rare and special status species were included as conservation targets in both the coarse and fine filter analyses. The vegetation representation analysis (coarse filter) set goals for all vegetation types, and thus included common species. Similarly, focus teams were careful to include common species when selecting targets.
5. Targets can include focal species such as keystone, foundation, indicator, and umbrella species. The focus teams selected target species that fit all of these descriptors.
6. There must be adequate data available for a selected target species to facilitate meaningful analysis. The Upland Habitat Goals Project used the best information available and supplemented the data with expert opinion. However, for some target species, especially invertebrates, data were insufficient to adequately evaluate coverage by the Conservation Lands Network.



## 5. Set Conservation Goals for Coarse Filter Targets.

The Vegetation Focus Team used the rarity rankings to establish acreage goals for each vegetation type in each landscape unit. Percentage protection goals are 90% of remaining acreage for Rarity Rank 1 vegetation types, 75% for Rarity Rank 2, and 50% for Rarity Rank 3. These percentage goals are quite high compared with other conservation planning efforts, which tend to be in the 30% to 40% range (Groves 2003). One reason for setting high goals is the finding that the minimum amount of protected habitat required for all species within a region to persist varies widely from one region to the next and depends on the species present, their habitat requirements, habitat fragmentation, and the amount of human disturbance (Fahrig 2001). Establishing high goals increases the probability that the minimum habitat requirements for the majority of conservation targets will be met or exceeded.

Further rationale for setting high conservation goals includes:

- **Past Habitat Loss.** Because there is no historic baseline data for upland vegetation type acreages, the magnitude of loss is not known. However, overall habitat loss has been significant. The nine-county Bay Area is comprised of approximately 4.5 million acres; a recent analysis by the Bay Area Open Space Council found that although 1.2 million acres have been conserved, roughly 1.24 million acres have been converted to other uses. According to the Farmland Mapping and Monitoring Program, urban areas make up 720,000 acres, cultivated agriculture has converted 370,000 acres, and rural residential land uses (parcels less than 10 acres) cover another 150,000 acres. Furthermore, the Greenbelt Alliance 2006 report *At Risk: The Bay Area Greenbelt* (see Figure 1.3) estimates that another 400,000 acres are threatened with development in the next 30 years.
- **Species Richness Depends on Larger Areas.** Species richness, defined as the total number of plant and animal species in a given area, is related to the size of that area. Because the Bay Area is a biodiversity hotspot – a region with high numbers of unique species facing high rates of habitat conversion – a larger Conservation Lands Network is necessary to protect that richness.
- **Fewer Fine Filter Target Adjustments.** A comprehensive Coarse Filter CLN with high goals for common vegetation types minimizes the need for fine filter adjustments for individual taxa or environmental factors such as climate and soils. Setting high goals for vegetation types within each landscape unit further protects each species across its geographic range and environmental gradients. High goals for locally rare vegetation types (within landscape units) capture unique local environments (climate and geology) and other biogeographic phenomena.
- **Unprecedented Environmental Change.** Rapid changes in the global and regional environments require a dynamic approach to conservation. The interactions between urban growth, climate change, weed invasions, atmospheric nitrogen deposition, and other factors – coupled with ongoing habitat loss – pose novel threats to biodiversity. Large contiguous areas distributed across regional climate gradients provide room for local range shifts driven by climate change. Redundancy and spreading of risks become ever more crucial to maintain resilience in light of divergent climate change projections and general unpredictability.
- **Our Vision and Ability.** The Bay Area is a world leader in open space and habitat protection. The region has a network of protected lands second to none, and this reflects the high value residents place on open space and wildlife habitat. As a biodiversity hotspot with numerous endemic, threatened, and endangered species intertwined with intensive human land uses, the only opportunities to conserve many species and unique habitats lie within the nine Bay Area counties.



## 6. Design a Coarse Filter Conservation Lands Network Using Marxan Site Selection Software and Expert Opinion.

Next, the vegetation type conservation targets and associated protection goals were used to design a network of conservation lands that met the stated goals. This reserve design was referred to as the Coarse Filter Conservation Lands Network, and was the configuration presented to the fine filter focus teams to review for coverage for fine filter targets.

To develop the Coarse Filter Conservation Lands Network, the project employed the following principles, which have been developed by several conservation biologists over many years to guide the selection of conservation areas (Groves 2003).

- Species well distributed across their native range are less susceptible to extinction than species confined to small portions of their range.
- Large blocks of habitat containing large populations of target species are superior to small blocks of habitat containing small populations.
- Blocks of habitat close together are better than blocks far apart.
- Habitat in contiguous blocks is better than fragmented habitats.
- Blocks of habitat that are roadless or otherwise inaccessible to humans are better than roaded and accessible blocks.
- Interconnected blocks of habitat are better than isolated blocks because dispersing individuals travel more easily through habitat resembling that preferred by the species in question.

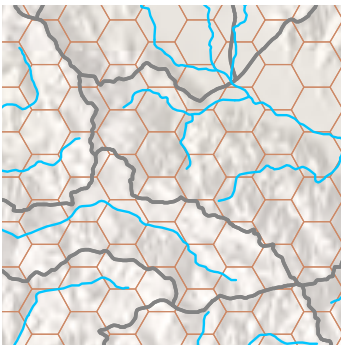
In designing a conservation network for the Bay Area, a myriad of factors had to be considered with less than complete information. To manage this complexity, the conservation planning software Marxan was selected to assist with the reserve design. Marxan, developed at the University of Queensland in Australia, is an optimization algorithm widely used by conservation planners. The software identifies a near-optimal spatial solution that achieves all of the conservation goals, which are inputs to the program. Marxan uses algorithms to rapidly run and evaluate millions of conservation network options while considering user inputs such as conservation targets, goals, land use, adjacency to existing protected lands, and suitability (ecological integrity) of the landscape for biodiversity conservation. More information on Marxan can be found at [www.uq.edu.au/marxan](http://www.uq.edu.au/marxan).

The automated Marxan-generated Coarse Filter Conservation Lands Network served as a starting point for discussion; the CLN was revised according to the expert opinion of the focus team participants. Expert opinion, as used in the context of the Upland Habitat Goals Project, reflects the accumulated knowledge of the conservation community, and provided invaluable information at numerous stages of the project.

## 7. Configuring the Marxan Site Selection Software.

This section provides an overview of how Marxan was used to derive a draft Coarse Filter Conservation Lands Network for review, revision, and discussion by focus team members. A detailed description of the application and settings in Marxan can be found in Appendix B (*Data and Methods*, Chapter 4).

**a. Establish Planning Units.** The Marxan software requires consistently-sized planning units covering the study area. Not to be confused with the larger irregular physiographic-based landscape units, the 100ha hexagonal planning units were overlaid on the entire study area. Marxan ties all input data and results to these hexagons. While it is possible to run Marxan with parcel data, the project team deliberately used hexagonal planning units to preclude Marxan from targeting specific parcels.



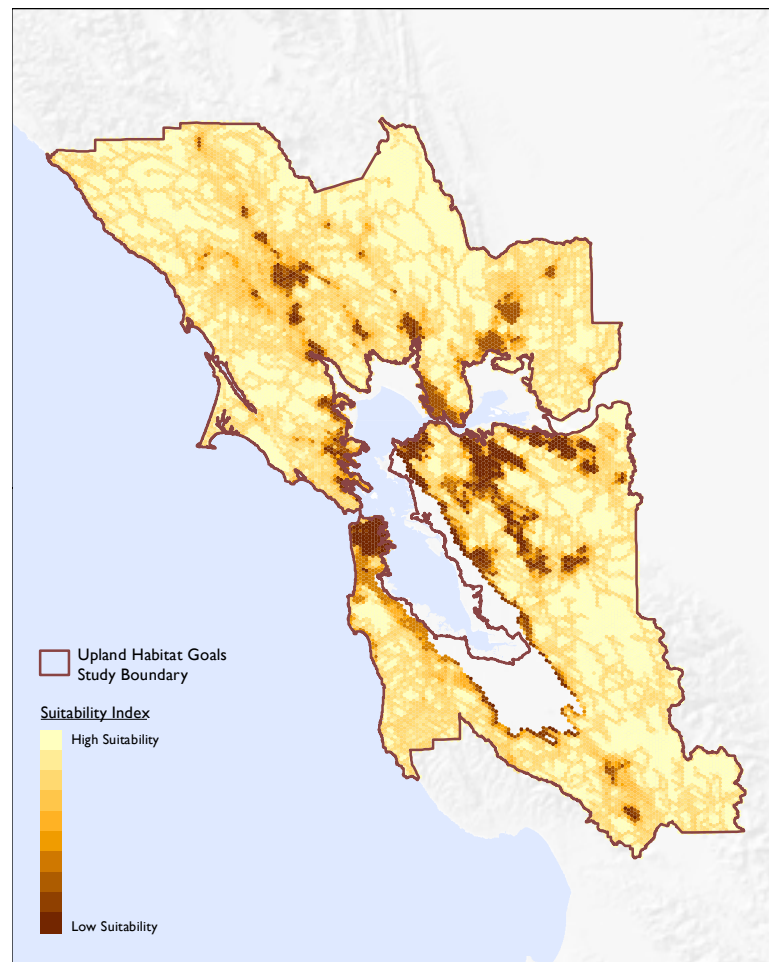


**b. Develop the Conservation Suitability Layer.** To facilitate Marxan’s identification of areas best suited for target species conservation, the project team developed a data layer to estimate ecological integrity. The Conservation Suitability layer used three indirect measures of ecological integrity that contribute to habitat degradation and fragmentation:

- **Population density** (USGS Dasymetric Population Density)
- **Distance to paved roads** (USGS Distance to Roads)
- **Parcelization** – the total number of parcels that intersect each hexagonal planning unit (digital parcel maps compiled by GreenInfo Network for each county, except for Solano County – which lacks digital parcel data, and San Francisco County – because of its urban land use)

Larger, intact regions with minimal habitat fragmentation are considered to have higher ecological integrity. These three factors were summed to create a Conservation Suitability index for every hexagonal planning unit. In Figure 3.7, areas shown in brown are of low suitability (many small parcels, close to roads, high population density) and the light tan areas are more suitable (larger parcels, further distance to roads, lower population density).

**Figure 3.7 ■ The Conservation Suitability Layer.** This data layer estimates ecological integrity by combining data on population density, distance to roads, and parcelization.



**c. Select Features to “Lock In.”** The project team chose to build the CLN from the existing protected lands. Marxan was configured to “lock in” any planning unit with 10% or more of its area in protected lands; thus the software preferentially chose hexagons adjacent to protected areas to create large blocks of conserved lands.

**d. Create Compactness.** Marxan can be calibrated to create more or less compact reserve designs depending on the level of connectivity desired. After consultation with experts at NatureServe and The Nature Conservancy, and trial and error to observe the impact of various settings to the network design, a setting was selected that provided reasonable compactness. The focus team experts manually adjusted the CLN to enhance connectivity during their review of the Coarse Filter Conservation Lands Network.

**e. Achieve the Goals.** Marxan settings allow the user to ascribe the importance of reaching a goal for individual conservation targets or all targets, and assess a penalty if the goals are not met. The project team’s desire to attain the stated goals and consultation with Marxan experts resulted in the selection of a relatively high penalty number for all conservation targets, which forces Marxan to meet all of the stated goals.

**f. Creating the Coarse Filter Conservation Lands Network: Iterations and Runs.** Marxan was programmed to complete one million iterations each of the 20 times it was run. Marxan creates a “near optimal” conservation reserve network based on these runs and iterations, generating statistics on the number of times a planning unit is selected for inclusion in the Conservation Lands Network. This latter measure is an indication of the “irreplaceability” of a site to meet the conservation goals. Sites selected 90-100% of the time, for example, could be considered *required* to meet conservation goals.

Similarly, Marxan allows the user to select how the results are displayed. The project team selected the summed solutions option, which uses the number of times each hexagon was chosen (out of the total number of times the software was run) to determine which hexagons to include in the CLN. The following categories were chosen for inclusion in the Conservation Lands Network:

**Areas Essential to Conservation Goals (darkest blue).** Planning units in this category were selected 16 or more times during 20 Marxan runs (80-100%). The lands in this category were selected because they support high value conservation targets and/or are adjacent to existing protected lands. Conservation of these areas should be pursued since they serve vital functions in any potential network configuration, and conservation goals will be difficult to meet without them.

**Areas Important to Conservation Goals (medium blue).** Planning units in this category were selected between 11 and 15 times during 20 Marxan runs (55-79%). Conservation opportunities in these areas should also be pursued as they represent habitats in areas of high conservation suitability and are generally adjacent to Areas Essential to Conservation Goals and protected lands.

**Areas of the Conservation Lands Network That Are Fragmented (light purple).** Numerous areas smaller than the 100ha (247ac) planning unit hexagon are included in the CLN. These Fragmented Areas flag hexagons with substantial human footprint where special care is needed because the accuracy and viability of targets may be compromised by map scale, incomplete data, and/or ecological degradation.

**Areas for Further Consideration (light blue).** There are numerous areas where Marxan did not capture important biodiversity targets, develop a viable local configuration, or provide within-landscape unit connectivity. These areas were not added to the Conservation Lands Network because without sufficient data, it was not clear which were the most important areas to add. Specific decisions in these areas can be made only with better biological data and fine-scale planning.

More detailed descriptions of Fragmented Areas and Areas for Further Consideration can be found in Chapter 10 (*The Conservation Lands Network: Summary and Conclusions*).



Peter LaTourrette / www.BirdPhotography.com

## 8. Select Fine Filter Conservation Targets.

Once the coarse filter analysis shaped the Coarse Filter Conservation Lands Network, fine filter targets were used to:

- Conduct a quantitative and qualitative assessment of the effectiveness of the Coarse Filter CLN for conserving the target species.
- Identify additional habitat requirements, including linkages, for target species.
- Describe viability issues and stewardship recommendations for target species.

The Vegetation Focus Team selected plant fine filter targets; fine filter focus teams convened to select targets for mammals, birds, fish, amphibians, reptiles, and invertebrates using the Conservation Target Selection Criteria (Figure 3.6). The project team drew potential target species from the CNDDDB, University of California Museum of Vertebrate Zoology (MVZ), and the California Wildlife Habitat Relationship (CWHR) database; focus teams refined the lists.

Details of the role of the fine filter focus teams are shown in Figure 3.8. Each fine filter focus team devised a slightly different approach to match the unique characteristics of their species group. Chapters 5 through 8 document the approach, conservation targets, adjustments to the Coarse Filter Conservation Lands Network, and recommendations emerging from each of the fine filter focus teams.

### Figure 3.8 ■ The Role of the Fine Filter Focus Teams.

**The fine filter focus teams played a critical role in refining the Coarse Filter Conservation Lands Network to meet the habitat and ecological process requirements of mammal, bird, fish, amphibian, reptile, and invertebrate species.**

The fine filter focus teams were asked to do the following:

- Choose conservation targets for their species groups in accordance with the Conservation Target Selection Criteria.
- Use their expert knowledge to review the Coarse Filter Conservation Lands Network for coverage of conservation targets and recommend additional data sources to assist with the review.
- Describe threats to target species' viability as well as to essential processes and functions, and recommend key stewardship and management actions.

The focus teams were presented with the following set of questions to facilitate their review of the Coarse Filter Conservation Lands Network.

1. Is the habitat of the target species well covered by the Coarse Filter Conservation Lands Network?
2. Are there special habitat features not covered by the Coarse Filter Conservation Lands Network? Specific habitats such as cliffs (important for bats and birds) may require special attention and incorporation as fine filter targets.
3. For species requiring large habitat areas, does the Coarse Filter Conservation Lands Network include enough suitable habitat in each landscape unit to support a locally viable population even in the absence of explicit connections to other landscape units?
4. Are the connections among landscape units sufficient to support the species?
5. Has the species been extirpated from significant parts of its historical range, despite sufficient habitat to support a viable population? For example, some species, such as porcupine and western spotted skunk, have been locally extirpated even though their general habitat requirements are met by the Coarse Filter Conservation Lands Network.
6. Where there is little or no occurrence data, are the habitat requirements met for the species, and what additional information would be necessary to make a determination of adequate conservation?
7. Are there special management requirements to conserve the species even if the habitat requirements appear to be met?

## 9. Review the Coarse Filter Conservation Lands Network for Target Species Inclusion.

Once each focus team agreed upon suitable conservation targets, occurrence data from the CNDDDB, MVZ, focus team members, and expert opinion were used to evaluate coverage by the Coarse Filter CLN for target species habitats. Additionally, CWHR was tapped for target species habitat requirements and range. In cases where there was a question about whether coverage was adequate, CWHR range maps and average habitat suitability by vegetation type were used to conduct a habitat suitability analysis to facilitate the evaluation. Full application of CWHR requires information on vegetation stage and size, which is unavailable for the full region. Nonetheless, CWHR yields useful information on species viability and management requirements.

In most cases, the fine filter focus teams determined that the Coarse Filter CLN provided sufficient coverage for fine filter targets – a result of setting high conservation goals for the vegetation type targets. For a few fine filter targets that were not adequately covered – including CNDDDB plants, old-growth redwoods, Northern Spotted Owl nesting sites, and vernal pools – fine filter targets were added as an input into Marxan for the final run. Other inadequately covered fine filter targets – including streams, riparian vegetation types, and ponds – were added to the CLN after the final Marxan run.

## 10. Make Additional Adjustments to the Conservation Lands Network.

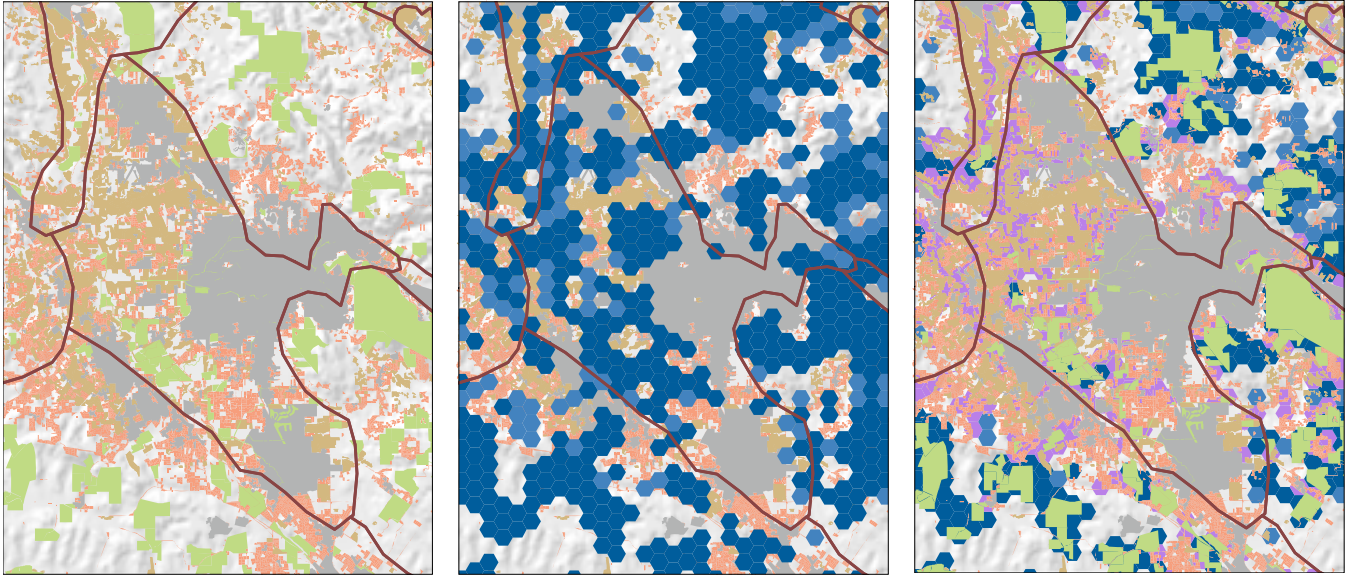
Once Marxan was run for the final time, the team made additional adjustments to address the inclusion of Urban, Rural Residential, and Cultivated Agriculture areas in the CLN. Marxan was programmed to select an entire 100ha hexagon if more than 10% of the area was comprised of existing protected lands or if a conservation target was found within the hexagon and was needed to meet the 90%, 75%, or 50% conservation goals. This directive resulted in an over-selection of Cultivated Agricultural, Rural Residential, and Urban lands, collectively referred to as Converted Lands – yet the target locations, if accurate, may be important for maintaining or re-establishing connectivity in these disturbed areas. To address the over-selection problem, Cultivated Agricultural, Rural Residential, and Urban areas were erased, leaving fragmented sections of the CLN. If at least 25% of the hexagon was removed during the erase process, then the area remaining in the CLN was categorized as a “Fragmented Area” and colored light purple. The erasure process is illustrated in Figure 3.9. Fragmented Areas are discussed in more detail in Chapter 10 (*The Conservation Lands Network: Summary and Conclusions*).

The process of removing Converted Lands also removed much of the Central Coast Riparian Forest and Sycamore Alluvial Woodland vegetation types. These important riparian vegetation types (9,156 acres of Central Coast Riparian Forests and 29 acres of Sycamore Alluvial Woodland) were added to the CLN after the last Marxan run.



Stuart B. Weiss

**Figure 3.9 ■ Excluding Converted Lands from the Conservation Lands Network.** This example from the Santa Rosa Plain Landscape Unit shows how adjustments were made to the Conservation Lands Network after the final Marxan run. The map on the left shows Urban (gray), Rural Residential (orange), and Cultivated Agriculture (tan) areas. Marxan selected hexagons (middle) in these areas if 10% or more of the hexagon was protected or if a conservation target occurred there. Urban, Rural Residential, and Cultivated Agriculture areas selected by Marxan were removed from the Conservation Lands Network. If at least 25% of the hexagon was erased, the retained area was labeled a Fragmented Area (shown in light purple on the map on the right).



### 11. Assess Viability and Ecological Integrity of Conservation Targets.

Viability refers to a conservation target’s ability to survive disturbances and adapt to evolutionary pressures (Soulé 1987). Ecological integrity is an ecosystem’s resilience under stress (Haskell *et al.* 1992) and is therefore a key component of a target species’ viability. Target species, and the ecosystems on which they depend, rely on the continuation of the ecological processes and functions to survive disturbances.

The development of the Conservation Suitability layer (section 7.b) was the first step taken to maximize the viability of conservation targets. Marxan was then programmed to select areas of high conservation suitability, and to select areas of lower suitability only if they were necessary to meet the high goals for high-value targets. For example, riparian forests and threatened and endangered species, all high-value targets with a 90% conservation goal, frequently occur in areas of lower suitability such as Rural Residential and Cultivated Agriculture Areas.

Viability is impacted by a myriad of continually interacting factors. The Upland Habitat Goals Project considered these nine factors when evaluating the viability of the conservation targets:

1. Climate change
2. Atmospheric nitrogen deposition
3. Fire
4. Ecological succession
5. Floods and drought
6. Landslides and erosion
7. Invasive plants
8. Non-native animals
9. Pathogens and disease

Each of these factors is discussed in detail in Chapter 9. Connectivity, obviously a key viability factor, is addressed separately below.

Only some of these viability factors have been mapped. For example, nitrogen deposition has been mapped at the 4km scale by the Community Multiscale Air Quality (CMAQ) model; CAL FIRE has mapped fire perimeters since 1950; the presence of Sudden Oak Death is available in digital form. However, there are no consistent digital or print maps for other factors, including the plethora of invasive plant species throughout the region.

Even for factors that are mapped, it was difficult to incorporate viability directly into Marxan when designing the Conservation Lands Network. Yet viability factors are critical to the survival of some target species, and may require explicit stewardship actions. For example, nitrogen deposition alters the nutrient balance in grasslands, increasing the growth of annual grasses and other weeds that can lead to local extinction of species such as the Bay Checkerspot Butterfly (Weiss 1999). Areas with high nitrogen deposition should still be included in the CLN but will require appropriate grazing and other grassland management actions to mitigate the effects.

Given the lack of specific data on viability factors and the difficulty of incorporating the existing data directly into Marxan, a qualitative approach was used to assess impacts to viability. Focus team experts were queried regarding viability factors specific to their species group and appropriate management recommendations. In addition, Chapter 9 of this report includes Viability Summaries for these nine factors, including for each:

- **Process** – the natural and/or anthropogenic process or processes that are disrupting or supporting important ecological functions.
- **Distribution** – the temporal and spatial distribution of the agents and processes.
- **Ecological impacts and threats to biodiversity** – the impacts of the process on ecological systems and particular conservation targets.
- **Network design and management responses** – how network design mitigates the impacts of the process, and what management options can address the impacts.
- **Policy and institutional responses** – institutions with responsibilities for addressing impacts, with local examples and references.
- **Monitoring** – a description of existing or recommended monitoring programs.
- **Conclusions, management recommendations, and research needed.**
- **References for further information.**

## 12. Identify Evaluation Criteria.

The Upland Habitat Goals Project intends to issue a biennial report card that will measure progress toward achieving the goals of the Conservation Lands Network, along with an updated Conservation Lands Network reflecting newly conserved lands and new data. Initial evaluation criteria that will be measured prior to the release of the first report card include additional acres conserved and percent of vegetation type goals met by landscape unit. Additional work will be completed to identify more meaningful measures of biological diversity conservation. Chapter 13 (*Research Needs, Measuring Success, and CLN 2.0*) discusses this in more detail.

## Connectivity and the Conservation Lands Network

The connectivity of conserved lands warrants special attention: it is vital to species viability as well as to ecological processes that support viability. Linkage opportunities are found in broad swaths of native vegetation, in agricultural landscapes, in narrow riparian corridors running through urban areas, and even in a single key highway underpass.

The project team considered three levels of connectivity – within landscape units, between landscape units, and to areas beyond the Conservation Lands Network. Many linkages were added to the CLN after the final Marxan run was completed, especially those between landscape units and to areas beyond the study area.



Andy LaCasse

As discussed above, within Marxan parameters were set to prioritize adjacency to existing protected lands and compactness of the Conservation Lands Network; this promoted linkages within landscape units. However, these Marxan-generated connections may not be optimal for all species, so the fine filter focus teams reviewed the Coarse Filter Conservation Lands Network and modified and/or added connections as needed for their conservation targets.

Linkages between landscape units are essential for conservation of wide-ranging species with low population densities, such as mountain lion and American badger. No single landscape unit can support a viable population of these or other target species with sizeable range requirements. Linkages between some landscape units are tenuous and highly constrained (e.g., the Caldecott Tunnel and Highway 580/BART underpasses), while others provide more options (e.g., the Altamont Pass and Highway 101 in northern Sonoma County). Narrow stream corridors are often the only linkage opportunities through urban and agricultural landscapes. Major linkage zones between landscape units were identified and added to the Conservation Lands Network; these include the 580/BART corridor between the South and Middle East Bay Hills Landscape Units and the Highway 101/Coyote Valley corridor between the Santa Cruz Mountains North and Mt. Hamilton Landscape Units.

Linkages to the regions beyond the Conservation Lands Network were addressed, in part, by reviewing protected lands adjacent to the study area boundary and adjusting the CLN to connect to these areas as appropriate. In addition, key areas were added for connectivity outside of the project boundary, including Pacheco Pass and Chittenden Gap in the south Bay, as well as wildlands north of Sonoma, Napa, and Solano Counties.

While a detailed linkage analysis was beyond the scope of the project, SC Wildlands is conducting such an analysis. Entitled *Critical Linkages: The Bay Area and Beyond*, this analysis covers the nine-county Bay Area as well as Santa Cruz, Monterey, and San Benito Counties to the south, and Mendocino and Lake Counties to the north. Linkage recommendations will be incorporated into the Upland Habitat Goals Conservation Lands Network. Preliminary results from Critical Linkages suggest that while it will lead to local refinements to the CLN, no major adjustments will be necessary. More information is available at [www.scwildlands.org/projects/bayarea.aspx](http://www.scwildlands.org/projects/bayarea.aspx).



Save Mount Diablo



## Climate Change and the Selection of Conservation Areas

Global climate change must be considered in any conservation planning process. If changing climates are not considered, the Conservation Lands Network might not support target species in the long term. The Upland Habitat Goals Project's use of geographic stratification and high conservation goals helps to create a buffer against climate change by ensuring representation and redundancy. This strategy effectively captures a broad range of climatic gradients that contribute to the region's species richness. Additionally, the connectivity captured by the Conservation Lands Network provides species room to move as temperatures change.

Targeting locally rare vegetation types, which are often the manifestation of diverse and rare local climates, also captures climatic diversity. For example, a high goal for blue oak woodland in the Sonoma Coast Range Landscape Unit targets the warmest, driest areas in that overall cool, wet landscape unit. In most landscape units, the Coarse Filter Conservation Lands Network results captured full gradients from valley floors to mountain peaks. In other landscape units, such as Mt. Diablo, the project explicitly added such gradients where Marxan did not incorporate them. Finally, undeveloped areas abutting the baylands were added manually to provide room for upslope migration of baylands species due to predicted sea-level rise.

For a more detailed discussion of climate change and predicted impacts, see the Climate Change Viability Summary in Chapter 9.

The project is fortunate to be the focus of a comprehensive regional climate change adaptation planning process, headed by Dr. David Ackerly of UC Berkeley's Department of Integrative Biology and involving leading scientists from the region. The effort will complete a climate gap analysis that examines how the Conservation Lands Network intersects with the Bay Area's present and future climate space and climatic diversity. The study will also present a synthesis of vegetation type conversions and projected loss of forest lands that emerges from numerous vegetation models predicting climate change. The Conservation Lands Network will be revised to incorporate this information. Preliminary results indicate that changes to the CLN as a result of this climate change research will be minor. For more information, see [ib.berkeley.edu/labs/ackerly/cc/cca-sfba.html](http://ib.berkeley.edu/labs/ackerly/cc/cca-sfba.html).



## CHAPTER

# 4

## Coarse Filter: Vegetation



Kathy Korhholz

The vegetation of the Bay Area is a complex manifestation of the region's Mediterranean-type climate, topography, geology, and land use history. Vegetation types vary in a fine-scale mosaic, creating a rich landscape in which disparate vegetation types abut and intermingle. Using these vegetation types to develop a Coarse Filter Conservation Lands Network was the first step toward establishing goals for conserving the region's upland habitats.

The objective of the coarse filter analysis was to identify gaps in protection, set conservation goals, and create a Coarse Filter Conservation Lands Network that filled the gaps while meeting the goals. The Vegetation Focus Team identified the following process to meet that objective:

- Create a coarse filter vegetation map
- Identify vegetation type conservation targets
- Create rarity rankings for these targets
- Establish percentage conservation goals for each rarity rank
- Complete a vegetation representation analysis (gap analysis) using existing protected lands to evaluate current protection levels for vegetation type conservation targets
- Set acreage goals for each vegetation type target based on the gaps in protection

### Vegetation Focus Team

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The coarse filter analysis was led by the Vegetation Focus Team, which met over the course of a year to complete the work.

Virginia Boucher, University of California, Davis, UC Reserve System

Julie Evens, California Native Plant Society

Melvin George, PhD, University of California, Davis, UC Cooperative Extension

Dan Gluesenkamp, PhD, Audubon Canyon Ranch

Todd Keeler-Wolf, PhD, California Department of Fish and Game/California Native Plant Society

Jeff Kennedy, University of California, Davis, Information Center for the Environment

Janet Klein, Marin Municipal Water District

Lech Naumovich, California Native Plant Society

Casey Stewman, California Native Plant Society/URS Corporation

Andrea Williams, Inventory and Monitoring, National Park Service/Marin Municipal Water District

### Creating the Coarse Filter Vegetation Map

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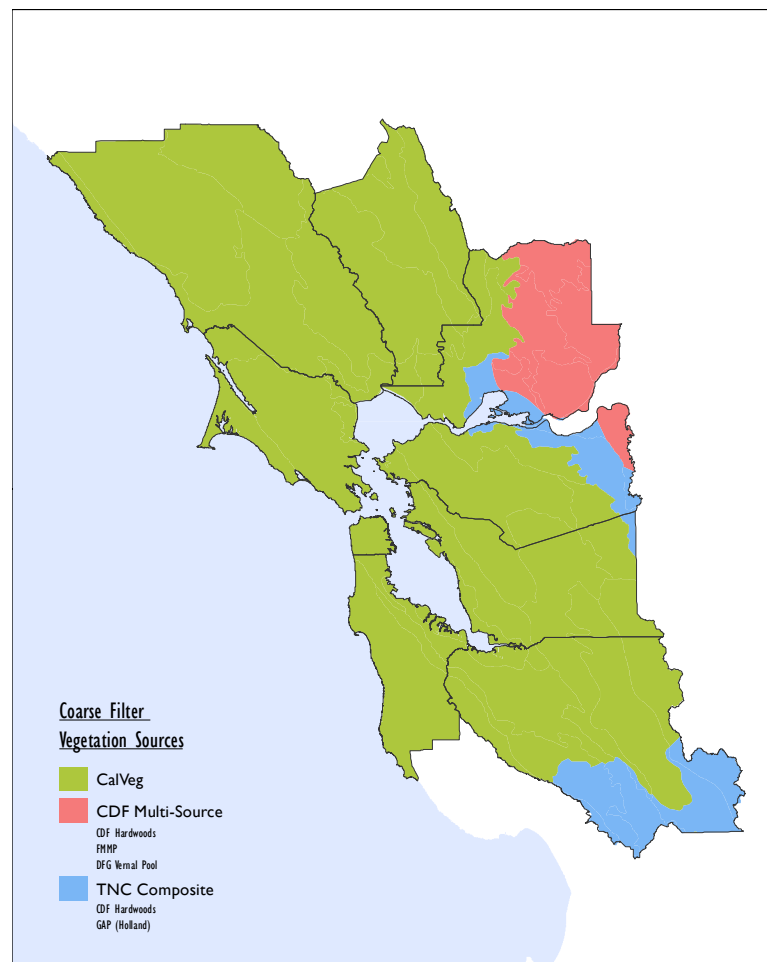
The first challenge faced by the Vegetation Focus Team was the lack of a consistent vegetation map covering the region. The team's preferred vegetation classification system was *A Manual of California Vegetation* (MCV; Sawyer *et al.* 2009) because of the detail it provides. However, only a few areas within the Upland Habitat Goals study area are

mapped using MCV, and the project’s conservation planning software, Marxan, is more effective with consistent vegetation classifications. An alternative vegetation classification system developed by the US Forest Service, CalVeg, covers almost the entire region but has some spatial inaccuracies and lacks sufficient detail for annual grasslands, shrub communities, riparian corridors, and isolated wetlands.

The Vegetation Focus Team agreed to use a modified version of CalVeg, referred to as the Upland Habitat Goals Coarse Filter Vegetation Map, which provided adequate and consistent coverage for the full study area. The Coarse Filter Vegetation Map is a composite of several data sources (Figure 4.1):

1. **The USDA Forest Service CalVeg Vegetation Map (CalVeg,** [www.fs.fed.us/r5/rsl/projects/classification](http://www.fs.fed.us/r5/rsl/projects/classification)). CalVeg is the primary source of the vegetation data.
2. **The Nature Conservancy’s Composite Vegetation Map (TNC Composite).** Developed by the Nature Conservancy for the Central Coast Ecoregional Plan (The Nature Conservancy of California 2006), this was used to fill in two gaps in coverage by CalVeg.
3. **The California Department of Forestry and Fire Multi-Source Vegetation Map (CDF Multi-Source,** [frap.cdf.ca.gov/data/frapgisdata/download.asp?rec=fveg02\\_2](http://frap.cdf.ca.gov/data/frapgisdata/download.asp?rec=fveg02_2)). This composite of the California Department of Forestry Hardwoods, the Department of Conservation Farmland Mapping and Monitoring Program (FMMP), and the Department of Fish and Game California Vernal Pool Assessment was used to fill gaps in CalVeg coverage in the Suisun Marsh region of Solano County and northeastern Contra Costa County.

**Figure 4.1 ■ Sources Used to Create the Coarse Filter Vegetation Map.**

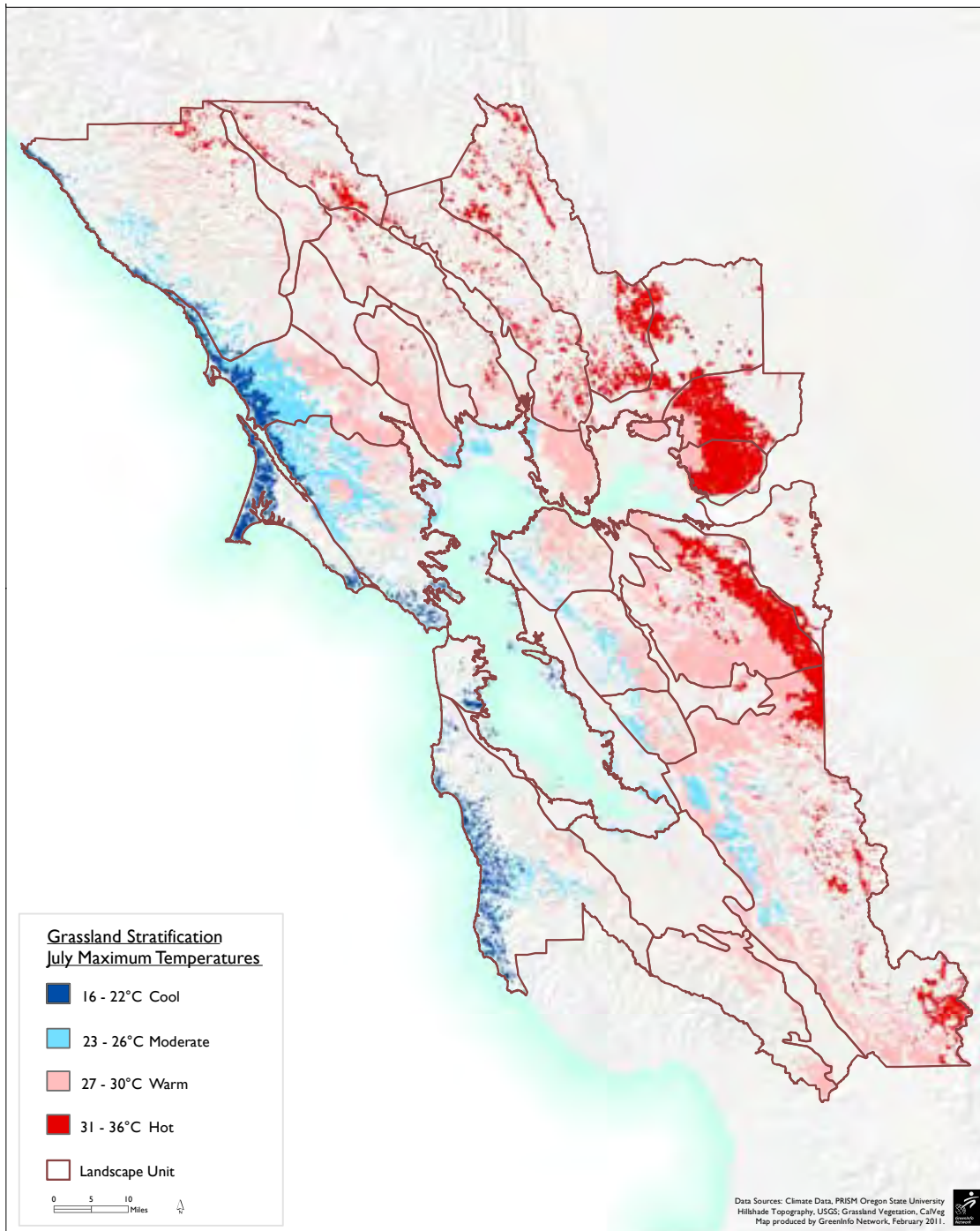


The team made two primary enhancements to this composite vegetation map (Figure 4.1). First, a serpentine geology layer from the USDA Natural Resources Conservation Service State Soil Geographic (STATSGO) Database was added to capture the unique vegetation types found on serpentine soils. Second, a climatic stratification was developed to differentiate the approximately one million acres identified as Annual Grasslands in CalVeg. These grasslands were separated into Cool, Moderate, Warm, and Hot Grasslands based on July maximum temperatures established by PRISM (800m-scale Parameter-elevation Regressions on Independent Slopes Model), a climate mapping system developed at Oregon State University. Figure 4.2 illustrates these temperature stratifications.



Stuart B. Weiss

**Figure 4.2 ■ Stratification of Annual Grasslands.** The Upland Habitat Goals Project used July maximum temperatures (PRISM) to stratify nearly one million acres designated as Annual Grasslands by CalVeg into four vegetation types: Cool, Moderate, Warm, and Hot Grasslands.



## Riparian Vegetation

Riparian areas pose special challenges at the regional scale of the Upland Habitat Goals Project. While the Coarse Filter Vegetation Map captures the larger patches of riparian forests as mapped by CalVeg, it misses the many narrow ribbons of remnant riparian habitat. To capture these smaller riparian areas, the USGS National Hydrologic Database (NHD) was used in the fine filter process to define stream corridors; streams are included as conservation targets in the final version of the Conservation Lands Network.

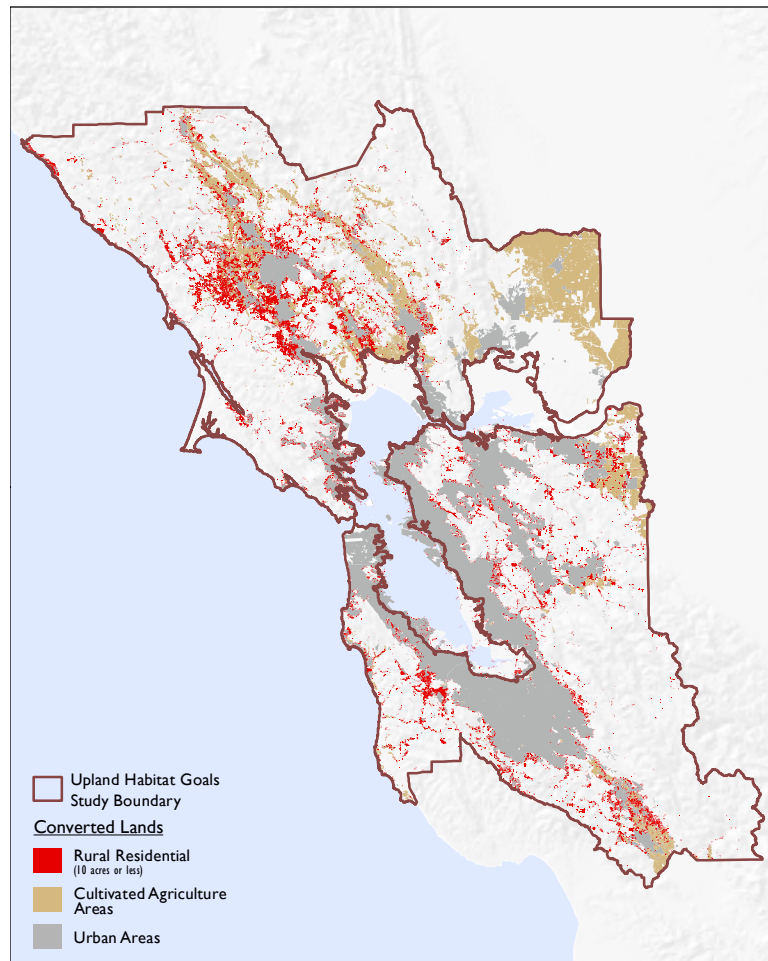
## Converted Lands

The last step in the development of the Coarse Filter Vegetation Map added the Farmland Mapping and Monitoring Program (FMMP) Urban and Cultivated Agricultural data, along with rural residential areas with parcels less than 10 acres – areas collectively referred to as Converted Lands (Figure 4.3). The FMMP data were more current (2008) than similar land use types in CalVeg, and thus provided an important update. Rural residential parcels, typically found on the urban fringe, are of lower conservation suitability. Appendix B (*Data and Methods*, Chapter 4) describes how the Rural Residential data layer was created.

Marxan occasionally selected Converted Lands for inclusion in the Conservation Lands Network if they contained conservation targets needed to meet the 90%, 75%, or 50% goals, or if the 247-acre hexagon included 10% or more of protected lands. As noted in Chapter 3 (*Approach and Methodology*), Converted Lands over-selected by Marxan were removed from the CLN (Figure 3.9).

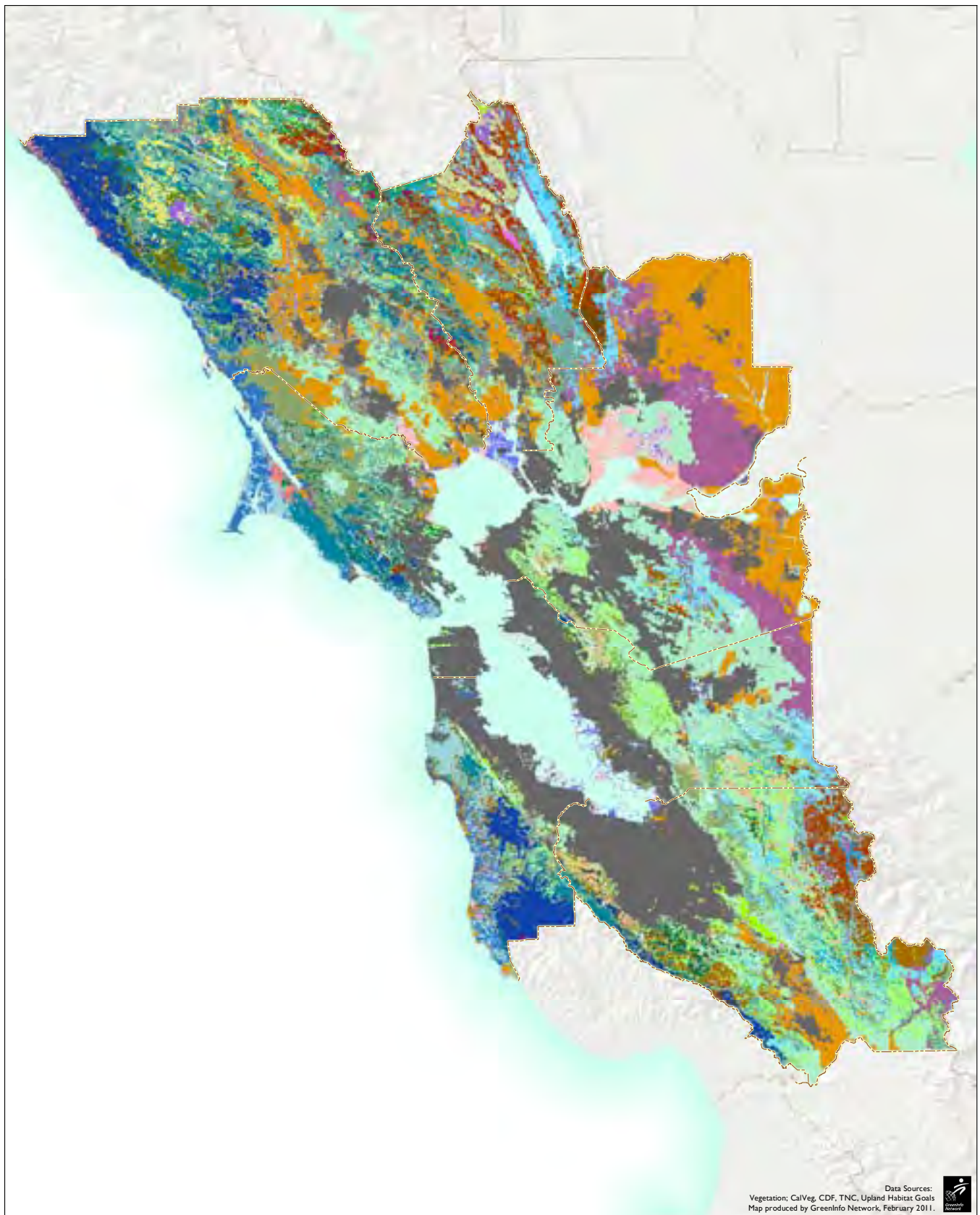


**Figure 4.3 ■ Converted Lands: Urban, Cultivated Agriculture, and Rural Residential Land Uses.**



The final version of the Coarse Filter Vegetation Map (Figure 4.4) is a 30m grid GIS dataset with 61 cover types, 52 of which are natural or semi-natural land cover. Figure 4.5 describes the composition of each vegetation type shown on the Coarse Filter Vegetation Map.

**Figure 4.4 ■ The Coarse Filter Vegetation Map.** For a zoomable version of this map, visit [www.BayAreaLands.org](http://www.BayAreaLands.org).



Vegetation Type

 Barren / Rock	 Monterey Cypress Forest
 Bishop Pine Forest	 Monterey Pine Forest
 Black Oak Forest / Woodland	 Native Grassland
 Blue Oak Forest / Woodland	 Non-Native Ornamental Conifer / Hardwood Mixture
 Blue Oak / Foothill Pine Woodland	 Non-Native / Ornamental Conifer
 California Bay Forest	 Non-Native / Ornamental Grass
 Canyon Live Oak Forest	 Non-Native / Ornamental Hardwood
 Central Coast Riparian Forest	 Non-Native / Ornamental Shrub
 Chamise Chaparral	 Oregon Oak Woodland
 Coast Live Oak Forest / Woodland	 Permanent Freshwater Marsh
 Coastal Salt Marsh / Coastal Brackish Marsh	 Ponderosa Pine Forest (Non-Maritime)
 Coastal Scrub	 Pygmy Cypress Forest
 Coastal Terrace Prairie	 Redwood Forest
 Cool Grasslands	 Rural Residential
 Coulter Pine Forest	 Sargent Cypress Forest / Woodland
 Cultivated Agriculture	 Semi-Desert Scrub / Desert Scrub
 Douglas-Fir Forest	 Serpentine Barren
 Dune	 Serpentine Conifer
 Eucalyptus	 Serpentine Grassland
 Grand Fir Forest	 Serpentine Hardwoods
 Hot Grasslands	 Serpentine Knobcone Pine
 Interior Live Oak Forest / Woodland	 Serpentine Leather Oak Chaparral
 Juniper Woodland and Scrub / Cismontane Juniper Woodland	 Serpentine Riparian
 Knobcone Pine Forest	 Serpentine Scrub
 McNab Cypress	 Sycamore Alluvial Woodland
 Mixed Chaparral	 Tanoak Forest
 Mixed Conifer / Pine Forest	 Urban
 Mixed Montane Chaparral	 Valley Oak Forest / Woodland
 Moderate Grasslands	 Warm Grasslands
 Montane Hardwoods	 Water
	 Wet Meadows

**Figure 4.5 ■ Coarse Filter Vegetation Type Descriptions.**

<b>Vegetation Type</b>	<b>Description</b>	<b>Source</b>
<b>Coniferous Forests</b>		
Bishop Pine Forest	Overstory dominated by Bishop pine	TNC, CalVeg
Coulter Pine Forest	Open stands of Coulter pine with shrub and grass understory	TNC, CalVeg
Douglas-Fir Forest	Overstory dominated by Douglas-fir, with montane hardwood species as secondary canopy cover and occasional redwoods in mesic pockets	TNC, CalVeg
Grand Fir Forest	Dense forest dominated by grand fir	TNC, CalVeg
Knobcone Pine Forest	Dense to moderate stands of knobcone pine, often with shrub understory	TNC, CalVeg
Mixed Conifer / Pine Forest	Dense forests with pines, firs, and other conifers with secondary hardwoods and shrub understory	TNC, CalVeg
Monterey Cypress Forest	Planted stands of Monterey cypress	TNC, CalVeg
Monterey Pine Forest	Native stands of Monterey pine (San Mateo County Coast), and planted stands in other areas	TNC, CalVeg
Ponderosa Pine Forest (Non-Maritime)	Inland forests with overstory ponderosa pines	TNC, CalVeg
Pygmy Cypress Forest	Stands of pygmy cypress	TNC, CalVeg
Redwood Forest	Overstory dominated by redwood with a secondary canopy cover of Douglas-fir and tanoak	TNC, CalVeg
<b>Hardwood Forests</b>		
California Bay Forest	Dense stands dominated by bay trees with secondary canopy of diverse hardwoods	TNC, CalVeg
Montane Hardwoods	A diverse array of oaks, madrone, buckeye, bay, and other hardwoods with scattered conifers and dense canopy cover; composition varies substantially with local climate	CalVeg
Tanoak Forest	Dense to moderate stands dominated by tanoaks with secondary cover of montane hardwoods, Douglas-fir, and redwood	TNC, CalVeg
<b>Herbaceous</b>		
Barren / Rock	Area of no vegetation cover: large rock outcrops in mountains, and barren areas in urban areas	TNC, CalVeg
Coastal Salt Marsh / Coastal Brackish Marsh	Tidally influenced wetlands with Spartina, rushes, and other salt-tolerant plants	TNC, CalVeg
Coastal Terrace Prairie	Diverse grasslands with native perennial grasses and forbs, scattered shrubs	TNC, CalVeg
Cool Grasslands	Grasslands dominated by annuals, with varying amounts of native perennials, where July maximum temperatures are less than 22° C	UHG
Dune	Sandy soils with some active sand movement supporting low stands of diverse native perennials and beach grass, sometimes with small swale wetlands	TNC, CalVeg
Hot Grasslands	Grasslands dominated by annuals, where July maximum temperatures are greater than 30° C	UHG
Moderate Grasslands	Grasslands dominated by annuals, with varying amounts of native perennials, where July maximum temperatures are between 22° and 26° C	UHG
Native Grassland	Grasslands that have been explicitly identified as having a large proportion of native perennial grasses	TNC, CalVeg
Permanent Freshwater Marsh	Wet areas with stands of rushes, cattails, and other marsh vegetation	TNC, CalVeg
Warm Grasslands	Grasslands dominated by annuals, with varying amounts of native perennials, where July maximum temperatures are between 26° and 30° C	UHG
Wet Meadows	Low-growing vegetation in wet areas dominated by sedges, rushes, and grasses	TNC, CalVeg
<b>Oak Forests / Woodlands and Other Woodlands</b>		
Black Oak Forest / Woodland	Dense to open stands dominated by black oak; other montane hardwoods, and conifers present as secondary canopy cover	TNC, CalVeg
Blue Oak / Foothill Pine Woodland	Dense to open mixed stands of blue oaks and foothill pines with an understory of shrubs and grasslands	TNC, CalVeg



Vegetation Type	Description	Source
Blue Oak Forest / Woodland	Dense to open nearly pure stands of blue oak with largely grassland understory	TNC, CalVeg
Canyon Live Oak Forest	Dense stands of canyon live oak	TNC, CalVeg
Coast Live Oak Forest / Woodland	Dense to open stands dominated by coast live oak and secondary cover by other oaks and hardwoods	TNC, CalVeg
Interior Live Oak Forest / Woodland	Dense to open stands of interior live oak with scrubby or grassland understory	TNC, CalVeg
Juniper Woodland and Scrub / Cismontane Juniper Woodland	Open stands of California juniper trees and shrubs, with other shrubs and grassy understory	TNC, CalVeg
Oregon Oak Woodland	Moderate to open stands dominated by Oregon oak	TNC, CalVeg
Valley Oak Forest / Woodland	Moderate to open stands dominated by valley oak	TNC, CalVeg
Riparian Forests		
Central Coast Riparian Forest	Mixed stands of willow, cottonwood, sycamore, maple, box elder, and other trees and shrubs along streams	TNC, CalVeg
Sycamore Alluvial Woodland	Moderate to open stands of sycamore along streams	TNC, CalVeg
Serpentine Variants		
McNab Cypress	Dense to moderate stands of McNab cypress on serpentine rock	TNC, CalVeg
Sargent Cypress Forest / Woodland	Dense to moderate stands of Sargent cypress on serpentine rock	TNC, CalVeg
Serpentine Barren	Barren / rock on serpentine rock	UHG
Serpentine Conifer	Coniferous forest on serpentine rock	UHG
Serpentine Grassland	Grassland on serpentine rock	UHG
Serpentine Hardwoods	Hardwood types (oaks, montane hardwoods, etc.) on serpentine rock	UHG
Serpentine Knobcone Pine	Knobcone pine forest on serpentine rock	UHG
Serpentine Leather Oak Chaparral	Shrublands on serpentine rock dominated by leather oak	TNC, CalVeg
Serpentine Riparian	Riparian forest on serpentine rock	UHG
Serpentine Scrub	Coastal or semi-desert scrub on serpentine rock	UHG
Shrublands		
Chamise Chaparral	Dense shrub stands dominated by chamise	TNC, CalVeg
Coastal Scrub	Dense to moderate stands of coyote brush, ceanothus, poison oak, sage, sagebrush, and diverse other shrubs with grassy openings	TNC, CalVeg
Mixed Chaparral	Dense shrublands with diverse species, including ceanothus, manzanita, Prunus, toyon, and other shrubs; composition varies substantially with local climate	TNC, CalVeg
Mixed Montane Chaparral	Diverse dense shrub community at elevations above 3000ft; various species of manzanita, ceanothus, and other shrubs	TNC, CalVeg
Semi-Desert Scrub / Desert Scrub	Moderate to open shrublands in drier areas including sagebrush, sage, and other xeric shrubs	TNC, CalVeg
Anthropogenic		
Cultivated Agriculture	Cultivated row crops, vineyards, orchards, and other crops that require soil tillage	FMMP
Eucalyptus	Dense stands of planted non-native eucalyptus, usually blue gum	TNC, CalVeg
Non-Native Ornamental Conifer / Hardwood Mixture	Stands of planted non-native conifers and hardwoods	TNC, CalVeg
Non-Native / Ornamental Conifer	Stands of planted non-native conifers	TNC, CalVeg
Non-Native / Ornamental Grass	Areas of planted grasses, often golf courses	TNC, CalVeg
Non-Native / Ornamental Hardwood	Areas of planted non-native hardwoods	TNC, CalVeg
Non-Native / Ornamental Shrub	Areas of planted non-native shrubs	TNC, CalVeg
Rural Residential	Parcels less than 10 acres in size	UHG
Urban	Urban and suburban land uses	FMMP

**Sources:** TNC, CalVeg – from The Nature Conservancy Central Coast Ecoregional Plan, modified from CalVeg.

UHG – Upland Habitat Goals custom vegetation types, including the climatic stratification of grasslands and serpentine variants of other vegetation types.

FMMP – Farmland Mapping & Monitoring Program, California Department of Conservation.

## Coarse Filter Analysis Assumptions

The Vegetation Focus Team established the following assumptions for the vegetation representation analysis:

1. The Coarse Filter Vegetation Map used to identify vegetation type conservation targets is of adequate spatial accuracy, is sufficiently complete, and uses the correct vegetation type classifications to support the identification of important areas of biodiversity.
2. Protecting a minimum percentage of each vegetation type in the study area is important for biodiversity conservation. Vegetation types with the least coverage, due to either rarity or major habitat loss, should receive higher protection goals to ensure they persist and support the current level of biodiversity.
3. Landscapes that are less fragmented by people, parcels, and roads are better suited for conservation because they offer better opportunities for biodiversity conservation.
4. Existing protected lands should be included when developing a network of conservation lands. It is preferable for future conservation lands to be contiguous to existing protected lands.
5. The Coarse Filter Conservation Lands Network generated by Marxan provides a starting point for discussion with the Vegetation Focus Team whose expert opinion will be used to refine the Conservation Lands Network.
6. Refinement of the Coarse Filter Conservation Lands Network will occur when the fine filter focus teams select conservation targets and recommend habitat conservation goals for birds, mammals, fish, riparian habitat, amphibians, reptiles, and invertebrates.

## Setting Conservation Goals for Vegetation Types

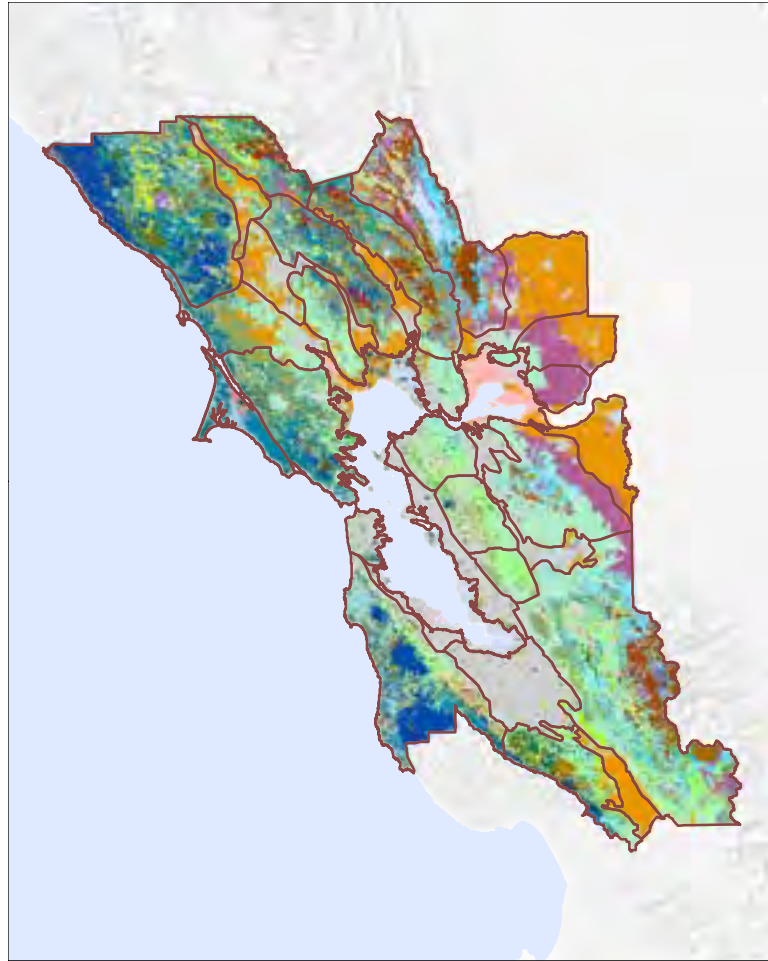
With these assumptions in mind, the Vegetation Focus Team then established vegetation type conservation goals with the following steps:

**1. Selecting Conservation Targets.** The coarse filter approach requires conserving a representative portion of each vegetation type across its range. The landscape units were overlaid on the Coarse Filter Vegetation Map (Figure 4.6), to identify 556 vegetation type conservation targets. (Appendix C, *Vegetation Type Conservation Targets*, lists each vegetation type conservation targets by landscape unit.)



**Figure 4.6 ■ Coarse Filter Vegetation Map, Overlaid with Landscape Units.**

Overlaying the Coarse Filter Vegetation Map with the landscape units identified 556 vegetation type conservation targets. Vegetation maps for each landscape unit are available online at [www.BayAreaLands.org](http://www.BayAreaLands.org).



**2. Ranking Vegetation Types by Rarity.** The Vegetation Focus Team then assigned a rarity ranking from 1 (high) to 4 (low) to each vegetation type conservation target – that is, to each vegetation type in every landscape unit.

Rarity rankings are described as follows:

**Rank 1:** Globally unique or highest priority locally rare vegetation types. Examples: Old-growth Redwood, Serpentine Grasslands, Valley Oak Forest / Woodland, Redwood Forest east of Napa Valley.

**Rank 2:** Locally rare vegetation types comprising 5% or less of a landscape unit. Examples: Blue Oak / Foothill Pine Woodland in the Mt. Hamilton Landscape Unit, Douglas-Fir Forest in the Russian River Valley Landscape Unit, Montane Hardwoods in the Blue Ridge Berryessa Landscape Unit.

**Rank 3:** Locally and globally common vegetation types, also referred to as matrix species, comprising more than 5% of a landscape unit. Examples: Blue Oak Forest / Woodland in the Mt. Hamilton Landscape Unit, Hot Grasslands in Blue Ridge-Berryessa Landscape Unit.

**Rank 4:** Converted Lands that include Urban, Cultivated Agriculture, or Rural Residential land use areas that do not contribute to biodiversity.

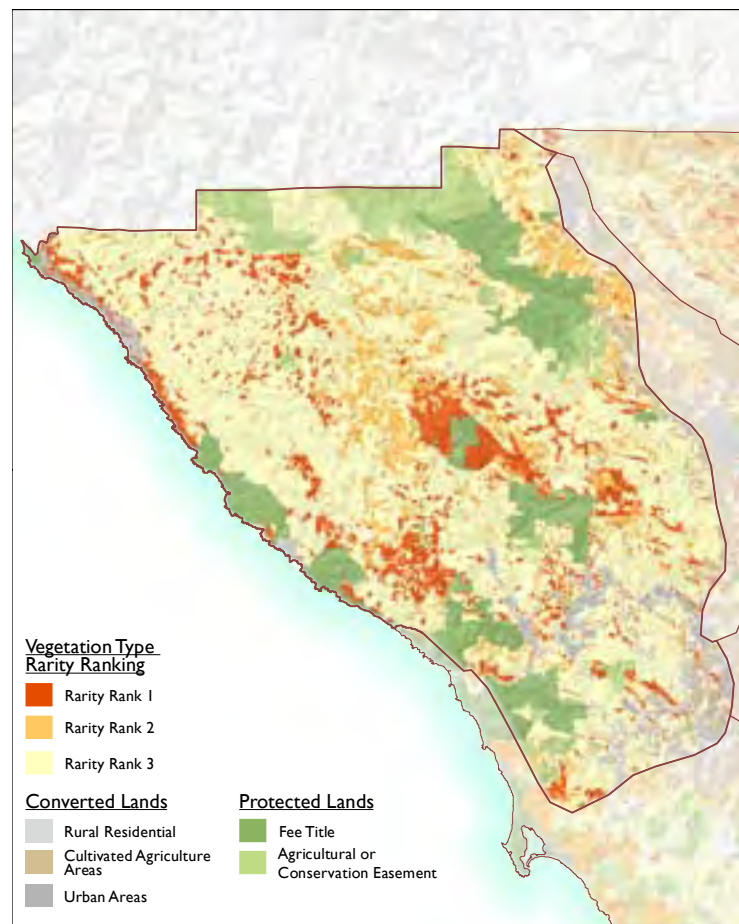
Rarity Rankings for a given vegetation type may vary from one landscape unit to the next, depending on its local abundance. For example, Oregon Oak Woodland is Rarity Rank 1

within the Sonoma Mountains Landscape Unit (only 788 acres mapped), but Rarity Rank 2 within the Sonoma Coast Range Landscape Unit (22,000 acres mapped). Similarly, Blue Oak Forest / Woodland is Rarity Rank 1 in the Sonoma Coast Range Landscape Unit (108 acres), Rarity Rank 2 in the Sierra Azul Landscape Unit (5,523 acres), and Rarity Rank 3 in the Mt. Hamilton Landscape Unit (87,000 acres). The emphasis on local rarity within landscape units captures unique local biodiversity and environments in the Conservation Lands Network.

Due to their uniqueness throughout the Bay Area, vegetation types associated with serpentine rock were always assigned a Rarity Rank 1, with the exception of the large tracts (~26,000 acres) of Serpentine Leather Oak Chaparral found in the Blue Ridge Berryessa Landscape Unit, which were assigned a Rarity Rank 2. Similarly, because of significant habitat losses, Riparian, Wetland, Dune, Native Grasslands, and Valley Oak Woodland vegetation types were always assigned a Rarity Rank 1.

To illustrate how these rarity rankings might be distributed throughout a given landscape unit, Figure 4.7 maps the vegetation type rarity rankings in the Sonoma Coast Range Landscape Unit. The Rarity Rank 1 areas shown in orange (~48,000 acres) include a total of 18 vegetation types, such as serpentine vegetation types, Tanoak Forest, Cool Grasslands along the immediate coast, Bishop Pine Forest, and Central Coast Riparian Forest. The Rarity Rank 2 areas are yellow (~47,000 acres) and include 12 vegetation types, such as California Bay Forest, Oregon Oak Woodland and Mixed Montane Chaparral. The light tan Rarity Rank 3 areas (~300,000 acres) include Redwood Forest, Douglas-Fir Forest, and Moderate, Warm, and Hot Grasslands.

**Figure 4.7 ■ Distribution of Rarity Rankings in the Sonoma Coast Range Landscape Unit Vegetation Type.** As an example of vegetation type rarity within a given landscape unit, this map shows the distribution of rarity rankings for the vegetation types in the Sonoma Coast Range Landscape Unit.



**3. Setting Conservation Goals.** The Vegetation Focus Team established the following conservation goals for the rarity rankings:

**Rarity Rank 1: 90% conservation**

**Rarity Rank 2: 75% conservation**

**Rarity Rank 3: 50% conservation**

**Rarity Rank 4: no conservation goals**

Conservation goals for each of the 556 vegetation type conservation targets (vegetation type by landscape unit) were developed by determining the total acreage of each vegetation type in a landscape unit, applying the percentage protection goal (90%, 75%, 50%) and subtracting the protected acreage in the 2010 Bay Area Protected Areas Database (BPAD; see Chapter 3 (*Approach and Methodology*) for a full discussion of this database). Goals were not set for Rank 4 lands, which are anthropogenic vegetation types or Converted Lands and generally do not support biodiversity.



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The only exception to this methodology is the Central Coast Riparian Forest vegetation type. When the Converted Lands categories were added to the Coarse Filter Vegetation Map, the little riparian habitat that was mapped by CalVeg was removed. To compensate for this loss, all of the Central Coast Riparian Forest and Sycamore Alluvial Wodland vegetation types were added to the Conservation Lands Network after the final Marxan run. This step, described more thoroughly in Chapter 5 (*Fine Filter: Riparian Habitat and Fish*), brought the goal to 100% for the Central Coast Riparian Forest vegetation type.

Figure 4.8 summarizes the acreage goals for each vegetation type in the region. A more detailed table listing acreage goals for each vegetation type by landscape unit conservation target is found in Appendix C.

#### **4. Selecting and Applying Plant Fine Filter Targets to the Coarse Filter Analysis.**

To ensure that the Coarse Filter Conservation Lands Network offered sufficient coverage for plant species of special concern, California Natural Diversity Database (CNDDDB) plant occurrence data and expert opinion were used for a plant fine filter analysis. CNDDDB records as of summer 2007 were used to develop a list of plant fine filter targets for the study area. The data were filtered to eliminate older and less spatially accurate occurrences. The plant lists were reviewed by California Native Plant Society (CNPS) chapter members, who prioritized the top 15 species in nearly all the landscape units. This prioritization was used to set goals for plant fine filter targets for Marxan. For the top 15 species prioritized by CNPS, a 90% protection goal was set; all other CNDDDB plant species were assigned a 75% protection goal. The final Marxan run used the same prioritized list of plant species, using the most current CNDDDB occurrence records as of summer 2010.

A table listing the plant species selected by the CNPS chapters is in Appendix E (*Fine Filter Conservation Targets*), and more detail on the methods is included in Appendix B (*Data and Methods*, Chapter 4).

#### **5. Creating the Coarse Filter Conservation Lands Network.**

To produce the first draft of the Coarse Filter Conservation Lands Network, Marxan was run using the vegetation type conservation targets with 90%, 75%, and 50% goals and the plant fine filter targets with 90% and 75% goals. Marxan was calibrated to achieve all of the acreage goals listed in Figure 4.8. The resulting draft Coarse Filter Conservation Lands Network generated by Marxan was used as the starting point for discussion by the Vegetation Focus Team.

**Figure 4.8 ■ Vegetation Type Acreage Goals.** This table shows total acreage goals for each vegetation type (except those in Rarity Rank 4), the amount already protected, and the additional acreage required to meet the goals. A more detailed table showing acreage goals for vegetation types within each landscape unit can be found in Appendix C (*Vegetation Type by Landscape Unit Acreage Goals*).

Vegetation Type	Total acreage	Acreage goals by Rarity Rank			Total acreage goals	Protected acreage	Acreage to meet goals
		Rank 1 90% goal	Rank 2 75% goal	Rank 3 50% goal			
Barren / Rock	6,654	287	4,751	0	5,038	1,378	3,684
Bishop Pine Forest	7,224	3,481	8	1,673	5,162	3,968	2,569
Black Oak Forest / Woodland	4,193	2,381	1,160	0	3,541	333	3,208
Blue Oak / Foothill Pine Woodland	32,516	376	24,073	0	24,449	12,184	12,266
Blue Oak Forest / Woodland	191,358	1,487	6,742	90,358	98,587	70,637	29,847
California Bay Forest	48,913	1,525	11,645	15,846	29,016	27,266	6,854
Canyon Live Oak Forest	7,154	166	5,227	0	5,393	1,459	3,941
Central Coast Riparian Forest	13,704	12,334	0	0	12,334	5,187	7,175
Chamise Chaparral	91,771	1,296	31,110	24,426	56,831	43,942	12,895
Coast Live Oak Forest / Woodland	213,052	529	21,136	92,141	113,806	91,461	28,477
Coastal Salt Marsh / Coastal Brackish Marsh	1,880	1,692	0	0	1,692	899	815
Coastal Scrub	90,173	3,681	41,706	15,237	60,625	59,813	12,587
Coastal Terrace Prairie	870	783	0	0	783	12	771
Cool Grasslands	72,283	14,767	41,906	0	56,674	41,948	18,373
Coulter Pine Forest	266	239	0	0	239	68	179
Douglas-Fir Forest	163,145	3,517	5,674	75,836	85,027	65,960	35,355
Dune	771	694	0	0	694	489	222
Grand Fir Forest	216	194	0	0	194	53	141
Hot Grasslands	269,259	0	0	134,629	134,629	54,433	81,104
Interior Live Oak Forest / Woodland	8,923	8	6,686	0	6,694	4,639	2,216
Juniper Woodland and Scrub / Cismontane Juniper Woodland	197	178	0	0	178	197	0
Knobcone Pine Forest	6,755	466	4,678	0	5,144	2,320	2,824
McNab Cypress	9,677	8,710	0	0	8,710	5,101	3,701
Mixed Chaparral	15,139	0	11,354	0	11,354	3,995	7,362
Mixed Conifer / Pine Forest	430	0	323	0	323	135	188
Mixed Montane Chaparral	145,329	1	31,061	51,957	83,018	44,452	39,350
Moderate Grasslands	143,794	0	0	71,897	71,897	62,570	13,651
Montane Hardwoods	327,514	178	17,296	152,128	169,601	90,190	80,304
Monterey Cypress Forest	91	0	0	42	42	53	3
Monterey Pine Forest	1,958	0	0	979	979	1,593	155
Native Grassland	1,165	1,049	0	0	1,049	877	172
Oregon Oak Woodland	37,876	1,448	27,201	0	28,649	4,812	23,836
Permanent Freshwater Marsh	2,361	2,125	0	0	2,125	498	1,631
Ponderosa Pine Forest (Non-Maritime)	11,521	30	8,616	0	8,646	2,626	6,172

Vegetation Type	Total acreage	Acreage goals by Rarity Rank			Total acreage goals	Protected acreage	Acreage to meet goals
		Rank 1 90% goal	Rank 2 75% goal	Rank 3 50% goal			
Pygmy Cypress Forest	106	96	0	0	96	106	0
Redwood Forest	172,431	5,906	53,829	47,048	106,783	49,623	57,867
Sargent Cypress Forest / Woodland	2,955	2,660	0	0	2,660	2,318	519
Semi-Desert Scrub / Desert Scrub	45,901	87	34,353	0	34,440	26,222	9,547
Serpentine Barren	1,149	1,034	0	0	1,034	707	349
Serpentine Conifer	8,095	7,285	0	0	7,285	3,273	4,021
Serpentine Grassland	16,632	14,671	248	0	14,919	5,992	8,927
Serpentine Hardwoods	16,863	15,177	0	0	15,177	5,572	9,614
Serpentine Knobcone Pine	457	411	0	0	411	238	185
Serpentine Leather Oak Chaparral	39,386	11,810	19,697	0	31,508	18,195	13,344
Serpentine Riparian	135	121	0	0	121	57	64
Serpentine Scrub	1,026	924	0	0	924	551	375
Sycamore Alluvial Woodland	97	87	0	0	87	68	25
Tanoak Forest	28,065	25,259	0	0	25,259	2,044	23,218
Valley Oak Forest / Woodland	6,795	6,115	0	0	6,115	2,729	3,405
Warm Grasslands	516,149	0	3,964	255,432	259,396	130,235	129,160
Wet Meadows	205	185	0	0	185	46	139
<b>Total</b>	<b>2,784,579</b>	<b>155,450</b>	<b>414,444</b>	<b>1,029,629</b>	<b>1,599,523</b>	<b>953,526</b>	<b>702,787</b>

## 6. Draft Coarse Filter Conservation Lands Network Review by the Vegetation

**Focus Team.** In their review of the draft Coarse Filter Conservation Lands Network, the Vegetation Focus Team made the following adjustments:

- All occurrences of old-growth redwood within the Redwood Forest vegetation type were marked as Rarity Rank 1 targets.
- Vernal pools identified by the Department of Fish and Game Vernal Pool Assessment data for Solano County were added as a Rarity Rank 1 target.
- Connections to protected lands adjacent to – but just outside of – the Upland Habitat Goals geographic scope were added to enhance linkages to areas beyond the boundaries of the study area.

The revised Coarse Filter Conservation Land Network was used as the starting point for the fine filter focus teams, which reviewed coverage for their respective conservation targets.

## Assessing the Viability of Vegetation Conservation Targets

As discussed in Chapter 3, protecting land from development is only the first step in conserving biodiversity. Vegetation patterns are a function of the ecological processes that support diversity at many spatial and temporal scales. Understanding the roles of these processes is central to assessing the long-term viability of conservation targets. Many ecological processes and functions are implicitly addressed in the design of the Conservation Lands Network: it is representative, and focused on large contiguous blocks of habitat that are well connected both within and between landscape units. Other processes and functions are best considered as stewardship challenges – for example, managing grazing to allow native plants to thrive.

The following interrelated processes are key factors in the viability of the vegetation mosaic across the landscape. These viability factors, along with several others, are discussed fully in Chapter 9 (*Conservation Target Viability*).

1. **Climate change:** Vegetation exists in quasi-equilibrium with the local climate. As temperatures and water balance change over time, fire frequency, drought stress, insect outbreaks, and other mechanisms will change, affecting mortality and recruitment and thus the composition and structure of vegetation. Climate projections indicate a general increase in aridity, which may lead to an increase in shrublands at the expense of woodlands and forests.
2. **Nitrogen deposition:** Air pollution delivers substantial amounts of reactive nitrogen to landscapes downwind of major urban and agricultural sources. This added nitrogen fertilizes ecosystems, and can lead to more intense weed invasions, increased grass biomass and fire intensity, and loss of native forbs. Low biomass vegetation types, especially those on nutrient-poor soils such as serpentine, are particularly susceptible. Appropriate grazing regimes are the only way to manage nitrogen deposition impacts over large areas; smaller areas can be managed by mowing and prescribed burns.







3. **Fire:** Fire is an inevitable factor in Bay Area landscapes, given a long dry season combined with frequent human and infrequent natural ignition sources. Many vegetation types are dependent on a certain frequency and intensity of fires. A lack of fire alters successional patterns leading to changes in vegetation types, and too-frequent fire can eliminate key plant species. Prescribed fire is an important management tool where it can be used safely. Fire management is especially complex near the urban-wildland interface.
4. **Succession:** Succession is the change in vegetation composition and structure as new species become established, or as existing species disappear. The dynamic nature of vegetation requires land managers to anticipate changes and determine when and where to intervene. Successional issues are particularly important in Cool and Moderate Grasslands, where rapid invasion by coyote brush, Douglas-fir, and other trees and shrubs can eliminate open habitat. Douglas-fir can also invade the understory of oak woodlands and montane hardwoods, eventually becoming the dominant species. In mature stands, the senescence of oak trees in the absence of recruitment leads to conversion to grasslands. Appropriate disturbance regimes (e.g., grazing, fire, and mechanical treatments) need to be implemented to manage succession.
5. **Disease:** Sudden Oak Death, a disease caused by the pathogen *Phytophthora ramorum*, has led to massive mortality of tanoaks and coast live oaks in the coastal mountains that can lead to vegetation type conversions. Other species, including bay trees, can rapidly fill in gaps left by the dead trees (Brown and Allen-Diaz 2005).
6. **Invasive plants:** Non-native plants pose a significant threat to native vegetation. Bay Area grasslands have already been converted to a predominant cover of non-native annual grasses and forbs, and invasions of shrubs such as broom and gorse threaten native grasslands, shrublands, and woodlands. Climate change is predicted to contribute to increased frequency and intensity of fires, leaving burned areas vulnerable to invasion by non-native species. Weed management is an ongoing process that requires a long-term commitment of resources for management.
7. **Grazing and range management:** Many, if not most, grasslands and open woodlands are used for cattle grazing, which benefits many plant species; many native grassland forbs require moderate grazing. In the absence of grazing, dead grass biomass, called thatch, accumulates preventing native species from getting established. Vernal pools and serpentine grasslands, in particular, require some grazing to maintain native diversity in high nitrogen deposition areas. Poor grazing management can be destructive, especially in riparian zones. Grazing regimes vary in intensity and duration, but modern range management provides many tools to implement appropriate grazing regimes.

## Data Gaps Identified in the Coarse Filter Analysis

Several data gaps were identified during the coarse filter analysis.

1. **Vegetation map.** Conservation planning in the Bay Area would be more accurate and effective with a current, regional vegetation map with a detailed classification system. CalVeg, the primary data source for the Upland Habitat Goals Coarse Filter Vegetation Map, has some spatial inaccuracies and lacks sufficient detail for annual grasslands, shrub communities, riparian corridors, and isolated wetlands. It also lacks any detail about the structure of the vegetation types.
2. **Species occurrence information.** The species occurrence data used for the analyses were mostly derived from the California Natural Diversity Database, which is notably incomplete. Biological surveys for key species would improve the Conservation Lands Network.
3. **Historical baseline.** No historical maps exist that describe Bay Area vegetation types and distribution prior to extensive disturbance caused by the arrival of Europeans. The best-known source of historical information is the hand-drawn Wieslander maps produced in the 1920s and 30s by the US Forest Service, and named after their creator. The Wieslander Vegetation Type Mapping Project, a collaboration between UC Berkeley and UC Davis, has completed the digitizing and georeferencing of these maps. However, an analysis has not yet been completed to evaluate loss of vegetation types; this baseline information would guide restoration efforts.
4. **Stewardship classification for the Bay Area Protected Areas Database (BPAD).** The lack of accurate stewardship information on existing protected lands is a fundamental data gap. Not all protected lands are managed with biodiversity as the primary objective; ideally, this information would influence their inclusion in the Conservation Lands Network. The Upland Habitat Goals Project partially compensated for this data gap by removing lands from the BPAD that do not contribute to biodiversity (e.g., cultivated agriculture, publicly-owned golf courses) prior to the coarse filter analysis. While some stewardship classification systems have been developed, the complexity of protected land management in the Bay Area makes it difficult to apply these systems without detailed review. A careful survey of the level of stewardship provided to protected lands would reveal areas where stewardship needs improvement and provide an estimate of stewardship funding needs. One option is to work with GreenInfo Network, developer of the California Protected Areas Database (CPAD). GreenInfo is applying the USGS GAP Analysis Program conservation status rankings to CPAD entries. GAP ranks are 1 to 4, and based on degree of protection and management for conservation purposes. A conservation status rank of 1 indicates the highest level of protection; 4 is the least protected. More information can be found at [www.biogeog.ucsb.edu/projects/gap/report/gap\\_rep\\_sum.html](http://www.biogeog.ucsb.edu/projects/gap/report/gap_rep_sum.html).

GreenInfo Network intends to improve the method for determining these ranks by incorporating specifics about management plans for protected areas. CPAD includes the Bay Area but does not include conservation easements.

These and other data gaps are discussed further in Chapter 13 (*Research Needs, Measuring Success, and Conservation Lands Network 2.0*).

## CHAPTER

# 5

# Fine Filter: Riparian Habitat and Fish



Jonathan Koehler

## Introduction

The Riparian/Fish Focus Team met four times from April to August 2008 and crafted an approach for establishing conservation goals befitting the unique nature of riparian resources. The focus team included experts in stream geomorphology, hydrology, and fish biology from federal, state, and local agencies, nonprofit conservation organizations, and environmental consulting firms; together, they shaped the methodology for identifying conservation targets, setting conservation goals, and recommending conservation actions.

While this focus team was charged with ensuring that fish and riparian resources were more than adequately represented in the Conservation Lands Network, the group recognized that streams and riparian areas also provide vital habitat for many of the Bay Area's mammals, birds, amphibians, reptiles, and invertebrates. Thus, the recommendations from the Riparian/Fish Focus Team are designed to benefit all riparian-dependent species.

## Riparian/Fish Focus Team Members

Gordon Becker, Center for Ecosystem Management and Restoration  
Kit Crump, National Oceanic and Atmospheric Administration  
Leslie Ferguson, San Francisco Bay Regional Water Quality Control Board  
Leticia Grenier, PhD, San Francisco Estuary Institute  
Rainer Hoenicke, PhD, San Francisco Estuary Institute  
Jonathan Koehler, Napa County Resource Conservation District  
Robert Leidy, PhD, US Environmental Protection Agency  
Lisa Micheli, PhD, Sonoma Ecology Center/Pepperwood Preserve  
Paul Randall, EOA, Inc.  
Ken Schwarz, PhD, Horizon Water and Environmental  
Gail Seymour, California Department of Fish and Game  
Phil Stevens, Urban Creeks Council

The Riparian Habitat / Fish Focus Team prepared a separate, detailed report, which is available at [www.BayAreaLands.org/reports](http://www.BayAreaLands.org/reports).

The overarching goal of the Riparian/Fish Focus Team was to define a network of important streams, riparian habitat, and associated upland areas, and to recommend conservation actions to conserve, restore, and sustain riparian ecosystems and their invaluable functions to support healthy native fish populations. Toward that end, the focus team selected fish and other relevant conservation targets consistent with the Conservation Target Selection Criteria (Figure 3.6), described species habitat requirements, agreed on conservation goals for the targets, identified a network of streams with associated riparian and upland areas to accomplish the goals, and evaluated coverage of the conservation targets' habitat requirements by the Coarse Filter Conservation Lands Network.

The ecological processes of nearly all Bay Area riparian ecosystems have been disrupted, in some cases radically, and as much as 95% of riparian habitat has been lost (CCMP 2007). To achieve effective conservation of riparian ecosystems, the entire hydrologic continuum – including low-order headwaters and high-order streams – must be considered for conservation and restoration. Restoration focused only on in-channel fixes will not be successful without addressing problems throughout the watershed, including the basin, riparian corridor, and floodplain. Similarly, protection and restoration actions will not be successful in the long-term absent appropriate stewardship. The Riparian/Fish Focus Team emphasized the critical need for extensive restoration of riparian ecosystems.

The Upland Habitat Goals Project necessarily takes a regional approach to the thousands of miles of streams in the Bay Area. Yet, the conservation and restoration needs of riparian systems are extremely site-specific and cannot be accurately prescribed from this regional viewpoint. As a result, the recommended conservation actions are general and focus on restoring ecological processes. They cover a range of actions including comprehensive watershed planning, conservation of headwaters areas, and regulatory actions such as the designation of impaired waterways and the Total Maximum Daily Load (TMDL) planning process. The only exceptions to these general recommendations are the specific recommendations that come from the *Public Draft Recovery Plan for the Evolutionarily Significant Unit of Central California Coast Coho Salmon* (NMFS 2010), Priority Recovery Actions for the Central California Coast Steelhead Distinct Population Segment (NMFS 2007), and Essential Watersheds and Priority Stream Segments for Focused Conservation Actions to Protect Native Fishes, San Francisco Estuary, California, prepared by Robert Leidy, PhD, US Environmental Protection Agency (Leidy 2008; see Appendix D, *Essential Streams of the San Francisco Estuary*).

The Upland Habitat Goals Project used expert opinion and the best available data from multiple sources to identify the priority streams, watersheds, and riparian habitat for conservation. It should be noted that while the project established priorities for streams based on presence of fish conservation targets, the importance of all riparian corridors for biodiversity is captured by the inclusion of all blue-line streams (streams that run most of the year and are shown on USGS topographic maps) from the National Hydrography Dataset (NHD, 1:24,000) in the Conservation Lands Network. The resulting riparian network extends beyond the Upland Habitat Goals study area boundaries into urban areas and the baylands, the subject of the San Francisco Baylands Ecosystem Goals. In the case of the Russian and Pajaro River basins, the former originates outside of the study area, while the latter flows outside of the study area south to Monterey Bay.

Conservation target viability was assessed at the CalWater 2.2.1 Planning Watershed level (the finest scale readily available in GIS format), ranging from 1,000 to 20,000 acres in size (median size is 6,894 acres) and using indicators of watershed ecological integrity. Indicators used included human population density, impervious surfaces, cultivated agriculture, timber harvesting, urbanization, distance to roads, and protected lands (BPAD 2010; see [www.BayAreaLands.org/gis/all-datasets.php](http://www.BayAreaLands.org/gis/all-datasets.php) for the full list). These human-caused disturbances impair ecological processes by causing sedimentation, alteration of stream channel geomorphology, loss of vegetation, and barriers to fish passage, among other impacts.

This chapter is a summary of the work of the Riparian/Fish Focus Team. A detailed description of the methodology can be found in the Riparian/Fish Focus Team Report, available for review and download at [www.BayAreaLands.org/reports](http://www.BayAreaLands.org/reports).

## Riparian Defined

The San Francisco Estuary Institute reviewed numerous definitions of “riparian” in *Comparison of Methods to Map California Riparian Areas* (Collins *et al.* 2006). The most expansive definition is from the National Research Council, which delineates riparian areas as all lakeshores, stream or river channels, estuarine and marine shorelines, and wetland margins. Definitions postulated by state and federal agencies typically are more restricted, focusing on streams, rivers, and associated vegetation.

The Riparian/Fish Focus Team chose the more limited definition and focused on streams, rivers, and associated riparian vegetation types. These areas may be perennial, intermittent, or ephemeral, and are transitional between terrestrial and aquatic ecosystems. The Upland Habitat Goals Coarse Filter Vegetation Map identifies three riparian vegetation types: Central Coast Riparian Forests, Sycamore Alluvial Woodlands, and Serpentine Riparian. During the coarse filter analysis, the Vegetation Focus Team assigned all riparian vegetation types in all landscape units a Rarity Rank 1 with a 90% conservation goal.



Jonathan Koehler

However, this 90% goal is for existing vegetation as mapped; much riparian vegetation has already been lost and the remnants are poorly mapped.

## The Unique Role of Riparian Areas in Climate Change Adaptation

Riparian areas are anticipated to play a unique role in adaptation to climate change for many reasons (Seavy *et al.* 2009). First, riparian species tend to be particularly resilient because they typically need to adapt to both seasonal and annual variations in environmental conditions such as drought or flooding, both of which are predicted to increase in frequency under climate change. As impacts of climate change continue, the maintenance and restoration of riparian zones can enhance resiliency both within and beyond riparian areas. Second, riparian habitats function as wildlife corridors for many plant and animal species, giving them room to move and adapt to climate change. Third, rivers and streams cross elevational gradients, connecting different ecological zones as well as aquatic and terrestrial ecosystems. Lastly, the cooler temperatures found in riparian zones provide refuge as temperatures increase.

## Riparian and Fish Resources in the San Francisco Bay Area

An extensive report titled *Ecology, Assemblage Structure, Distribution and Status of Fishes in Streams Tributary to the San Francisco Estuary, California* was completed in 2007 by Focus Team member Robert Leidy, PhD, US Environmental Protection Agency. Given the availability and thoroughness of this important document, only a brief overview of riparian resources is offered here.

As with so many ecosystems in California, riparian and fish resources have been severely impacted by human alterations to the landscape that have destroyed riparian forests and disrupted ecological processes. Some estimates put the loss of riparian habitat as high as 95% (CCMP 2007). A testament to these losses, the Evolutionarily Significant Unit (ESU) of Central California Coast coho salmon is federally listed as endangered, and has been extirpated from San Francisco Bay. Four Distinct Population Segments (DPS) of steelhead coincide with the Upland Habitat Goals study area – Central California Coast, Central Valley, Northern California, and South-Central California Coast – and all four are listed as federally threatened. Chinook salmon, which primarily pass through the Bay, are also listed as either threatened or endangered depending on the ESU.

In addition to these anadromous species, eleven fish species are endemic to the streams of the San Francisco Estuary (Leidy 2007), considered part of the Sacramento-San Joaquin Province (Moyle 2002). Figure 5.1 shows the geographic distribution and status of these native species.



Stuart B. Weiss

**Figure 5.1 ■ Current Geographic Distribution and Population Status of Native Stream Fishes of the San Francisco Estuary** (Leidy *et al.* 2011).

Geographic Distribution	Estimated Population Abundance (Number of adults)			
	Extirpated (0)	Low (<1000)	Moderate to High (1000 - 500,000+)	Unknown
<b>Extirpated</b> (not present in any watersheds)	thicktail chub <sup>1</sup> coho salmon tidewater goby <sup>2</sup>			
<b>Narrow / Restricted</b> (1- 5 watersheds)		green sturgeon <sup>2</sup> Delta smelt <sup>2,3</sup> chum salmon pink salmon sockeye salmon Sacramento perch <sup>1,2</sup>	hitch <sup>1,2</sup> hardhead <sup>1</sup> splittail <sup>1,2,3</sup> longfin smelt <sup>2,3</sup> shiner perch <sup>2</sup> starry flounder <sup>2</sup>	river lamprey <sup>2</sup> western brook lamprey <sup>2</sup> eulachon speckled dace <sup>1</sup>
<b>Intermediate to Widespread</b> (6 or more watersheds)		white sturgeon <sup>2</sup> Chinook salmon <sup>2</sup>  rainbow trout/ steelhead <sup>3</sup>  tule perch <sup>1,4</sup>	Pacific lamprey <sup>2</sup> Sacramento blackfish <sup>1</sup> California roach <sup>1</sup> Sacramento pikeminnow <sup>1</sup> Sacramento sucker <sup>1</sup> rainbow trout/steelhead <sup>2</sup> threespine stickleback <sup>2</sup> prickly sculpin <sup>2</sup> riffle sculpin <sup>1</sup> staghorn sculpin <sup>2</sup> tule perch <sup>1,2,4</sup> longjaw mudsucker <sup>2</sup>	

<sup>1</sup> Freshwater dispersant.

<sup>2</sup> Primarily estuarine resident (*i.e.*, tidally-influenced riverine environments), or known to maintain estuarine and non-estuarine stream populations.

<sup>3</sup> Population abundances (*i.e.*, the number of adult individuals within a population) are known to vary greatly depending on amount of total Estuary outflow and/or local streamflow conditions.

<sup>4</sup> Tule perch exhibit low to moderate-to-high population abundances in the southern and northern Estuary, respectively.

Leidy also notes that Estuary streams typically support three to five of the following assemblages, as defined by the dominant fish in the assemblage:

1. Rainbow trout / upper mainstem-headwater tributary assemblage
2. Mixed native fishes / middle mainstem-lower large tributary assemblage
3. Mixed native and non-native fishes / lower small to large mainstem assemblage
4. Estuarine fishes / tidal riverine assemblage
5. Reservoir-affected assemblage / lacustrine assemblage
6. California roach / small, warm, intermittent tributary assemblage

## Riparian/Fish Focus Team Methodology

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### Working Assumptions and Guiding Principles

The Riparian/Fish Focus Team adopted the following Working Assumptions and Guiding Principles developed by team member Robert Leidy, PhD, to guide conservation target selection and final recommendations.

1. There is a strong correlation between watershed area and native fish species diversity. Therefore, conservation actions focused on the largest watersheds have the potential to protect the greatest number of native fish species. Similarly, there is a high correlation between San Francisco Estuary Anchor Watersheds and Essential Streams (defined in the section on Stream Conservation Targets) for steelhead as identified in Becker *et al.* (2007) and the diversity of other native fish species. All identified Anchor Watersheds and Essential Streams for steelhead are included as Priority 1 watersheds.
2. Anchor Watersheds and Essential Streams identified in Becker *et al.* (2007) constitute the best remaining habitat for steelhead and have the most immediate restoration needs and potential. However, other streams in Anchor and non-anchor watersheds that support steelhead and/or assemblages of native fishes should also be considered in the establishment of conservation goals.
3. Coho salmon are the rarest and most at-risk species in the coastal areas. Streams and watersheds that currently support or recently supported coho generally include the best remaining fish habitat, especially for steelhead. Therefore, coho streams are considered the Anchor Watersheds and Essential Streams for coastal areas.
4. Any prioritization of streams for fishes must consider the ecological importance of maintaining connectivity, both lateral (riparian) and longitudinal (tidal to headwaters). This is important when considering buffer widths, fish immigration and emigration, and dispersal for recolonization and maintenance of populations.
5. Fishless streams, especially first- and second-order headwaters, are critical to maintaining native fishes, particularly rainbow trout that may occur immediately downstream. The protection of undeveloped headwaters of first- and second-order streams through easements and fee acquisition and other innovative mechanisms is a conservation priority.
6. All freshwater dispersant fishes in estuary watersheds are variously isolated from other watersheds, depending on geographic location and other physical and biological factors. Within the estuary there are general geographic gradients of increasing watershed isolation from north to south, and from large to small drainage area. Therefore, whenever possible, conservation targets should be in close proximity in order to decrease isolation.
7. Any conservation prioritization for native fishes must include a full range of watershed sizes. Several relatively small- to medium-sized watersheds support intact assemblages of native fishes.
8. Watersheds and stream segments from all landscape units should be represented in the conservation strategy where possible and supported by the data.
9. Ecological redundancy of conservation targets is a priority. For a given conservation target, goals should be set in all landscape units within the target's geographic range.
10. All watershed segments dominated by wildland landscapes are high priority conservation targets. Existing land uses should be maintained in these wildland watersheds through easements, fee acquisition, and novel management approaches. For example, the headwaters of Alameda Creek and Coyote Creek watersheds are high priority for fish conservation targets, and actions should focus on maintaining existing ranching land uses.
11. Streams flowing through urbanized baylands are important components to the ecological functioning of less-developed headwater landscapes, especially because they provide longitudinal connectivity.

12. Recommended conservation actions for all stream segments flowing through landscapes dominated by low-to-high density urban, residential, residential-commercial, and agricultural landscapes include, at a minimum, limiting additional streamside encroachment through the establishment of appropriate riparian buffers, maintaining the corridor for potential steelhead restoration, and implementing aggressive sediment and non-point source pollution control measures.

## Selection of Conservation Targets

To advance the goal of fish and riparian biodiversity protection, the Riparian/Fish Focus Team selected three main types of conservation targets – riparian vegetation, fish species, and streams.

**1. Riparian Vegetation Targets.** The focus team accepted the recommendations from the Vegetation Focus Team that assigned to all riparian vegetation types Rarity Rank 1 with a 90% conservation goal. The Upland Habitat Goals Coarse Filter Vegetation Map identifies three riparian vegetation types: Central Coast Riparian Forest, Sycamore Alluvial Woodland, and Serpentine Riparian. Both focus teams acknowledged the dearth of accurate riparian vegetation maps and the gross underestimation of the extent of riparian vegetation. The riparian vegetation that is mapped includes only the largest remaining patches – those of at least four acres.

**2. Fish Conservation Targets.** The Riparian/Fish Focus Team selected all native fish species found in San Francisco Bay Area streams as conservation targets, with the goal of maintaining healthy assemblages of native fishes. Fish conservation targets are listed in Figure 5.2.

The team opted to use the presence or absence of two listed anadromous fish – steelhead/ rainbow trout (*Oncorhynchus mykiss*) and coho salmon (*Oncorhynchus kisutch*) – and their habitat requirements as surrogates indicating favorable conditions for native fishes. The Evolutionarily Significant Unit (ESU) of Central California Coast coho salmon, extirpated from estuary tributaries, was listed as threatened in 1997 and endangered in 2005 under the Endangered Species Act. The Northern California, Central California, and South-Central California Coast Steelhead Distinct Population Segments (DPS) are still found in the Estuary and coastal streams. All are federally listed as threatened. Recovery plans are in development for these steelhead DPS.



Jonathan Koehler



**Figure 5.2 ■ Fish Conservation Targets in San Francisco Bay Area Streams Draining to the Ocean and Bay.** Species in **bold** are endemic to the Sacramento-San Joaquin Province and known from streams of the San Francisco Estuary (Leidy 2007).

<b>Native Anadromous Fish</b>	<b>Native Resident Fish</b>	<b>Native Resident Fish in Estuary and Ocean*</b>
Chinook salmon	<b>California roach</b>	arrow goby
chum salmon	coastrange sculpin	Bay goby
coho salmon	<b>hardhead</b>	<b>Delta smelt</b>
green sturgeon	<b>hitch</b>	jack smelt
Pacific lamprey	Pacific staghorn sculpin	longfin smelt
pink salmon	prickly sculpin	longjaw mudsucker
rainbow trout / steelhead	rainbow trout / steelhead	northern anchovy
river lamprey	riffle sculpin	Pacific herring
	<b>Sacramento blackfish</b>	speckled sandab
	<b>Sacramento perch</b>	starry flounder
	<b>Sacramento pikeminnow</b>	tidewater goby**
	<b>Sacramento sucker</b>	<b>splittail</b>
	speckled dace	shiner perch
	<b>thicktail chub**</b>	speckled dace
	three-spine stickleback	three-spine stickleback
	<b>tule perch</b>	white sturgeon
	western brook lamprey	

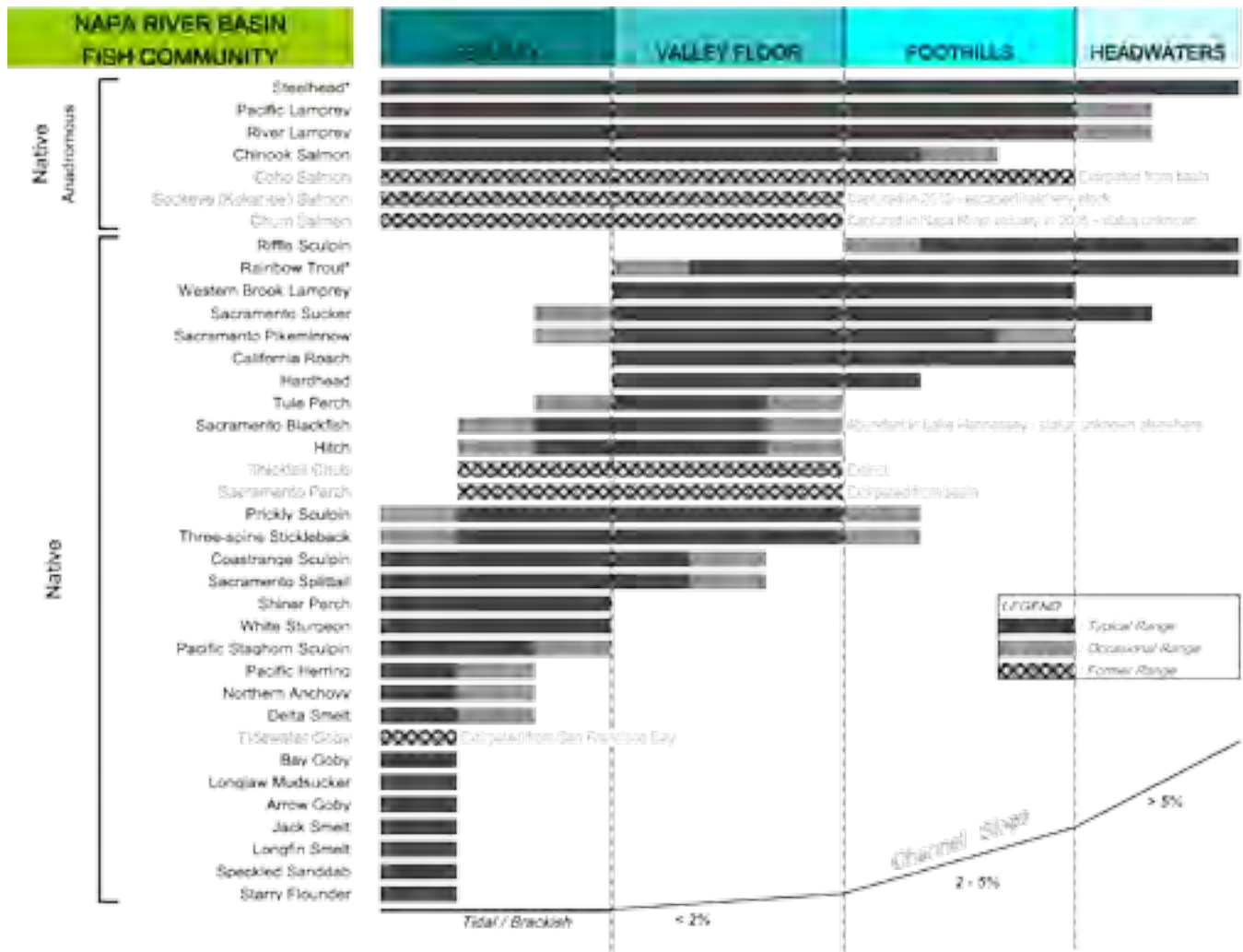
\* Typical range is in the Estuary; the Upland Habitat Goals Project focuses on the health and integrity of watersheds entering the Bay and ocean.

\*\* Extirpated species.

The streams that currently support coho and steelhead are the most intact watersheds that supply the complex habitat needs of anadromous fish, as well as the habitat requirements of other native fishes. Small runs of Chinook and chum salmon are present in some streams, but quick examination of their overlapping distributions with coho and steelhead indicate that habitat requirements for these species are well represented by those for coho and steelhead. However, there are valuable and unique assemblages of other native fishes, as well as land-locked rainbow trout, whose habitat requirements do not completely overlap with those for steelhead. Such areas were added as conservation targets based on the expert opinion of focus team members.

Figure 5.3 illustrates native fish ranges along various classifications of channel slope in the Napa River Basin, further reinforcing the importance of protecting and restoring streams throughout their lengths. According to focus team members, the Napa River Basin channel slope classification is applicable to other Estuary streams because the basin supports (or has supported) nearly all of the native fish taxa of the region, and has the range of habitats found throughout Estuary watersheds.

**Figure 5.3 ■ Fish Ranges by Channel Slope for the Napa River Basin** (Koehler 2007).



\* Steelhead and rainbow trout are the same species –steelhead are migratory and trout are resident.

Sources: Stillwater Sciences Limiting Factors Analysis 2002; Napa River Fisheries Monitoring 2006; CDFG and NCRCD surveys; Leidy 1997; Moyle 2002.

**3. Stream Conservation Targets.** The Riparian/Fish Focus Team chose all Bay Area streams as conservation targets, and prioritized the streams to indicate relative importance and guide protection and restoration actions. Priority rankings do not increase or decrease conservation goals, but help focus attention on the most important streams and watersheds, especially for listed anadromous fish species and important assemblages of native fishes.

Some stream priorities were upgraded because they provide important habitat for Foothill Yellow-legged Frog, a conservation target for the Amphibians, Reptiles, and Invertebrates Focus Team. These streams are noted in the listing of Priority 1 and 2 Streams found in Appendix E, *Fine Filter Conservation Targets*.

Within the San Francisco Estuary, the team used two primary data sources to identify priority streams. The first is the *San Francisco Estuary Watersheds Evaluation: Identifying Promising Locations for Steelhead Restoration in Tributaries of the San Francisco Estuary* (Becker et al. 2007), completed by the Center for Ecosystem Management and Restoration (CEMAR). This report and accompanying data were used to identify priority steelhead streams. The second source for estuary tributaries was *Essential Watersheds and Priority Stream Segments for Focused Conservation Actions to Protect Native Fishes, San Francisco Estuary, California*, drafted by focus team member Robert Leidy, PhD, US Environmental Protection Agency (Leidy 2008), and edited by the focus team. This document (Appendix

D) represents a significant compilation of expert knowledge for Bay Area streams organized by stream segments. It offers detailed information on species presence, stream conditions, and recommended priority conservation actions.

The Becker *et al.* 2007 report identified tributaries to the San Francisco Estuary that, if protected and restored, have the highest probability of restoring steelhead populations. The authors evaluated the 58 Bay Area watersheds tributary to the estuary against two criteria: the presence of reproducing steelhead populations, and the amount of available rearing habitat. The underlying assumption is watersheds with the greatest amount of functioning steelhead rearing habitat are most likely to contribute to smolt production, which – in turn – strengthens the regional spawning run.

Rearing habitat was classified into two categories: suitable and available. Suitable habitat is defined as that which can support juvenile rearing, without regard to the presence of passage barriers. Available habitat areas can support juvenile rearing and are accessible to spawning steelhead. Stream reaches above barriers that have a good probability of removal were considered available habitat.

With available rearing habitat identified and further analysis, the authors concluded that eight of the region's watersheds account for roughly 75% of the regional steelhead rearing habitat. These watersheds with the most extensive habitat were deemed *Anchor Watersheds* to indicate their significance. Anchor Watersheds are Alameda, Coyote, San Francisquito, Corte Madera, Sonoma, and Suisun Creeks and the Guadalupe and Napa Rivers. Further review of 54 streams within the Anchor Watersheds identified 43 Essential Streams (Figures 5.4 and 5.5) that account for the majority (approximately 83%) of available rearing habitat; restoration efforts should be focused on these streams.

Figure 5.4 lists Anchor Watersheds and Essential Streams in the San Francisco Estuary. Figure 5.5 maps the location of these watersheds and streams. Note that not all anchor watershed tributaries were included in the analysis because the habitat in some tributaries had not been characterized, precluding a determination of the presence or absence of available steelhead rearing habitat. This omission is recorded as a data gap.

The Leidy 2008 Report (Appendix D) provides more detail on the Essential Streams and includes additional streams and stream segments important to native fishes.

For coastal streams, the primary data sources used to identify streams and relative priority were the *Public Draft Recovery Plan for the ESU of the California Central Coast Coho Salmon* and the CalFish Coho Distribution data. Some steelhead streams contributing to coho streams were also added from the CalFish Steelhead Winter Distribution dataset. Coho Core Areas identified in the Draft Recovery Plan are listed in Figure 5.4.



Stuart B. Weiss

**Figure 5.4 ■ Anchor Watersheds and Essential Streams of the San Francisco Estuary and Coho Core Areas**

(Becker *et al.* 2007, NMFS 2010). Independent streams are indicated with (I).

Estuary Watersheds		Coastal Watersheds	
CEMAR Anchor Watersheds / CalWater 2.2.1 Hydrologic Areas	CEMAR Essential Streams	Coho Recovery Plan Core Areas	Coho Core Area Streams
Alameda Creek / Alameda HA	Alameda Creek	Gazos Creek	Gazos Creek
	Indian Joe Creek		Old Woman's Creek
	San Antonio Creek	Redwood Creek	Redwood Creek
Corte Madera Creek / San Rafael HA	Stonybrook Creek		Fern Creek
	Cascade Creek		Green Gulch
	Corte Madera Creek	Gualala River (I)	Pepperwood Creek
Coyote Creek / Coyote HA	San Anselmo Creek	Lagunitas Creek (I)	Cheda Creek
	Arroyo Aguague		Lower Lagunitas Creek floodplain and estuarine areas
	Coyote Creek		
Guadalupe River / Guadalupe HA	Upper Penitencia Creek		Olema Creek
	Alviso Slough		San Geronimo
	Arroyo Calero	Pescadero Creek (I)	No Core Areas
Napa River / Napa River HA	Guadalupe Creek	Pine Gulch	No Core Areas
	Campbell Creek	Russian River (I)	Devil Creek
	Carneros Creek		Dutch Bill Creek
San Francisquito Creek / portion of Palo Alto HA	Dry Creek		East Austin Creek
	Heath Canyon Creek		Felta Creek
	Iron Mine Creek		Freezeout Creek
	Montgomery Creek		Green Valley Creek
	Napa Creek		Mill Creek
	Napa River		Palmer Creek
	Pickle Canyon Creek		Purrington Creek
	Redwood Creek		Sheephouse Creek
	Ritchey Creek		Upper East Gray Creek
	Segassia Canyon Creek		Wallace Creek
	Sulphur Creek	Salmon Creek	Coleman Valley Creek
Wing Canyon Creek		Finley Creek	
Sonoma Creek / Sonoma Creek HA	Bear Creek		Nolan Creek
	Los Trancos Creek		Salmon Creek
	McGarvey Gulch		Tannery Creek
	San Francisquito Creek		Thurston Creek
	Squealer Gulch / Purisima Creek	San Gregorio Creek	Alpine Creek
Suisun Creek / portion of Fairfield HA	West Union Creek		Bogess Creek
	Bear Creek		Harrington Creek
	Calabazas Creek		Mindego Creek
	Carriger Creek		San Gregorio
	Fowler Creek	Walker Creek	Frink Canyon
Suisun Creek / portion of Fairfield HA	Redwood Creek		Walker Creek
	Sonoma Creek		
	Trinity Creek		
	Suisun Creek		

Figure 5.5 ■ Anchor Watersheds and Essential Streams of the San Francisco Estuary (Becker *et al.* 2007).



Using these data sources along with additional datasets detailed in the next section, the focus team established three stream priority classifications.

### Priority 1 Streams

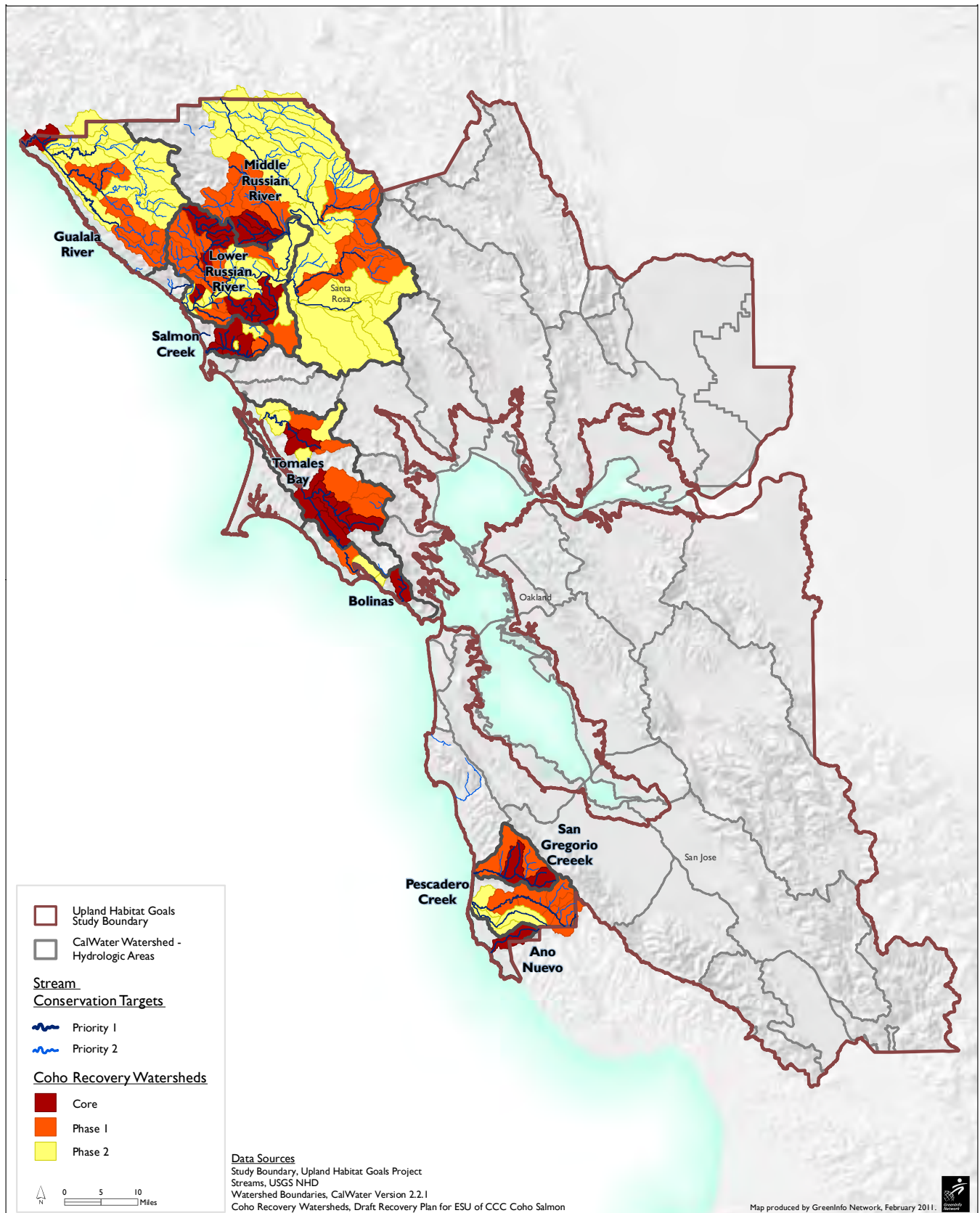
Priority 1 streams and watersheds have existing steelhead populations, available rearing habitat, and current or historic coho populations that must be conserved and/or restored as soon as possible for fish conservation to be effective. Restoring flows is essential to the conservation of these species. The following streams were identified as Priority 1:

1. Essential Streams for steelhead draining to the San Francisco Estuary as identified in Becker *et al.* 2007.
2. Coho Core Area and most Phase 1 Expansion Area streams from the *Public Draft Recovery Plan for the Evolutionarily Significant Unit of Central California Coast Coho Salmon* (see Figure 5.6: Coastal Stream Conservation Targets). Both Dependent and Independent coho streams were given a Priority 1.
3. Historic coho streams listed in the CalFish Coho Distribution data.
4. Streams draining to the Bay with high diversity assemblages of warm-water native fish (Leidy 2008).
5. The best coastal steelhead streams not covered by coho salmon (CalFish Winter Steelhead Distribution and Riparian/Fish Focus Team expert opinion).
6. The healthiest steelhead streams in the Pajaro River basin (expert opinion of Riparian/Fish Focus Team and *Santa Clara Valley Habitat Conservation Plan*).



Robert A. Leidy

**Figure 5.6 ■ Coastal Stream Conservation Targets.** Core Areas and most Phase 1 Expansion Areas from the *Public Draft Recovery Plan for the Evolutionarily Significant Unit of the Central California Coast Coho Salmon* were designated as Priority 1 streams (NMFS 2010).



## Priority 2 Streams

Priority 2 streams and watersheds should receive substantial protection and restoration for long-term fish conservation. Priority 2 streams have smaller steelhead and land-locked rainbow trout populations and /or other healthy assemblages of native fish. They may also be isolated stream segments with high conservation value. For example, Upper Stevens Creek in the Santa Cruz Mountains North Landscape Unit supports resident rainbow trout, California roach and Sacramento sucker; Coyote Creek above Coyote Reservoir supports rainbow trout and five other native fishes. In coastal areas, all identified winter steelhead streams were included as Priority 2. These are the majority of streams with any connection to the ocean. The following streams were identified as Priority 2:

1. Streams draining to the San Francisco Estuary with less-healthy steelhead runs (Becker *et al.* 2007) than those marked Priority 1.
2. Streams draining to the San Francisco Estuary with assemblages of native fish other than steelhead (Leidy 2008).
3. Most Phase II Expansion Areas from the *Public Draft Recovery Plan for the Evolutionarily Significant Unit of the Central California Coast Coho Salmon* were designated as Priority 1 streams (NMFS 2010).
4. Streams in the Pajaro River basin with less-healthy steelhead runs (Riparian/Fish Focus Team expert opinion and *Santa Clara County Habitat Conservation Plan*).
5. Coastal streams with steelhead streams draining into coho streams, including the Russian River basin (CalFish Winter Steelhead Distribution).
6. Streams draining to the San Francisco Estuary with landlocked rainbow trout (Leidy 2008).
7. Streams with “reservoir anadromy” where fish grow large in the reservoir and run upstream to spawn. Streams with such potential are listed below; there may be others in smaller reservoirs that are not listed. These streams largely overlap with Priority 2 streams supporting other native fish assemblages.
  - Calaveras Reservoir
  - San Antonio Reservoir
  - Lake Del Valle
  - Anderson Reservoir
  - Coyote Reservoir
  - Lake Sonoma
  - Lake Hennessey
  - Chesbro Reservoir
  - Lake Chabot
  - San Pablo Reservoir
  - Stevens Creek Reservoir
  - Uvas Reservoir

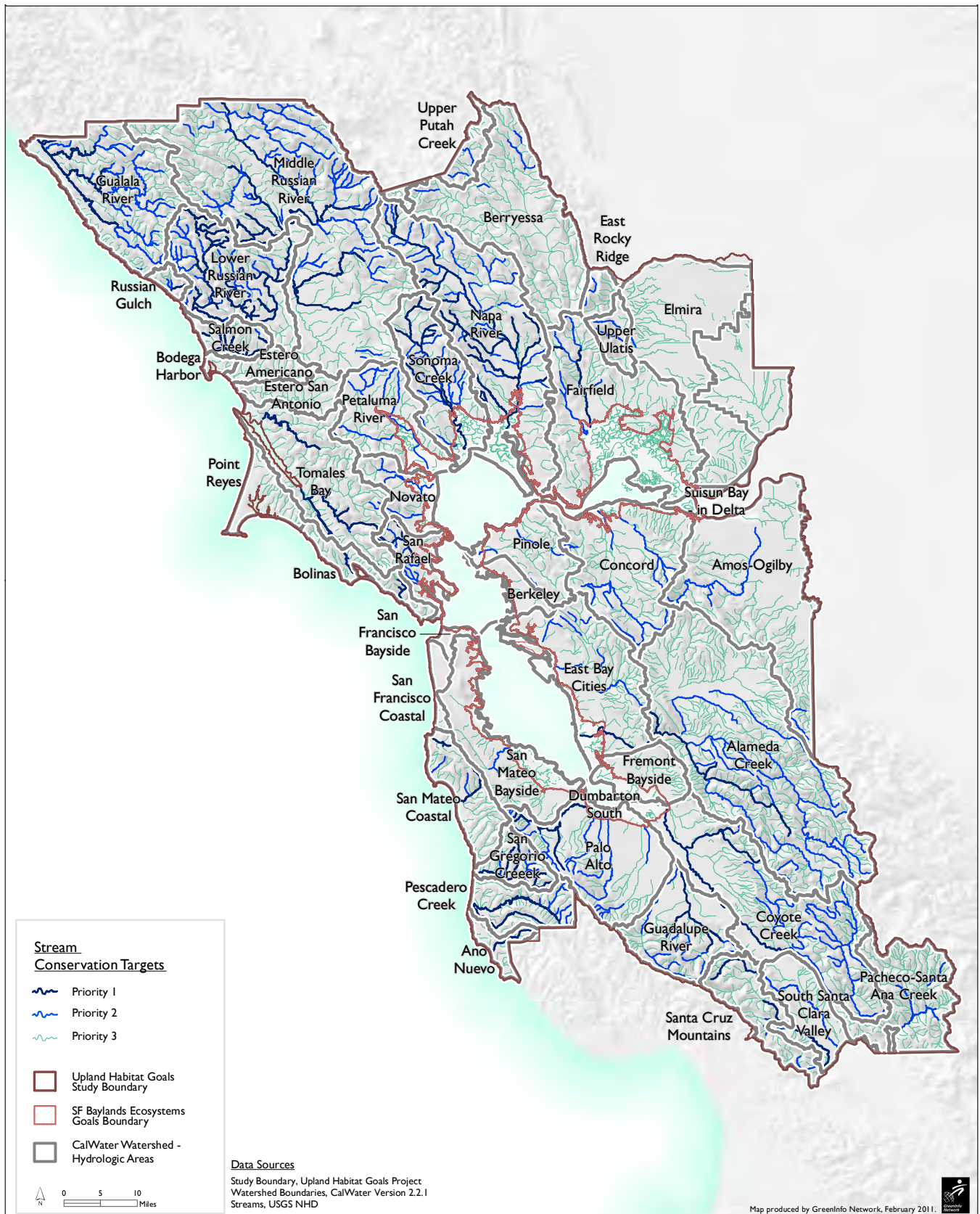
## Priority 3 Streams

Because of the critical role played by all riparian areas in providing hydrologic integrity, wildlife habitat, linkages, and buffering against climate change, all remaining streams are classified as Priority 3.

Figure 5.7 is a map of stream conservation targets. All Priority 1 and 2 streams, along with the data source and justification for the priority ranking, are listed in Appendix E, *Fine Filter Conservation Targets*. Priority 1 and 2 streams can also be found on the Conservation Lands Network Explorer, the online mapping tool at [www.BayAreaLands.org](http://www.BayAreaLands.org).



**Figure 5.7 ■ Stream Conservation Targets of the Conservation Lands Network.** All streams are included in the CLN and are assigned a priority ranking of 1, 2, or 3. A high-resolution, zoomable version of this map is available at [www.BayAreaLands.org](http://www.BayAreaLands.org).



## CEMAR Anchor Watersheds and CalWater 2.2.1 Watersheds

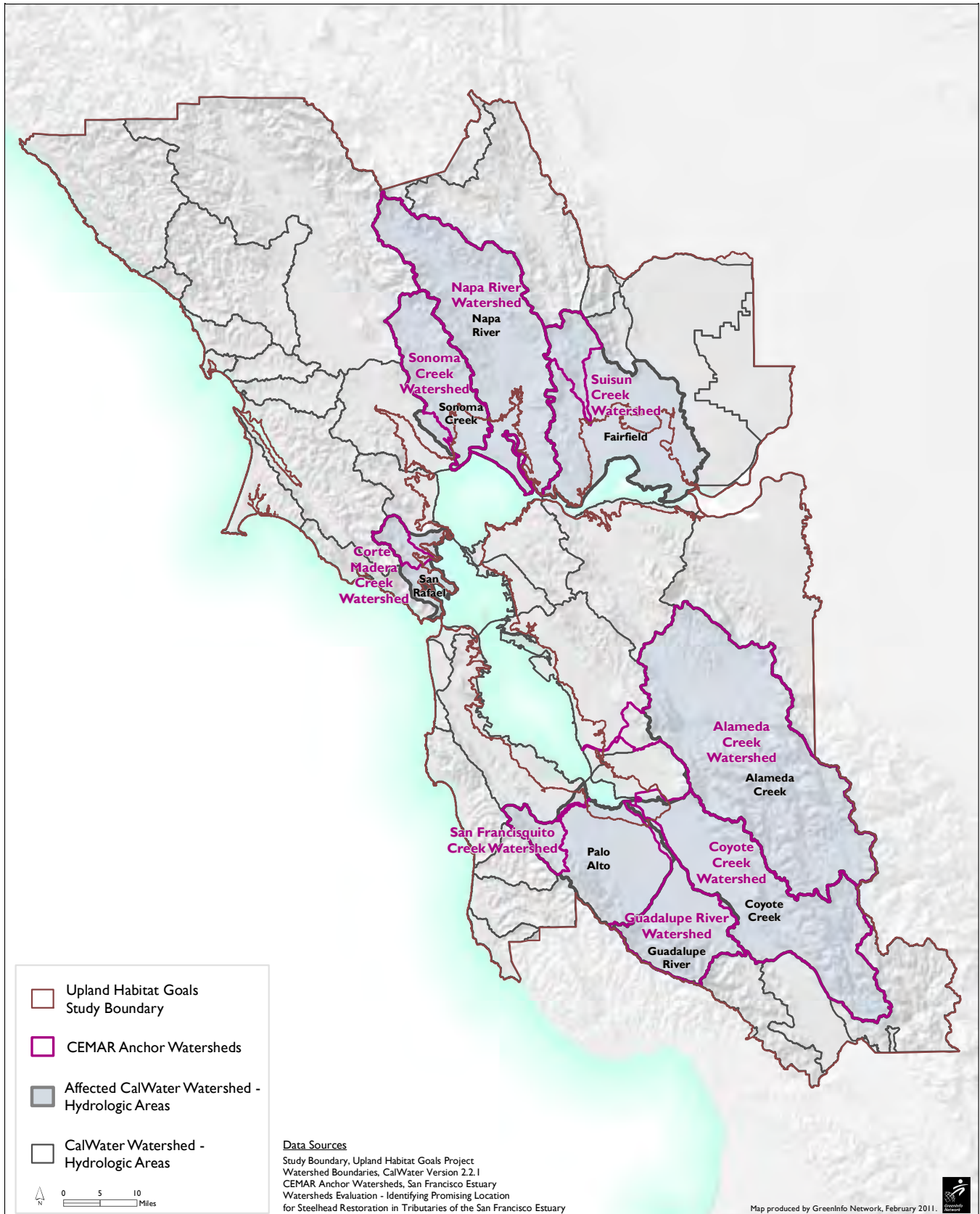
The Anchor Watersheds delineated in Becker *et al.* (2007) were customized for that study by the Center for Ecosystem Management (CEMAR). The Upland Habitat Goals Project chose to use the standardized CalWater 2.2.1 watersheds for these analyses rather than the Anchor Watersheds. CalWater is the California Statewide watershed delineation standard established by the California Interagency Watershed Mapping Committee within the Natural Resources Conservation Service. CalWater, found at [www.ca.nrcs.usda.gov/features/calwater/calwatershedsmmap.html](http://www.ca.nrcs.usda.gov/features/calwater/calwatershedsmmap.html), was used because the standardized dataset allows for repeatable analyses and facilitates future updates. In addition, the Coho Recovery Plan uses CalWater Planning Watersheds. CalWater has several levels of watershed delineations. Most of the Upland Habitat Goals analyses were conducted at CalWater's finest scale, the Planning Watershed (PWS), with a few employing the Hydrologic Area (HA) level.

In most cases, the CalWater dataset allows ready comparison to the CEMAR Anchor Watersheds. But, the CEMAR Anchor Watersheds do not line up exactly with the CalWater watershed levels; the few areas of discrepancy are shown in Figures 5.8 and 5.9.

**Figure 5.8 ■ Comparison of CEMAR Anchor Watersheds to CalWater 2.2.1 Watersheds.**

CEMAR Anchor Watershed	CEMAR Watershed Acreage	Calwater 2.2.1 Designation Corresponding to CEMAR Anchor Watersheds			
		Hydrologic Area(s)	Hydrologic Sub-Area	Super Planning Watershed	Planning Watershed
<b>Alameda Creek</b>	417,337	Alameda Creek with portions of Fremont and East Bay cities			
<b>Corte Madera Creek</b>	15,771	portion of San Rafael			San Anselmo and Ross Creek
<b>Coyote Creek</b>	237,206	Coyote Creek			
<b>Guadalupe River</b>	102,161	Guadalupe River			
<b>Napa River</b>	266,735	Napa River			
<b>San Francisquito Creek</b>	25,313	portion of Palo Alto		Portola Valley	
<b>Sonoma Creek</b>	99,080	Sonoma Creek			
<b>Suisun Creek</b>	32,600	portion of Fairfield	Suisun Creek		

**Figure 5.9 ■ Comparison of CEMAR Anchor Watersheds and CalWater 2.2.1 Hydrologic Areas.** The Upland Habitat Goals Project used CalWater 2.2.1 Hydrologic Areas for all analyses. These differ slightly from the Anchor Watersheds used by CEMAR in Becker *et al.* 2007.



## Compilation of Fish and Riparian Data

For fish conservation targets, available data were compiled for species' ranges and occurrences, as well as for specific priority watersheds. The key datasets used were the Essential Streams and Anchor Watersheds from Becker *et al.* 2007 and Leidy 2008. Additional datasets used or reviewed are:

1. Salmonid Habitat Restoration Planning Resource for San Mateo and Santa Cruz Counties
  - Historic Steelhead and Coho Streams
2. National Oceanic and Atmospheric Administration / National Marine Fisheries Service
  - Steelhead and Chinook distribution data
  - Central California Coast Steelhead Critical Habitat and Distribution (PDF map)
  - Critical Habitat Designations for West Coast Salmon and Steelhead (PDF map)
  - *Public Draft Recovery Plan for the Evolutionarily Significant Unit of Central California Coast Coho Salmon* and personal communication with Kit Crump 2010
3. CalFish
  - Winter Steelhead Distributions, May 2007 – this dataset represents stream reaches that are known or believed to be used by steelhead based on observations
  - Fish Barriers from the CA Statewide Passage Assessment Database (PAD)
  - Steelhead and Chinook Salmon Critical Habitat and distribution data
  - Chinook, Coho, and Steelhead abundance data
  - Coho distribution data
4. Department of Fish and Game Coho Recovery Strategy
  - Present Distribution of Coho Salmon (PDF map)

All of these datasets can be downloaded from [www.BayAreaLands.org/gis/all-datasets.php](http://www.BayAreaLands.org/gis/all-datasets.php).

Poorly-mapped riparian habitats represent a significant data gap. During the development of the Coarse Filter Vegetation Map (Chapter 4), riparian vegetation types were identified using the USDA Forest Service CalVeg GIS dataset, which was developed from satellite imagery. CalVeg has acknowledged spatial and classification accuracy issues, but it is the only dataset available for most of the study area. The San Francisco Estuary Institute has embarked on an extensive riparian mapping effort (the Bay Area Aquatic Resource Inventory, [sfei.org/BAARI](http://sfei.org/BAARI)) that should provide more accurate data for future updates of the Conservation Lands Network.

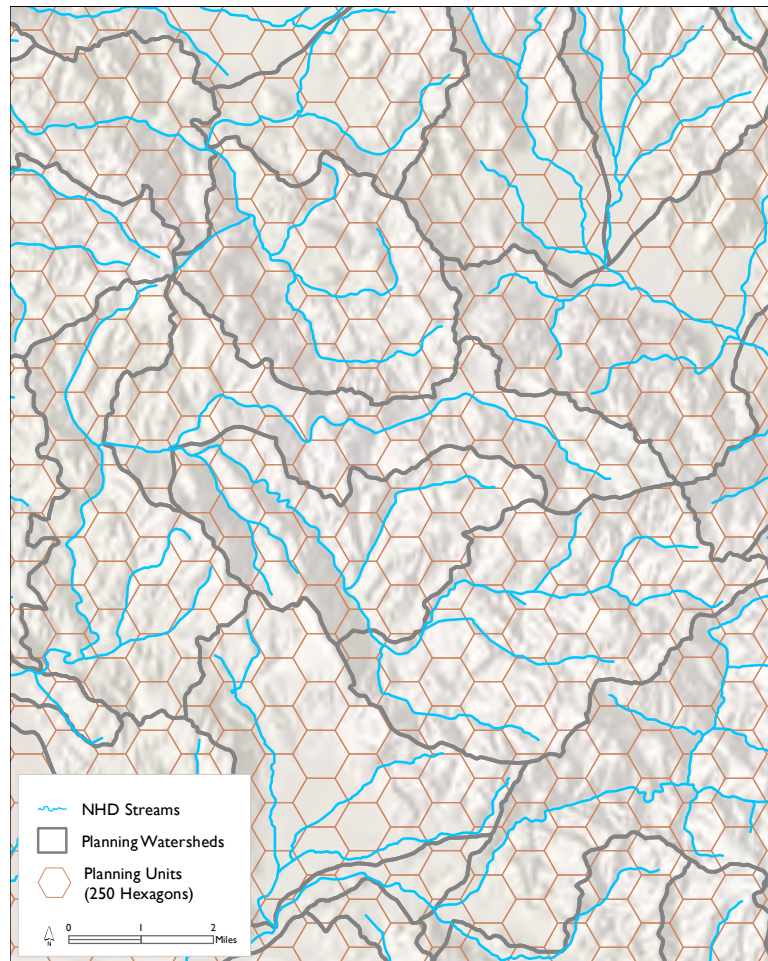
To compensate for the absence of a comprehensive riparian vegetation layer, the National Hydrography Dataset (NHD) 1:24,000 stream network ([nhd.usgs.gov](http://nhd.usgs.gov)) was used as the base coverage for riparian habitat. NHD captures the mainstems and major tributaries of all stream systems in the region, and the database has ongoing quality control and improvements. The 1:24,000 scale of NHD does not capture small headwater swales and seasonal streams (the first- and second-order streams called out in Guiding Principle 5). However, these fine-scale features are embedded within the Coarse Filter Vegetation Map and are captured by the 100ha scale of the Marxan hexagons.

To illustrate this point, Figure 5.10 shows a series of CalWater 2.2.1 Planning Watersheds with the NHD stream network, 100ha hexagonal planning units for Marxan, and hillshaded topography in the Southern Mayacamas Mountains (the Upper Napa Valley is the flat area in the upper right). The true first- and second-order headwater streams and swales are in the small canyons radiating from the NHD streams, and greatly increase the length of the stream network. Note how the upper watersheds are encompassed by the 100ha hexagons, indicating that the Coarse Filter Conservation Lands Network captures some of these important hydrologic features. Any 100ha hexagon selected by Marxan for inclusion in the Conservation Lands Network captures these fine-scale, low-order streams. However, site level efforts are likely needed to determine what actions are necessary for restoration on a stream-by-stream basis.



Robert A. Leidy

**Figure 5.10 ■ Inclusion of First- and Second-Order Streams in the Conservation Lands Network.** The 100ha planning units used by Marxan allows the CLN to capture some of the low-order headwaters streams.



## Conservation Goals for Fish and Riparian Habitat

Setting fine filter goals for riparian and fish conservation targets presented a unique challenge due to the linear nature of the resource. The other fine filter focus teams reviewed coverage of the Coarse Filter Conservation Lands Network for their species targets in each of the landscape units. However, watersheds are the more appropriate delineation for riparian and fish resources, so the Riparian/Fish Focus Team used CalWater 2.2.1 Hydrologic Areas (Figure 5.11) and Planning Watersheds to review coverage by the Coarse Filter Conservation Lands Network.

Because of the density of development, degraded and fragmented habitat, and incompatible land uses – all of which diminish species viability – urban landscape units (e.g., Santa Clara Urban) were not included when running Marxan to create the Coarse Filter CLN. However, as noted in Guiding Principles 11 and 12, the linearity of streams and impacts to stream health from uses throughout the watershed mandate stream conservation throughout their length – including in urban areas, where many streams reach the Bay. Therefore, stream corridors in urban areas are included in the Conservation Lands Network.

**Figure 5.11 ■ CalWater 2.2.1 Hydrologic Areas (Watersheds).** The Riparian/Fish Focus Team used CalWater Hydrologic Area and Planning Watersheds instead of landscape units to review coverage for fish, riparian, and stream conservation targets by the Coarse Filter Conservation Lands Network.



After selecting conservation targets and reviewing the available data, the focus team established goals for each target category.

**1. Riparian Vegetation.** The Riparian/Fish Focus Team concurred with the Vegetation Focus Team recommendation setting a 90% goal for all riparian vegetation types in all landscape units where they occur. The resulting acreage goals are shown in Figure 5.12. The total goal for riparian habitats is 12,542 acres (total acreage x 90% conservation goal), but 5,312 acres have already been protected, so 7,165 acres are needed to meet the 90% goal. By far, the most abundant riparian vegetation type is Central Coast Riparian Forest (total acreage of 13,704), which logically also has the highest acreage conservation goal at 12,334 acres. The highest goals for Central Coast Riparian Forest are found in the Mt. Hamilton, Russian River Valley, Santa Cruz Mountains North, and Sonoma Coast Range landscape units. Very little acreage remains of Serpentine Riparian (135 acres) and Sycamore Alluvial Woodland (97 acres), which have goals of 86 and 37 acres, respectively. As noted previously, riparian vegetation is poorly and inconsistently mapped in the Bay Area; this continues to be a significant data gap.

As noted in Chapter 3, the Converted Lands erasure process also removed much of the Central Coast Riparian Forest and Sycamore Alluvial Woodland vegetation types. These important riparian vegetation types (9,156 acres of Central Coast Riparian Forests and 29 acres of Sycamore Alluvial Woodland) were added to the CLN after the last Marxan run effectively increasing the conservation goal to 100%.

**2. Native Fish.** All 41 native fish targets (Figure 5.2) were named as conservation targets, toward the goal of restoring healthy native fish assemblages. The focus team stopped short of setting population goals for fish. Population goals were set for coho in the *Public Draft Recovery Plan* for coho, and can be found in that document.

**3. Streams.** All streams are conservation targets with three levels of priority. The focus team also prioritized conservation actions to achieve the overarching goal of restoring stream ecological processes and functions. Stream conservation actions include:

- Protection of all streams, via fee or easement acquisition, cooperative agreement, or protective policies.
- Once protection has been secured, restoration of riparian habitat and ecosystem functions and processes.
- Sound stewardship practices on public and private lands to maintain the ecological health of the streams.

The focus team emphasized the importance of conserving headwaters using fee purchase, conservation easements, or other means of preventing disturbance and development in these areas.



**Figure 5.12 ■ Acreage Goals for Riparian Vegetation Types by Landscape Unit.** All riparian vegetation types are Rarity Rank 1 with a 90% conservation goal. *Acreage to Meet Goals* is the amount of habitat that is in the Coarse Filter Conservation Lands Network but not yet protected.

Vegetation Type	Landscape Unit	Rarity Rank	Total Acreage	Acreage Goals by Rarity Rank			Total Acreage Goals	Protected Acreage	Acreage to Meet Goals
				Rank 1 (90%)	Rank 2 (75%)	Rank 3 (50%)			
<b>Central Coast Riparian Forest</b>	American Canyon	1	5	4	0	0	4	0	4
	Blue Ridge Berryessa	1	112	101	0	0	101	0	101
	Coastal Grasslands	1	768	691	0	0	691	171	520
	Contra Costa Delta	1	83	75	0	0	75	7	68
	Marin Coast Range	1	1,463	1,317	0	0	1,317	792	524
	Middle East Bay Hills	1	59	53	0	0	53	42	11
	Montezuma Hills	1	42	38	0	0	38	2	36
	Mount Hamilton	1	1,858	1,672	0	0	1,672	775	897
	Mt. Diablo Range	1	279	251	0	0	251	104	147
	Napa Valley	1	304	274	0	0	274	49	225
	North East Bay Hills	1	108	97	0	0	97	81	17
	Northern Mayacamas Mtns.	1	24	21	0	0	21	0	21
	Point Reyes	1	950	855	0	0	855	884	0
	Russian River Valley	1	1,535	1,381	0	0	1,381	149	1,232
	Santa Clara Valley	1	107	96	0	0	96	87	9
	Santa Cruz Mountains North	1	2,480	2,232	0	0	2,232	943	1,289
	Santa Rosa Plain	1	463	417	0	0	417	87	329
	Sierra Azul	1	662	596	0	0	596	475	120
	Solano Delta	1	136	122	0	0	122	15	107
	Solano Plains	1	85	77	0	0	77	3	74
	Sonoma Coast Range	1	1,118	1,006	0	0	1,006	245	761
Sonoma Mountains	1	275	247	0	0	247	21	226	
Sonoma Valley	1	152	137	0	0	137	42	95	
South East Bay Hills	1	307	276	0	0	276	127	149	
Southern Mayacamas Mtns.	1	93	84	0	0	84	16	68	
Tri-Valley	1	83	74	0	0	74	56	19	
Vaca Mountains West	1	154	138	0	0	138	13	125	
<b>Central Coast Riparian Forest Total</b>			<b>13,704</b>	<b>12,334</b>	<b>0</b>	<b>0</b>	<b>12,334</b>	<b>5,187</b>	<b>7,175</b>
<b>Serpentine Riparian</b>	Mount Hamilton	1	77	69	0	0	69	42	27
	Northern Mayacamas Mtns.	1	17	15	0	0	15		15
	Russian River Valley	1	13	12	0	0	12		12
	Santa Cruz Mountains North	1	6	5	0	0	5	4	1
	Sierra Azul	1	14	13	0	0	13	10	3
	Southern Mayacamas Mtns.	1	3	3	0	0	3		3
	Vaca Mountains West	1	4	4	0	0	4		4
<b>Serpentine Riparian Total</b>			<b>135</b>	<b>121</b>	<b>0</b>	<b>0</b>	<b>121</b>	<b>57</b>	<b>64</b>
	Mount Hamilton	1	68	61	0	0	61	68	0
	Sierra Azul	1	28	25	0	0	25	0	25
<b>Sycamore Alluvial Woodland Total</b>			<b>97</b>	<b>87</b>	<b>0</b>	<b>0</b>	<b>87</b>	<b>68</b>	<b>25</b>
<b>Grand Total</b>			<b>13,935</b>	<b>12,542</b>	<b>0</b>	<b>0</b>	<b>12,542</b>	<b>5,312</b>	<b>7,265</b>



## Review of the Coarse Filter Conservation Lands Network Coverage

Once the conservation goals were established, the focus team examined the Coarse Filter Conservation Lands Network to evaluate whether the goals were met. The team reviewed the Coarse Filter CLN using visual inspection of maps, gap analyses results, and expert opinion to identify areas where adjustment was needed to meet riparian and fish conservation goals.

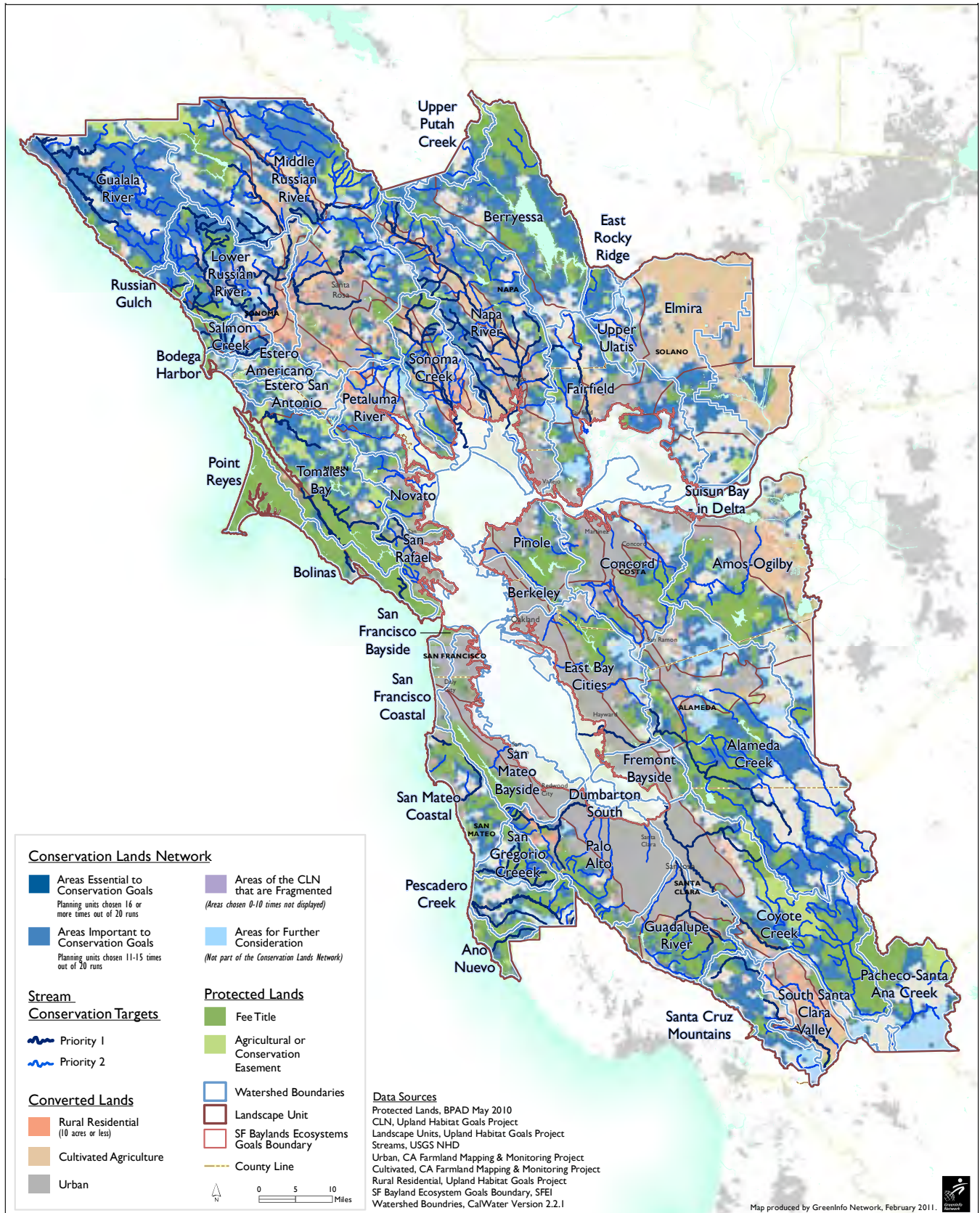
### Coarse Filter Conservation Lands Network Visual Inspection

Figure 5.13 displays the Coarse Filter Conservation Lands Network overlaid with Priority 1 and 2 streams (in dark and medium blue lines, respectively) and CalWater Hydrologic Areas. Priority 3 streams (not shown on Figure 5.13), are comprised of all remaining streams. The focus team reviewed a high resolution version of the map to determine how effectively the Coarse Filter CLN covered stream targets, paying particular attention to headwater areas.

A careful review of Figures 5.13 and 5.14 by the Riparian/Fish Focus Team revealed that a number of headwaters and upper watersheds were not adequately covered by the Coarse Filter Conservation Lands Network. However, adding entire headwater areas or even a major percentage of headwater areas would significantly increase the size of the Conservation Lands Network. Even adding just the headwaters of the Anchor Watersheds and Coho Core Areas would be a sizeable increase of the CLN. The gap analyses were used to determine how well the watersheds were covered with a focus on the Anchor Watersheds and Coho Core Areas.



**Figure 5.13 ■ The Coarse Filter Conservation Lands Network with CalWater Hydrologic Area Boundaries.** The Riparian/Fish Focus Team reviewed this map in detail to determine whether the Coarse Filter CLN provided sufficient coverage of stream conservation targets and associated watersheds. A high-resolution, zoomable version of this map is available at [www.BayAreaLands.org](http://www.BayAreaLands.org).



## CalWater 2.2.1 Planning Watershed Gap Analyses

The team conducted watershed gap analyses to identify Priority 1 and 2 stream watersheds not adequately covered by the Coarse Filter CLN. The focus team experts reviewed the results of the CalWater 2.2.1 Hydrologic Area and Planning Watershed gap analyses (Figure 5.14) to evaluate coverage for fish and riparian habitat goals.

The Project Team performed gap analyses utilizing the CalWater 2.2.1 Planning Watersheds to examine the levels of protection afforded by the existing protected lands (BPAD 2010) as compared to the Coarse Filter Conservation Lands Network.

The Planning Watershed gap analyses were performed to answer the following questions:

1. What fraction of each Planning Watershed is currently protected?
2. What fraction is protected under the Coarse Filter Conservation Lands Network?
3. Does the CLN add significantly to the protections offered by current protected lands (BPAD 2010)?
4. Are the headwaters of priority streams adequately protected?
5. What is the geographic distribution of protection?
6. How do protection levels vary among Planning Watersheds supporting different priority streams?

Jonathan Koehler

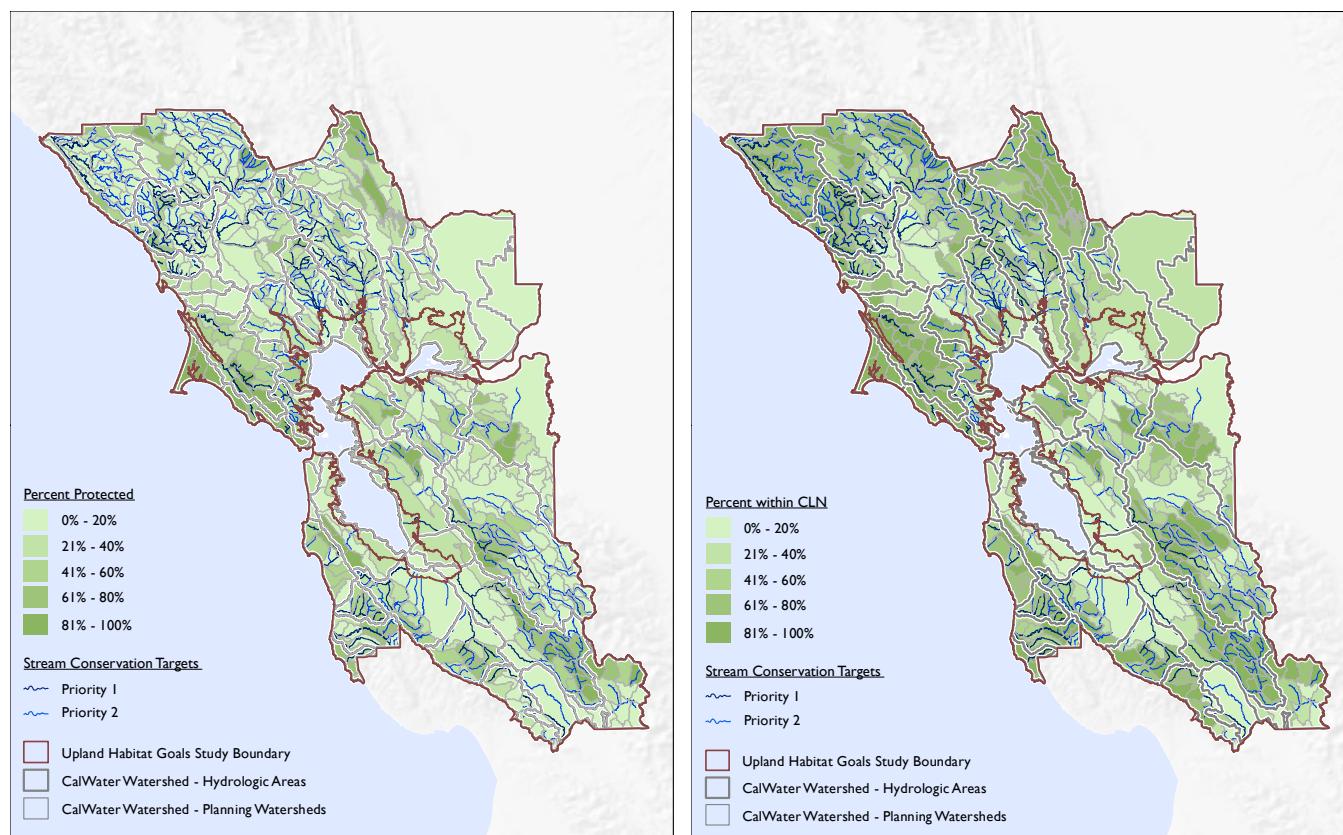


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Figure 5.14 presents both gap analyses as maps for visual inspection. The map on the left shows current protection levels (BPAD 2010) on the left, and the map on the right shows Coarse Filter Conservation Lands Network protection levels. Priority 1 and 2 streams are overlaid so that key watershed areas can be quickly identified. It is readily apparent that the Coarse Filter CLN dramatically increases overall levels of watershed protection, and greatly improves coverage of Priority 1 and 2 streams. For example, Hydrologic Areas such as the Gualala River currently have little protection, but the Coarse Filter CLN captures many Planning Watersheds within the basin. The Coarse Filter CLN also captured many headwaters areas, such as the spine of the Mayacamas Mountains feeding the Napa River, Sonoma Creek, and Russian River tributaries.

The *Riparian/Fish Focus Team Report* has a detailed discussion of the Planning Watershed gap analysis for each of the Anchor Watersheds and Coho Recovery Plan Core Areas. The focus team report is available for review and download at [www.BayAreaLands.org/reports](http://www.BayAreaLands.org/reports).

**Figure 5.14 ■ CalWater 2.2.1 Planning Watersheds Gap Analysis.** The map on the left shows coverage of Planning Watersheds by currently protected lands (BPAD 2010); the map on the right shows increased coverage of the Planning Watersheds under the Coarse Filter Conservation Lands Network.



## Conclusions from Review of the Coarse Filter Conservation Lands Network

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After reviewing the Coarse Filter Conservation Lands Network and gap analyses, the Riparian/Fish Focus Team concluded:

1. Overall protection achieved by the Coarse Filter CLN across most Priority 1 and 2 Planning Watersheds was good, especially considering that the Coarse Filter CLN was developed without consideration of fish and riparian targets (other than large patches of riparian forest).
2. No general rule on protection levels (e.g. 50%, 75%, or 90% for different streams) could be developed that would be applicable to the entire region.
3. Specific protection gaps at the Planning Watershed level were identified from the combination of maps, graphs, and tables, allowing further consideration of additional lands for the CLN in key watersheds. Ultimately, no lands were added to the Conservation Lands Network.
4. Protection of all upper watersheds of Priority 1 and 2 streams could not be met without a vast expansion of the CLN by hundreds of thousands of acres. This was deemed infeasible. Consequently, the focus team emphasized encouraging the continuation of well-managed ranching and using policy protections in the unprotected upper watersheds.
5. Many of the upper watersheds not included in the CLN are remote and rugged, with relatively few immediate threats.
6. At a minimum, the riparian corridors of all mapped National Hydrology Dataset streams require protection, even if the watershed areas around them are not conserved.
7. Conservation practitioners should use all means possible to ensure that these unprotected areas are not overly disturbed, remain in compatible land uses (e.g., rangeland or forestland), and are managed as needed to address water quantity and quality (as measured, for example, by in-stream flows and sediment levels).

## Fish and Stream Viability Factors

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Assessing the viability of fish and riverine habitats is immensely complex due to the interaction of upstream and downstream land uses. In-stream habitat quality and native fish populations are functions of conditions in the upper watersheds as well as in floodplains. In the Bay Area, upper watersheds may consist of forest or rangeland, while lower reaches may course through dense urban and/or cultivated agricultural areas before reaching the Bay. Alameda Creek is a good example of the diverse vegetative cover and land uses found along a stream's length. The headwaters lie in the remote backcountry of the Mt. Diablo and Mt. Hamilton Ranges, and after passing through rangeland, the spectacular Niles Canyon, and urban and suburban land uses, the creek is confined to a flood control channel before it reaches the Bay.

For evaluation of population viability, threats, and stresses, the Upland Habitat Goals Project deferred to the approach used by the National Marine Fisheries Service (NMFS) and the California Department of Fish and Game (DFG) in the coho recovery planning process because of its thoroughness and applicability to native fish conservation targets. Using a modified version of the Nature Conservancy's Conservation Assessment Planning, the Recovery Plan counts both key habitat and population as viability factors, also called attributes. Stresses are defined as the impacted condition of these measurable attributes; threats are the sources of the stresses. For example, poor agricultural practices are a threat that can result in erosion leading to sedimentation, a stressor for several life stages of coho.

The *Public Draft Recovery Plan for the Evolutionarily Significant Unit of Central California Coast Coho Salmon* (NMFS 2010) states that the primary threats to coho are roads and railroads, droughts (particularly from the Russian River south), and residential and commercial development. Logging and wood harvesting are cited as significant threats from the

Russian River north, and in some watersheds, channel modification and/or livestock farming and ranching pose significant threats. Only a brief discussion is presented here, but a more detailed discussion and watershed-specific information can be found in the Draft Coho Recovery Plan available for review at the NMFS website (listed under *Additional Resources*).

## Threats and Stresses for Coho Populations and Key Habitats

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**1. Roads and railroads.** All manner of roads and railroads contribute to diminished stream ecological health. In addition to the stresses they cause, they can enable growth, which induces additional stresses (described under item 2 below). Roads and railroads are considered one of the primary threats to coho recovery.

Stresses from roads and railroads include:

- Chronic and acute introduction of sediment from surface erosion and drainage
- Fish passage impairment or blockage due to culverts, bridges, etc.
- Risk of spills
- Alteration of drainage channels, hydrology, infiltration, and runoff patterns
- Alteration in riparian zone diversity, function, and composition
- Channel simplification, incision, and disconnection from the floodplain
- Alteration in channel and streambank stability
- Water-borne pollutants such as sediment, chemicals, and adverse changes in nutrient levels

**2. Residential and commercial development.** Urban, industrial, suburban, recreational, and rural residential developments permanently alter the natural environment and encroach on floodplains and riparian areas. Additional impacts result from household sewage, urban wastewater, increased sedimentation, industrial effluents, garbage, and solid waste. Residential and commercial development is considered one of the primary threats to coho.

Stresses from development include:

- Introduction of pollutants, garbage, urban/industrial wastewater, sediment, toxic chemicals, and changes in nutrient levels
- Alteration in riparian zone integrity, diversity, function, and composition
- Alteration in streambank stability
- Channel simplification, incision, and disconnection from the floodplain
- Alteration of drainage channels and hydrology
- Increased stormwater runoff
- Water diversion and withdrawal

**3. Droughts.** A drought can occur when there is less than average rainfall due to natural events or human actions that result in impacts to streamflow and riparian conditions. Drought is considered a primary threat to coho recovery from the Russian River south.

Stresses resulting from drought include:

- Insufficient flows to facilitate egg incubation, juvenile rearing, smolt outmigration, and juvenile upmigration
- Poor water quality leading to increased in-stream temperatures, low dissolved oxygen, decreased food availability, increased concentrations of pollutants, etc.

- Earlier-than-normal water diversion for anthropogenic purposes
- Insufficient flows to breach sandbars at river mouths; heavy winter and spring rains breach sandbars that build up at river mouths on the coast during the low-flow months

**4. Logging and wood harvesting.** Cited as a significant threat north of the Russian River, timber harvesting operations and post-logging impacts can cause changes to the hydrograph and increase water-borne pollutants such as sediment and nutrients. Development associated with timber harvesting requires the construction of skid trails, landings, and yarding corridors, re-opening of old roads, and/or the construction of new roads – all key threats to riparian habitat. After harvesting, timberlands are subject to land use conversion to vineyards or rural residential development.

Stresses resulting from timber harvest may include:

- Water-borne pollutants such as sediments, harmful chemicals, and excess nutrients
- Alteration in riparian zone integrity, diversity, function (e.g., large woody debris recruitment), and composition
- Alteration of drainage channels and hydrology
- Channel simplification and alteration in streambank stability
- Water diversion and withdrawal
- Compromised hillslope stability

**5. Livestock farming and ranching.** If not managed carefully, livestock grazing in a single location or roaming a larger area can pose a threat to coho and other fish. This category includes operations such as feed lots, dairy farms, chicken farms, and cattle ranching.

Stresses to be considered:

- Water-borne pollutants such as sediment, harmful chemicals, hormones, and excess nutrients
- Alteration in riparian zone diversity, function, and composition
- Alteration of drainage channels and hydrology due, in part, to soil compaction
- Channel simplification and alteration in streambank stability
- Water diversion and withdrawal

**6. Agricultural practices.** Agricultural practices are described as annual and perennial non-timber crop farming and associated operations other than grazing, ranching, and timber harvest operations. Such practices encompass all operations relating to developing, maintaining, plowing, planting, harvesting, fertilizing, and irrigating row crops, orchards, vineyards, commercial greenhouses, nurseries, gardens, and similar land uses. Of particular concern are the cumulative, chronic, and instantaneous water diversion and withdrawal methods.

**7. Channel modification.** Certain actions can directly or indirectly modify or degrade channel-forming processes and stream morphology. These actions include breaching or dredging of estuarine lagoons, flood control, large wood debris removal, levee construction, vegetation removal, herbicide applications, stream channelization, and bank stabilization that essentially channelize the stream.

**8. Climate change.** While specific results from climatic change are difficult to predict, nearly all models foresee weather events outside the normal range of variation, with increased air temperature being most probable. Changes in climate are predicted to lead to major changes in habitat composition and location. Actions in response to a changing climate may include an increased demand for existing water supplies and managing water storage to provide cool water refugia.



**9. Fire and fuel management.** Fighting wildfires and fire prevention actions, such as prescribed burns, can be detrimental to coho habitat. The construction of fire breaks and roads, use of fire retardants, fuel management activities, fire suppression, and water use planning are some of the detrimental actions associated with fire and fuel management.

**10. Fishing and collecting.** The legal and illegal harvesting of salmonids can impact coho viability. Actions include legal harvesting for recreation, subsistence, relocation, research, collection, and incidental capture. Illegal activities include poaching and unpermitted collection.

**11. Hatcheries and aquaculture.** Hatchery and fish farming operations also pose threats to viability. Stresses include introduction of salmonids from outside of the ESU, pollution and elevated nutrient levels from the facilities, and capture of wild spawners, reducing the total run size.

**12. Storms and flooding.** Storms and flooding become threats when rainfall is above average and can exacerbate already-degraded conditions. Stresses are loss of riparian and in-stream habitat attributes, increased turbidity, and channel scour beyond natural conditions.

**13. Disease, predation, and competition.** Both native and non-native species can have significant harmful impacts on salmonids and/or their habitat. Some specific actions contributing to this threat are the introduction of non-native species that prey upon and/or compete with native salmonids (e.g. mergansers); the introduction of non-native vegetation that competes with and/or replaces native vegetation (e.g. *Arundo donax*, or giant reed), and the creation of conditions favorable to increased populations and/or concentrations of native predators (e.g. sea lions).

**14. Mining.** Mining and quarrying, such as in-stream gravel mining, cause numerous deleterious impacts to streams and riparian habitat. Stresses including reduction in quantity and quality of stream gravel, reduced channel complexity and streambank stability, and alterations in the riparian zone integrity.

**15. Recreational areas and associated activities.** Legal and illegal recreational activities can alter, destroy, and/or disturb habitats and species. These activities can include off-road vehicle use, motorboats, mountain bikes, trail maintenance, equestrian uses, and golf courses.

**16. Water diversion and impoundments.** Appropriate and riparian surface water diversions, groundwater pumping, and the construction and maintenance of seasonal dams for water diversions cause changes to water flow patterns outside the natural range of variation. Stresses can include fish passage impairment or blockage, alteration in hydrology and riparian zone diversity, and loss of floodplain and estuarine habitats.



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## Assessing the Viability of Riparian and Fish Conservation Targets

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The Upland Habitat Goals Project stream, native fish, and riparian habitat conservation targets are consistent with the NMFS viability factors of key habitat and population because the methodology used to select a network of conservation lands was deliberately designed to avoid or mitigate many of the viability threats and stressors. For example, the Conservation Suitability layer used in the site selection software (Marxan) offers a rough measure of watershed and ecological integrity by combining population density, average distance to paved roads, and parcelization into a single index. The software was directed to select areas of high suitability. There are a few deviations from this directive where Marxan was forced to select areas of lower suitability to meet the goals for high priority targets. For example, Marxan selected riparian forests along streams in suburbanized Santa Rosa and urbanized Santa Clara Valley because it was necessary to meet the 90% conservation goal for riparian vegetation types.

To further assess conservation target viability, the team performed a watershed integrity cluster analysis to identify the most suitable Planning Watersheds for the conservation of fish and riparian resources, to locate threats, and to highlight the stewardship challenges specific to watersheds grouped according to similar integrity factors.

### Watershed Integrity Cluster Analysis

A watershed integrity cluster analysis at the CalWater 2.2.1 Planning Watershed level was performed by mapping factors representing some of the most significant threats. The analysis was conducted on the revised Conservation Lands Network after adjustments had been made to address deficiencies in the Coarse Filter Conservation Lands Network. Because multiple factors affect each watershed, a cluster analysis was employed to group similarly impacted Planning Watersheds; this allowed the team to more effectively map threats to integrity and identify appropriate management actions across the study area.

The analysis used hierarchical clustering in the statistics program JMP 8.0 based on the following threats calculated for each Planning Watershed (all datasets are at [www.BayAreaLands.org/gis](http://www.BayAreaLands.org/gis)):

#### 1. Residential and commercial development

- Percent urban land coverage from the California Department of Conservation Farmland Mapping and Monitoring Program (FMMP 2008) see Appendix B (*Data and Methods*, Chapter 3) for more details on datasets
- Population density, log transformed from USGS asymmetric map of 2000 population in the nine Bay Area counties (the logarithmic transformation stretches out the distribution and better distinguishes urban, suburban, and exurban development)

#### 2. Agricultural practices – percent Cultivated Agriculture land coverage from FMMP 2008

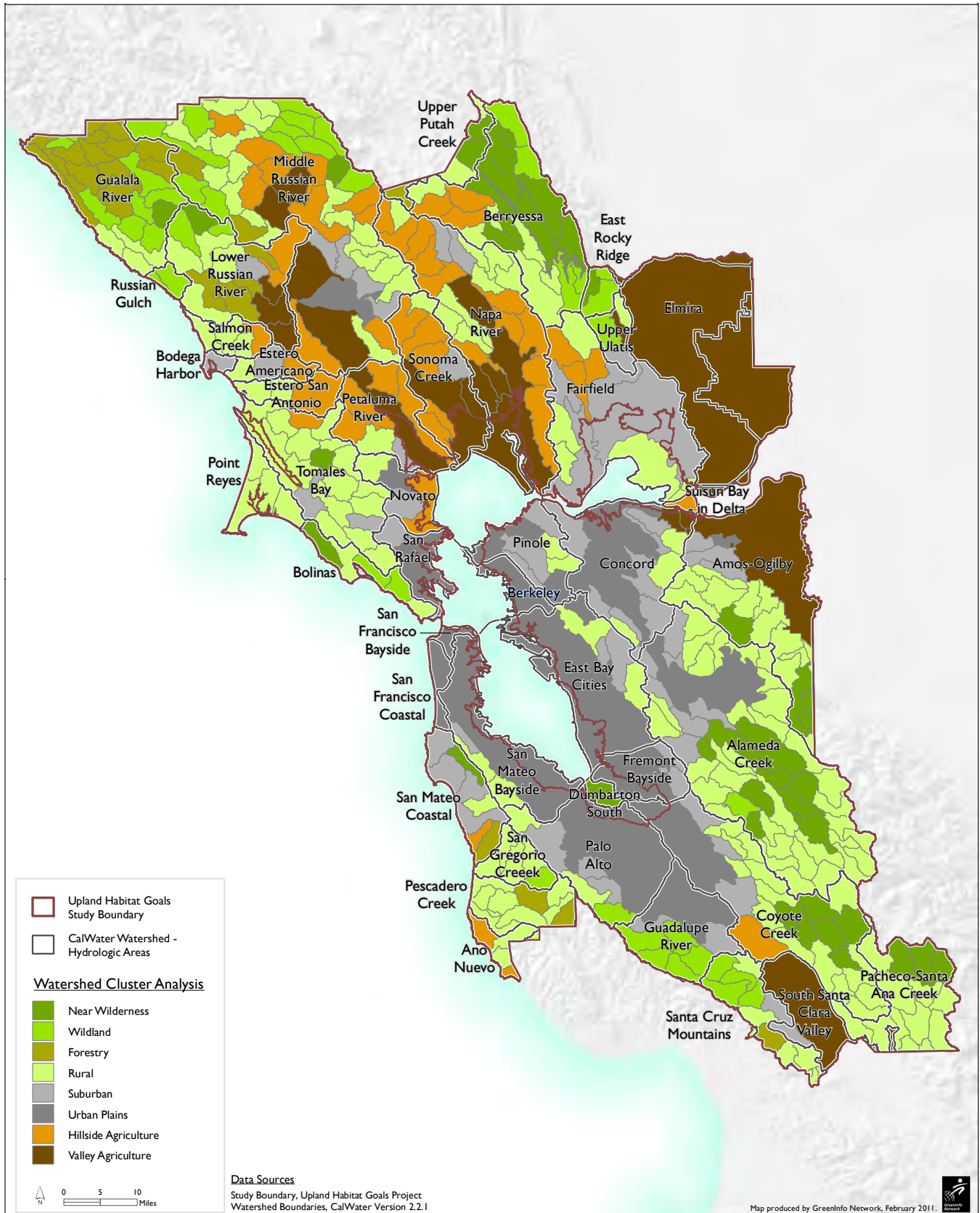
#### 3. Roads and railroads – Distance to Roads, from USGS National Overview Road Metrics – Euclidean Distance

#### 4. Logging and wood harvesting – percent land coverage in Timber Harvest Plans from CALFIRE to identify areas of active commercial and non-commercial forestry

#### 5. Fire – post-fire erosion potential from CAL FIRE, an application of the Universal Soil Loss Equation that takes into account slope steepness, soil type, and rainfall potential

The cluster analysis identified eight clusters of relevance to the Conservation Lands Network, mapped in Figure 5.15. Figure 5.16 details the number, area, and relative measures of threats for each cluster. Relative measures (High, Medium and Low) were determined by expert opinion (Stuart Weiss, PhD, Upland Habitat Goals Science Advisor) after examination of the cluster diagrams and diagnostics.

**Figure 5.15 Watershed Integrity Cluster Analysis.** This analysis of CalWater 2.2.1 Planning Watersheds combined potential impacts from roads and railroads, commercial and residential development, agricultural practices, logging, and fire to estimate watershed integrity. Near Wilderness and Wildland cluster types have the highest ecological integrity.



**Figure 5.16 ■ Watershed Integrity Clusters and Relative Threats.** The watershed integrity cluster analysis mapped the most significant threats to each watershed (CalWater 2.2.1 Planning Watersheds).

Cluster	No. of Planning Watersheds	Total Acreage	Acreage of Cluster Type in CLN	Protected Acreage of Cluster Type in CLN	Relative Threats from Various Factors L = low; M = medium, H = high					
					% Land in Urban	Popl'n Density	% Land in Ag.	Distance from Roads	% Land in Timber Harvest Plans	Post-fire Erosion Potential
<b>Near Wilderness</b>	48	338,264	274,877	158,868	L	L	L	L	L	H
<b>Wildland</b>	48	311,368	244,936	103,953	L	L	L	M	L	H
<b>Forestry</b>	31	170,334	124,281	24,348	L	M	L	M	H	H
<b>Rural</b>	211	1,267,389	850,380	462,199	L	M	L	M	L	M
<b>Suburban</b>	62	552,628	274,276	149,380	M	H	L	M	L	L
<b>Urban Plains</b>	42	686,233	Stream corridors	Stream corridors	H	H	L	H	L	L
<b>Hillside Agriculture</b>	51	467,452	223,553	83,169	L	M	H	M	L	M
<b>Valley Agriculture</b>	22	728,369	136,083	67,358	M	H	H	H	L	L

Each cluster type has a distinct set of characteristics and threats:

**1. Near Wilderness:** Forty-eight Planning Watersheds and 338,264 acres fell into this category, characterized by steep terrain with few roads and very low population density. These are the most intact Planning Watersheds; the primary land use is ranching and large tracts have already been conserved. The Near Wilderness areas appear to comprise headwaters in the Berryessa, Coyote Creek, and Alameda Creek Hydrologic Areas (Mt. Hamilton and Blue Ridge Berryessa landscape units) in the northeastern and eastern/southeastern regions of the study area. The steep slopes and remoteness keep the threat of residential and commercial development low. Post-fire erosion potential appears high, while livestock grazing and roads could also contribute to erosion.

Because Near Wilderness areas coincide with headwater areas, conservation actions should focus on maintaining the high ecological integrity through cooperative agreements and land use policies, and fee or conservation easement acquisition for properties with development potential. Stewardship should focus on best management practices for livestock grazing, restoration of degraded riparian zones, and erosion control for roads and after fires.

The Conservation Lands Network includes a total of 274,877 acres in the Near Wilderness cluster type – which includes 158,868 acres of land already conserved.

**2. Wildland:** These 48 Planning Watersheds encompassing 311,368 acres are also found in steep terrain, but with more roads than Near Wilderness. Wildland areas are distributed more widely throughout the study area, but are primarily near the outer boundaries. As is the case in the Near Wilderness Areas, these are highly intact Planning Watersheds with livestock grazing as the predominant land use, and little threat of commercial and residential development due to steep and remote terrain. Roads and post-fire erosion emerge as the primary threats.

Recommended conservation actions in Wildland Areas are the same as for Near Wilderness areas: focus on maintaining the high ecological integrity through cooperative agreements and land use policies, and fee or conservation easement acquisition for properties with

development potential. Stewardship should focus on best management practices for livestock grazing, restoration of degraded riparian zones, and erosion control for roads and after fires.

The Conservation Lands Network incorporates 244,936 acres of the Wildland cluster type, including 103,953 acres of already-conserved land.

**3. Forestry:** Thirty-one Planning Watersheds and 170,334 acres make up this smallest category, characterized by having active or recently-active Timber Harvest Plans posing a potential threat from logging, steep terrain, and medium population density. This cluster does not include urban or cultivated agricultural areas. These rugged Planning Watersheds are located primarily in the Gualala River Hydrologic Area (Sonoma Coast Range Landscape Unit) with a smaller area in San Mateo Coastal, San Gregorio Creek and Pescadero Creek Hydrologic Areas (Santa Cruz Mountains North Landscape Unit). These rugged Planning Watersheds with high precipitation support extensive second-growth redwood and Douglas-fir forests, and are key coastal watersheds for steelhead and coho. The highest threats come from logging and erosion, post-fire and otherwise, with medium threats posed by more roads and slightly higher population densities. The historical legacy of poor forestry practices has created long-term erosion issues necessitating watershed-scale restoration. Many forestry-related erosion issues occur in the Gualala River watershed, where a sediment TMDL was established in 2001.

Recommended conservation actions include the purchase of working forest conservation easements that embody sustainable forestry practices and have enforceable stream protections, pushing CAL FIRE to enforce stream protections required in Timber Harvest Plans, and encouraging the adoption of forestry best management practices (see *Additional Resources*). Restoration forestry, erosion control fixes for roads, and riparian zone restoration are all essential in these watersheds. High forest productivity and carbon storage may provide opportunities for carbon offsets under the California Air Resources Board Forestry protocols, which could conceivably finance management improvements and habitat restoration.

The Conservation Lands Network includes 124,281 acres of the Forestry cluster type with 24,348 acres already conserved.

**4. Rural:** These 211 Planning Watersheds, by far the largest cluster at 1,267,389 acres, are distributed across nearly all landscape units and characterized by moderate population densities in hilly - but not mountainous - terrain. Rural residential development occurs along the major roads, but there are virtually no urban or cultivated agricultural areas. Ranching is the major land use. Rural sprawl, roads, and post-fire erosion (including that caused by poorly managed livestock grazing) pose medium threats.

Working landscape conservation easements and the use of cooperative agreements that provide incentives for private landowners to improve resource management practices are especially useful in maintaining viable grazing and improving rangeland and forest management in Rural areas. Road erosion control, riparian restoration, managing water diversions and withdrawals, and the adoption of best management practices for rangeland are important for maintaining and restoring ecological functions. The Natural Resources Conservation Service and Resource Conservation Districts play pivotal roles in these watersheds by working directly with private landowners and offering technical and financial assistance to improve natural resource management.

The Conservation Lands Network incorporates 850,380 acres in the Rural cluster type, which includes 462,199 acres of already-conserved land.

**5. Suburban:** Sixty-two Planning Watersheds comprising 552,628 acres are characterized by higher population densities than Rural areas, with more roads, some urban areas, little cultivated agriculture, and low slopes. Extensive suburban development presents many threats for conservation targets. Flood control projects have altered stream channels, and riparian zones are often narrow. Still, many streams in these areas are used by anadromous fish to reach upper watersheds, and support pockets of native fish assemblages.



Cait Huttnik / LightOfMorn.com

The purchase of fee or conservation easements is rarely feasible in Suburban areas; the primary protection tools are regulatory and policy protections combined with public education efforts. Slope ordinances can be especially effective in conserving headwater areas. Restoration is critical to reconnect these areas to their upper watersheds. Conservation and restoration opportunities will depend on close cooperation between property owners, Resource Conservation Districts, local and regional watershed councils (e.g. Urban Creeks Council, Alhambra Creek Watershed Planning Group), regional water quality control boards, and water and flood control agencies.

The Conservation Lands Network includes 274,276 acres in the Suburban cluster type with 149,380 acres already conserved.

**6. Urban Plains:** These 42 Planning Watersheds and 686,233 acres are the densely populated urban areas in flatlands. These Planning Watersheds have the most highly modified stream systems with extensive flood control and channelization where riparian zones are narrow or even non-existent. Many if not all stressors resulting from commercial and residential development are present; despite this, some larger streams have regionally unique warm-water fish assemblages.

Fish passage to upper watersheds is a high priority, as is restoration of remnant riparian habitat. Urban runoff creates water quality impacts evidenced by the numerous TMDLs in varying stages of completion or proposal. One completed TMDL for Diazinon/Pesticide Toxicity addressed more than 30 impaired urban creeks or creek segments. Numerous urban streams are proposed for listing due to impairment from trash.

As with Suburban areas, protection and restoration strategies will rely on strong, enforceable policies at both the state and local levels, such as the listing of impaired streams under the Clean Water Act, and aggressive public education programs epitomized by the storm drain stenciling programs administered by numerous regional and local entities. Success will require close cooperation among landowners, city and county clean water programs, regional water quality control boards, water and flood control agencies, and local and regional watershed councils.

The Conservation Lands Network does not include any acreage in the Urban Plains but does include the stream corridors, and the Upland Habitat Goals Project recommends using any and all means to protect stream corridors, and establish riparian buffers as wide as possible.

**7. Hillside Agriculture:** Fifty-one Planning Watersheds covering 467,452 acres and found mostly in the North Bay, have medium population densities, substantial cultivated agriculture (primarily, but not exclusively, vineyards), and are located in moderately hilly terrain. Residential development and cultivated agriculture have altered and degraded many stream channels (especially first- and second-order streams below the scale of NHD), removed riparian vegetation, diverted water, and contributed to sedimentation and elevated nutrient levels. Most of the important larger watersheds have sediment TMDLs in place or pending. For example, sediment TMDLs are awaiting approval for both Napa River and Sonoma Creek, and nutrient TMDLs are in development for these same watersheds. Removal of fish passage barriers to upper watersheds is a high priority.

Comprehensive, broad-based watershed plans can address some of the problems caused by Hillside Agriculture, such as implementation of approved TMDLs. Slope ordinances, along with effective best management practices for agriculture – including erosion plans for vineyards and other cultivated agriculture – are especially important in these watersheds, as are regulations limiting irrigation and crop protection water withdrawals at key times of the year. The Natural Resources Conservation Service, Resource Conservation Districts, and collaborative programs such as the Fish Friendly Farming certification program (see *Additional Resources*) can implement watershed-scale restoration. Rural residential impacts can be managed somewhat effectively with local and regional policy protections such as zoning restrictions and riparian protection ordinances.

The Conservation Lands Network incorporates 223,553 acres in the Hillside Agriculture cluster type, and 83,169 of these acres are already protected.

**8. Valley Agriculture:** The 22 Planning Watersheds of Valley Agriculture comprise 728,369 acres of intensively modified flatlands with a cultivated agricultural matrix and high population densities in urban and suburban patches. They are found in most valleys that are not intensively urbanized in the North Bay (Santa Rosa, Napa), Central Valley fringe (Brentwood), and Santa Clara Valley. Streams and wetlands have been extensively modified by flood control actions, channelization, water diversion and withdrawal, gravel mining, and other actions associated with agricultural practices, as well as by commercial and residential development. Because these heavily developed lower watersheds include many impediments and diversions, fish passage to upper watersheds is especially important.

Wetlands near the Bay provide important rearing habitat for steelhead and salmon, but water quality in these areas can be impacted by agricultural and urban land uses. Valley Agriculture areas in Napa and Sonoma Counties comprise the best remaining baylands-to-uplands transitions, but projected sea level rise could cause these areas to shift inland as the lowest elevations are inundated. Many of the Planning Watersheds in this area are owned by public resource agencies such as the US Fish and Wildlife Service or conservation nonprofits, including the Sonoma Land Trust.

The purchase of agricultural conservation easements that prescribe riparian and wetlands protections are one conservation option in Valley Agriculture areas. Regulatory and voluntary programs, along with land use policies, are also important conservation tools here. As with Hillside Agriculture areas, the Natural Resources Conservation Service, Resource Conservation Districts, and collaborative programs such as the Fish Friendly Farming certification program can build political will to restore riparian and wetland areas.

The Conservation Lands Network includes 136,083 acres in the Valley Agriculture cluster type, of which 67,358 acres are currently protected.

### Watershed Integrity Cluster Gap Analysis

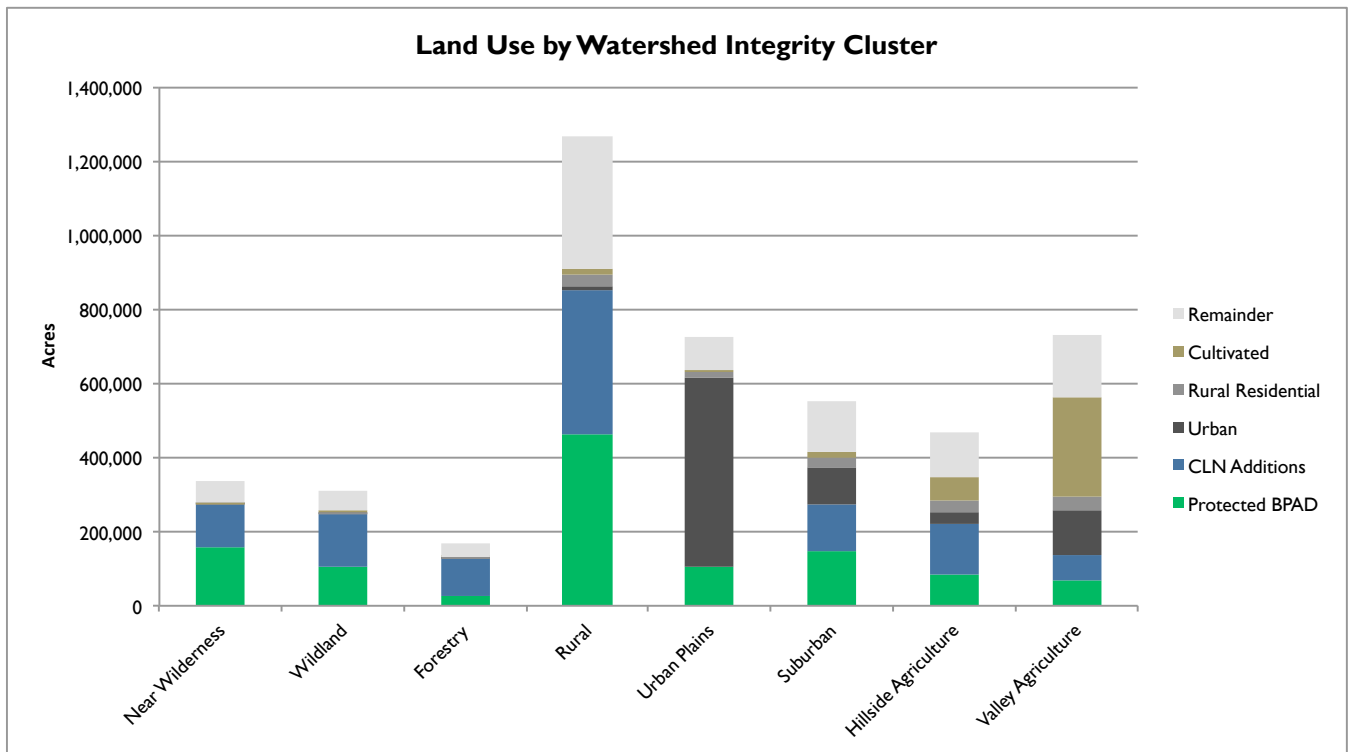
To evaluate the relationship between the Conservation Lands Network and the watershed integrity clusters, a gap analysis was completed. The distribution of land uses and protection levels for each watershed integrity cluster type are shown in Figure 5.17.

The analysis shows that 81% of the Near Wilderness and 79% of Wildland watersheds, the most intact watersheds, are included in the Coarse Filter Conservation Lands Network, with ~60,000 acres remaining in both cluster types. Remaining lands are areas with biodiversity conservation potential that are not in the CLN. In the largest cluster, Rural watersheds, the Coarse Filter Conservation Lands Network includes 67% of these watersheds with ~361,000 acres remaining. Forestry watersheds are included at 73%, with a remainder of 37,000 acres. 48% of Suburban watersheds are included – these areas obviously are the open spaces outside of the developed portions, with a remainder of 139,000 acres. Urban and Valley Agriculture are included in the Coarse Filter Conservation Lands Network at 10% and 19%, respectively – in these clusters, the areas available for conservation are limited, and even those areas have lower suitability for conservation because of the population density, roads, and parcelization.



Robert A. Leidy

**Figure 5.17 ■ Gap Analysis of Watershed Integrity Cluster Types and the Conservation Lands Network.** This gap analysis illustrates the relationship between the Watershed Integrity Cluster types and the Conservation Lands Network. The CLN captures a higher percentage of the most intact watersheds – Near Wilderness and Wildland.



## Recommended Conservation Actions

The San Francisco Bay Area has a history of broad-based conservation collaborations successfully tackling ambitious goals, such as the San Francisco Estuary Project and the South Bay Salt Ponds Restoration. Achieving the fish and riparian goals established by the Upland Habitat Goals Project requires a similar commitment to collaboration and a shared vision among diverse public agencies, private conservation organizations, and landowners. It is not feasible or realistic to acquire fee interests or conservation easements for the entire stream network; protection of riparian habitat will rely upon incentives and strong policies backed by enforcement. Cooperation among diverse stakeholders is also essential to accomplish the extensive ecological restoration required for healthy riparian habitats and ecological processes and functions.

The Riparian/Fish Focus Team developed eight recommended conservation actions to guide conservation practitioners toward the goals outlined here. The recommended conservation actions are summarized here, and covered in more depth in the *Riparian/Fish Focus Team Report* ([www.BayAreaLands.org](http://www.BayAreaLands.org)).

1. Implement the *Recovery Plan for the Evolutionarily Significant Unit of Central California Coast Coho Salmon* and the *Priority Recovery Actions for the Central California Coast Steelhead Distinct Population Segment*.
2. Encourage the development of comprehensive, multi-stakeholder watershed plans that forge the partnerships vital to coalescing action around large, complex issues.
3. Secure sensitive undeveloped headwaters and streamside lands through easements, fee acquisition, voluntary stewardship incentives, and policies.
4. Limit further encroachment of riparian areas by establishing and enforcing strong policies that mandate stream protections.

5. Restore stream channels and adjacent riparian habitat, including the strategic removal of barriers to fish passage where appropriate.
6. Implement aggressive sediment and non-point source pollution control measures.
7. Secure seasonal water releases to benefit native fishes, especially coho salmon and rearing and smolting steelhead.
8. Improve the stewardship of streams and riparian areas on public and private land.

Implementing these recommendations entails a range of actions from outright purchase to watershed plans to enforcing stream protection regulations. Each recommended action is discussed in more detail below.

### **1. Implement the *Recovery Plan for the Evolutionarily Significant Unit of Central California Coast Coho Salmon and the Priority Recovery Actions for the Central California Coast Steelhead Distinct Population Segment.***

The National Marine Fisheries Service (NMFS) released the *Public Draft Recovery Plan for the Ecologically Significant Unit of the Central California Coast Coho Salmon* in March 2010. The final plan, expected in 2011, will be available on the NMFS website, [www.swr.noaa.gov/recovery](http://www.swr.noaa.gov/recovery). The plan has extensively detailed sections for each of the 28 priority watersheds with very specific recommended actions that will not be duplicated here. The Upland Habitat Goals Project encourages conservation practitioners to review the plan for specific actions in watersheds of interest.

#### **Priority Recovery Actions for Central California Coast Coho Salmon ESU (NMFS, 2010):**

- Finalize and implement the *State Coastal Monitoring Plan*, which is essential for evaluating the long-term viability of Central California Coast (CCC) coho salmon and their habitats, as well as other species of listed salmonids.
- Focus restoration funds to prioritize funding in Core Areas and on activities that will increase the probability of freshwater survival.
- Promote restoration projects in overwintering habitats such as alcoves, backchannels, off channel areas, and estuaries.
- Encourage appropriate agencies to secure funding for, and engage in, full enforcement of relevant laws, codes, regulations, and ordinances protective of coho salmon and their habitats.
- Work with the Department of Fish and Game to improve freshwater sport fishing regulations to minimize unintentional and unauthorized take and incidental mortality of CCC coho salmon during migration.
- Urge the California Board of Forestry to develop no-take rules and/or apply for a statewide Forestry Habitat Conservation Plan and seek funding to support the effort.
- Assess and address the mechanisms driving forest conversions and provide incentives for sustainable forestry.
- Encourage forestry landowners to develop Habitat Conservation Plans protective of coho salmon and their habitat. Finalize the *Mendocino Redwood Company Habitat Conservation Plan*.
- Improve coordination between agencies to effectively address seasons of diversion, off-stream reservoirs, and bypass flows fully protective of CCC coho salmon.
- Encourage counties to control forest conversion and prioritize rezoning and grading ordinances protective of CCC coho salmon and their habitats.

The Department of Fish and Game completed the *Steelhead Restoration and Management Plan for California* in 1996 (see *Additional Resources* for link). The recovery planning process has barely begun for the threatened Central California Coast Steelhead DPS; the Recovery Outline was completed in 2007. In spite of the slow progress on a recovery plan, NMFS has stipulated several priority steelhead recovery actions that overlap with those for coho.





### Priority Recovery Actions for Steelhead (NMFS 2007):

- Research and monitor steelhead distribution, status, and trends.
- Promote operations of current recovery hatcheries and develop Hatchery and Genetics Management Plans to minimize negative influences of hatcheries.
- Improve freshwater habitat quantity and quality.
- Protect and restore habitat complexity and connectivity from the upper watershed to the ocean.
- Conduct focused freshwater habitat restoration in anadromous salmonid streams – e.g., erosion control, bank stabilization, riparian protection and restoration, and reintroduction of large woody debris.
- Balance water supply and allocation with fisheries needs through a water rights program, designate fully appropriated watersheds, develop passive diversion devices or offstream storage, eliminate illegal water diversions, and improve criteria for water drafting and dam operations.
- Improve agricultural and forestry practices – in particular, riparian protections, road construction, and road maintenance.
- Improve county/city planning, regulations (e.g. riparian and grading ordinances) and county road maintenance programs.
- Remove/upgrade high-priority man-made fish passage barriers (e.g. watercourse crossings and non-hydropower dams).
- Screen all water diversion structures.
- Replace existing outdated septic systems and improve wastewater management.
- Identify and treat point and non-point source pollution of streams from wastewater, agricultural practices, and urban environments.
- Modify channel and flood control maintenance and eliminate artificial breaching of sandbars for improvements in channel and estuarine habitats.

## 2. Encourage the development of comprehensive, multi-stakeholder watershed plans that forge the partnerships vital to coalescing action around large, complex issues.

Watershed planning processes, when well executed, comprehensive, and inclusive of diverse interests, can be the most effective approach to address the myriad of threats altering the biodiversity values of stream corridors. The involvement of stakeholders from the agricultural, environmental, urban, suburban, and commercial realms often raises awareness of differing viewpoints, impacts on riparian resources, and can lead to collaborative solutions. In Becker *et al.* 2007, the authors note the significant increase in the probability of successful protection and restoration actions in watersheds with comprehensive plans, in part due to the enormous political will that is needed to undertake large-scale restoration efforts. The Riparian/Fish Focus Team specifically recommends that watershed plans include the gathering of life cycle and geomorphic data, and include a limiting factor analysis as was done by the Marin Resource Conservation District for Lagunitas Creek.

Watershed plans have been completed for many Bay Area watersheds. A list of creek and watershed organizations and a description of their activities can be found at the Alameda County Watershed Forum website (see *Additional Resources*). Nearly all of the Anchor and Coho Core Area watersheds have completed watershed plans or plans in process. Because of the detail provided in most watershed plans, conservation practitioners are encouraged to review existing watershed plans for more specific recommended conservation action.

Two regional planning documents completed with diverse stakeholders also offer directives to restore the ecological health of streams and riparian ecosystems: the *Comprehensive Conservation and Management Plan* (CCMP) completed by the San Francisco Estuary Project and the *Integrated Regional Water Management Plan* completed in 2006 (see *Additional Resources* for links). Conservation practitioners are encouraged to consult these plans for detailed protection, restoration, and policy actions.

### **3. Secure sensitive undeveloped headwaters and streamside lands through easements, fee acquisition, voluntary stewardship incentives, and policies.**

The protection of headwaters is particularly important because of the correlation between intact headwaters and healthy assemblages of native fish (Leidy 2007). Numerous studies have found the protection of headwaters is also vital to successful restoration efforts. Becker *et al.* 2007 cites a Pacific Rivers Council report (Doppelt *et al.* 1993) describing the significance of these areas to stream ecosystem viability. Disturbances in the headwaters can diminish or negate benefits conferred by downstream restoration.

Many headwaters are already in public or conservation ownership, and the Conservation Lands Network adds more headwaters areas that are not yet protected. However, the Riparian/Fish Focus Team concluded that it is not feasible to add the thousands of acres necessary to include all headwaters in the Conservation Lands Network. Furthermore, compatible uses such as ranching are common in many headwaters, so keeping ranching economically viable and offering technical and financial assistance for sound stewardship is a viable option for meeting biodiversity goals.

As a result, the focus team recommends purchasing fee interests or conservation easements where there are willing sellers, and using voluntary incentive programs and policies to help range and forestland owners continue to manage their lands for biodiversity. The Natural Resources Conservation Service, Resource Conservation Districts, and the US Fish and Wildlife Service Partners for Wildlife Program all offer technical assistance and cost-sharing programs to protect and restore riparian resources. Funding for fee and easement acquisition is available from a variety of federal, state, and local agencies including the US Fish and Wildlife Service, the California Wildlife Conservation Board, California Coastal Conservancy, California State Parks, regional park districts, and private foundations.

Many streams are encumbered by easements for flood control purposes. Little is known about these easements and the rights associated with them (for example, the ability to remove vegetation or riprap banks). The focus team suggests an inventory and evaluation of these easements to determine their potential for protecting streamside habitat.

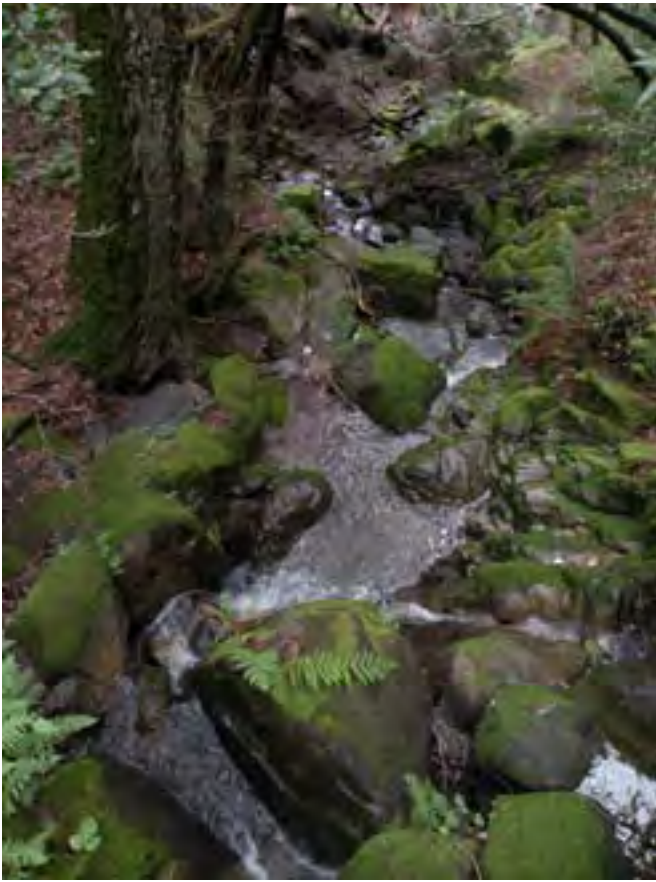
### **4. Limit further encroachment of riparian areas by establishing and enforcing strong policies that mandate stream protections.**

The Upland Habitat Goals Project recommends the enforcement of existing regulations and the adoption of ordinances and zoning designations where needed to protect and – in many cases – allow the restoration of ecological functions of riparian corridors. Stream protection policies and ordinances are the first line of defense (and often the only defense) for streams and riparian corridors traversing urban and suburban areas. Fee and easement acquisitions are rarely a viable option in developed areas where numerous small parcels abut a stream. Strong policies and regulations – including the designation of buffer areas – restrictions on removal of riparian vegetation, planting of non-native species, use of pesticides, and other measures backed by rigorous enforcement are critical in these developed regions.

The following actions are recommended to maximize the efficacy of policies and regulations for stream corridor conservation.

**a. Enforce existing federal, state, and local regulations and policies.** Numerous stream protection regulations are in place at the federal, state and local levels for riparian habitat and water quality. The Army Corps of Engineers, US Environmental Protection Agency (EPA) share responsibility for enforcing Sections 404 and 401 of the Federal Water Pollution Control Act of 1972 (the Clean Water Act). The US Fish and Wildlife Service and National Oceanic and Atmospheric Administration/National Marine Fisheries Service enforce the Endangered Species Act to protect species dependent on riparian ecosystems.

At the state level, several agencies offer riparian protections, including the Coastal Commission, State Water Resources Control Board through the regional boards, the Bay



Conservation and Development Commission, Department of Fish and Game, and CAL FIRE. The State Water Quality Control Board works with the Regional Boards to enforce Section 401 of the Clean Water Act. The North Coast and San Francisco Bay Regional Boards, in conjunction with the State Water Resources Control Board, are developing a Stream and Wetlands System Protection Policy to further the goal of protecting and restoring the physical characteristics of stream and wetlands systems (stream channels, wetlands, riparian areas, and floodplains) and natural hydrologic regimes to achieve water quality standards and protect beneficial uses.

At the local level, many cities and counties have policies that prevent or minimize impacts to streams, including those restricting development on hillsides (to limit habitat loss as well as runoff, erosion, and sedimentation), preventing development close to streams, and reducing stormwater runoff. Slope or hillside development ordinances can be especially effective at reducing impacts to riparian zones (Estes pers. comm. July 2010). Numerous cities and counties have included stream protection and buffer policies in their general plans, and some have enacted ordinances to implement these protections. A 2004 survey (San Francisco Bay Regional Water Quality Control Board 2004) found that 31 of the 85 cities within its jurisdiction had some form of stream buffer policy in their municipal code, zoning ordinance, general plan, or other policy document.

The FishNet 4C program is a good example of the use of policies – coordinated across many agencies – to conserve riparian habitat and stream corridors. Initiated in 1998 in response to the federal listing of coho and steelhead, FishNet 4C undertook an assessment of the general plans and implementing ordinances of its six member counties – Mendocino, Sonoma, Marin, San Mateo, Santa Cruz, and Monterey. Using a collaborative approach involving a long list of public and private partners, FishNet 4C identified 15 high-priority actions that underscore the policy and management gaps in habitat protection identified by the assessment. The detailed and comprehensive assessment was completed by UC Berkeley and FishNet 4C in 2001 (Harris and Kocher 2001). The counties and their many partners are now implementing these actions, which are listed at [www.fishnet4c.org/pdf/implementation\\_goals\\_final.pdf](http://www.fishnet4c.org/pdf/implementation_goals_final.pdf).

**b. Secure buffers as wide as possible.** Establishing and enforcing strong stream buffer policies is especially important because of the many ecosystem services provided by riparian areas. This can be a difficult task in many areas because of constraints imposed by development. One study (San Francisco Bay Regional Water Quality Control Board 2004) found that among Bay Area cities with stream buffer policies, the buffer distances vary greatly; approximately 38% required a 33ft or greater minimum buffer. The authors speculated that the distances were the result of political pressure rather than scientific criteria, underscoring the resistance that can be encountered when enacting stream protections.

Several studies articulate recommendations for riparian buffer widths based on the riparian function under consideration. One such report, *Comparison of Methods to Map California Riparian Areas* (Collins *et al.* 2006) by the San Francisco Estuary Institute, included an extensive literature review to describe riparian functions and corresponding riparian widths (see Figure 5.18); the variation shown highlights the complexity of making specific stream buffer recommendations.

**Figure 5.18 ■ Riparian Buffer Width Recommendations** (from Collins *et al.* 2006).

Riparian Function	Average min. and max. riparian buffer widths (rounded to 5m)
Sediment entrapment	10 - 75m
Contaminant filtration or chemical transformation	10 - 115m
Large woody debris input to water body	40 - 80m
Leaf litter input to water body	5 - 25m
Flood hazard reduction	15 - 65m
Aquatic wildlife support	20 - 60m
Bank or shoreline stabilization	15 - 25m
Riparian wildlife support	40 - 160m
Water body cooling	20 - 40m
Riparian microclimate control	70 - 130m
Multiple functions considered, in conjunction with riparian wildlife support	30 - 120m

Another study, *Setback Recommendations to Conserve Riparian Areas and Streams in Western Placer County* (Jones & Stokes 2005), offers an extensive analysis of ecological functions, species requirements, and human impacts. This study makes two recommendations:

- For first- and second-order stream segments, a minimum riparian setback should include the entire active floodplain plus a buffer of 30m. The study notes that even this size buffer is not sufficient for wildlife with large area requirements.
- For third-order or greater streams, and lower-order stream segments adjacent to protected lands, a setback of at least 100m (and, better, 150m) from the active floodplain is recommended for conserving and enhancing stream and riparian ecosystem functions, including most wildlife habitat functions.

A third study completed by Jones & Stokes for the Napa County Conservation Development and Planning Department (Robins 2002) recommended different buffer widths ranging from 25 - 300ft or more, depending on stream class and the ecosystem functions to be protected.

In its 2004 conservation plan, the Riparian Habitat Joint Venture (RHJV 2004) commented on the complexity of quantifying a specific target width for riparian habitat. Different species require varying widths for breeding success, and more research is needed. However, the plan concludes that wider riparian corridors are likely to provide more and better habitat.

**c. Coordinated public education program.** Compliance with stream protection policies can be improved by a public education program explaining the significance of riparian areas. Public education is especially important where streams reach exurban and urban areas and enforcement is difficult.

In more rural areas, Resource Conservation Districts and the Natural Resources Conservation Service play a vital role in not only educating property owners but also providing technical assistance for resource conservation. The Napa Resource Conservation District compiled a comprehensive guide for property owners entitled *Caring for Creeks in Napa County: Management Tips for Streamside Property Owners*. The Alameda Countywide Clean Water Program compiled the *Creek Care Guide: A Guide for Residents in the San Lorenzo Creek Watershed*. Links to these guides are in *Additional Resources*.



Jonathan Koehler

## 5. Restore stream channels and adjacent riparian habitat, including the strategic removal of barriers to fish passage where appropriate.

Once headwaters and key riparian corridors have been secured by acquisition, land use policies, landowner incentive programs or other means, restoration of the riparian ecosystem should be undertaken to remove impediments to ecological functions. Doppelt *et al.* 1993 advocates focusing restoration on relatively healthy habitat, and then expanding to adjacent areas. Becker *et al.* 2007 articulates a steelhead restoration strategy that encompasses three areas applicable to all streams:

- **Water Supply.** For Anchor Watersheds, analyze and estimate the water supply required for rearing habitat and processes.
- **Limiting Factors Analyses.** Complete limiting factors analyses (at least for key tributaries in the Anchor Watersheds) for use in prioritizing restoration activities.
- **Reconnection to the Bay.** Develop a comprehensive and well-funded program to reconnect high-quality spawning and rearing habitat to the Bay. Because the lower reaches of all Anchor Watersheds have been severely altered, this will require strong political will and significant funding.

Barriers to fish passage are a significant threat to steelhead and coho salmon viability and present a complex challenge to restoration advocates. Barriers are posed by dams, water diversions, poorly constructed roads, and culverts. According to the California Fish Passage Assessment Database (August 2008), there are a total of 2,116 barriers in CalWater 2.2.1 Hydrologic Areas of the Bay Area (see the Riparian/Fish Focus Team Report at [www.BayAreaLands.org/reports](http://www.BayAreaLands.org/reports)), with more barriers in cultivated agricultural areas such as Fairfield and Amos-Ogilby Hydrologic Areas in Solano County and eastern Contra Costa County. The lack of barriers (or the strong possibility of their removal) was a key criterion used to identify the Anchor Watersheds and Essential Streams in Becker *et al.* 2007. The *Public Draft Coho Recovery Plan* provides very detailed information on fish passage barrier types, locations, and recommended actions.

## 6. Implement aggressive sediment and non-point source pollution control measures.

Sedimentation and non-point source pollution result from numerous activities and are difficult to control. The impacts are widespread, as indicated by the list of 270 impaired waterways in 88 water bodies (including bays and estuaries) developed by the San Francisco Bay Regional Water Quality Control Board under Section 303(d) of the Clean Water Act. As with many regulatory programs, enforcement capability is the key to success.

**a. Enforce existing federal, state, and local regulations and policies.** Numerous water quality control regulations have been enacted at the federal, state, and local levels to stem sedimentation and non-point source pollution.

At the federal level, the Army Corps of Engineers and the US EPA share responsibility for enforcing Sections 404 and 401 of the federal Clean Water Act of 1972. Section 404 regulates the filling of wetlands and other waters, while Section 401 requires federal agencies to obtain certification from the state before issuing permits that would result in increased pollutant loads to waterbodies, including streams.

The State Water Resources Control Board and its regional boards are the primary enforcers of state water quality regulations under several different mandates (the nine counties of the Upland Habitat Goals study area fall under the jurisdiction of three Regional Boards – North Coast, San Francisco Bay, and Central Coast). Most important is the Regional Boards' ability to name impaired water bodies under Section 303(d) of the Clean Water Act and require the development of a Total Maximum Daily Load (TMDL) to address the impairment. TMDLs are action plans to restore clean water that define how much of a pollutant a water body can tolerate and still meet water quality standards, examine the water quality problems, identify sources of pollutants, and specify actions to resolve the problems. Once completed and approved, TMDLs are adopted by the Regional Board as amendments to the region's Basin Plan. Regional boards then must ensure the

implementation and ongoing monitoring of the adopted TMDLs. Implementation can take several forms including Regional Board regulatory actions in the form of permits, waivers, or enforcement orders, regulatory actions by another federal, state, or local agency, or non-regulatory actions.

In February 2009, the San Francisco Bay Regional Board approved a 303(d) list of impaired water bodies with more than 270 listings in 88 water bodies; this list awaits US EPA approval. Regional Board staff are developing thirty TMDL projects to address more than 160 of these listings leaving more than 100 TMDLs yet to be started. Figure 5.19 highlights the backlog of TMDLs awaiting action. Note that the Diazinon/Pesticide Toxicity TMDL for urban creeks addressed more than 30 impaired creeks or creek segments, and that many new streams are being proposed for listing due to impairment from trash.

**Figure 5.19 ■ TMDL Projects in the Upland Habitat Goals Study Area.**

<b>TMDL status</b>	<b>San Francisco Bay Regional Water Quality Control Board</b>	<b>North Coast Regional Water Quality Control Board</b> (within study area)	<b>Central Coast Regional Water Quality Control Board</b> (within study area)
Completed TMDL projects	Napa River Pathogens San Francisco Bay Mercury Sonoma Creek Pathogens Tomales Bay Pathogens Urban Creeks Diazinon/ Pesticide Toxicity Walker Creek Mercury	Gualala River Sediment Laguna de Santa Rosa Sediment and Nitrogen Redwood Creek Sediment Stemple Creek & Estero de San Antonio Sediment, Nutrients	
TMDL projects awaiting approval from Water Boards and/or US EPA	Guadalupe River Watershed Mercury Napa River Sediment Richardson Bay Pathogens San Francisco Bay PCBs Sonoma Creek Sediment		
TMDL projects in development	Lagunitas Creek Sediment Pacifica beaches, San Pedro Creek Pathogens Napa River Nutrients North San Francisco Bay Selenium San Francisquito Creek Sediment Butano and Pescadero Creeks Sediment Sonoma Creek Nutrients Tomales Bay Mercury Tomales Bay Siltation/Sediment Walker Creek Sediment	Laguna de Santa Rosa Phosphorus, Dissolved Oxygen, Temperature Mark West Creek Sediment, Temperature Santa Rosa Creek Indicator Bacteria, Sediment, Temperature Russian River (two reaches) Indicator Bacteria	Pajaro River Watershed Siltation TMDL
TMDL projects not yet begun		Gualala River Temperature Laguna de Santa Rosa Mercury Redwood Creek Temperature Russian River (all) Sediment, Temperature	
TMDL projects approved by US EPA			Pajaro River Fecal Coliform TMDL (including Pajaro River, San Benito River, Llagas Creek and Tequisquita Slough) Pajaro River (Including San Benito River, Llagas Creek and Rider Creek) Sediment TMDL Pajaro River (Including Llagas Creek) Nitrate TMDL

At the local level, many actions that limit encroachment of streams also prevent non-point source pollution and sedimentation. The 2007 CCMP Update provides a wealth of recommended actions that local governments can take to reduce sedimentation and non-point source pollution, including the incorporation of stormwater management plans into general plans.

Many cities and counties have formed clean water programs to meet the requirements of the Clean Water Act. The Contra Costa Clean Water Program includes the County, 19 cities, and the Contra Costa Flood Control and Water Conservation District working together to eliminate stormwater pollution through public education, inspection and enforcement activities, and outreach to local industries. The City of Oakland and the Alameda County Flood Control and Water Conservation District have partnered to create the Collaborative Creek Improvement Program to restore, preserve, and improve Oakland's creeks. The program selects projects based on community input, and implements the City's Open Space, Conservation, and Recreation General Plan element and the Creek Protection Ordinance.

**b. Maximize the use of existing voluntary incentive programs and increase financial support for such programs.** Technical assistance and incentives to modify management practices to reduce sedimentation and non-point source pollution can be effective. The Natural Resources Conservation Service, Resource Conservation Districts, CAL FIRE, and US Fish and Wildlife Service have programs that offer assistance with management and restoration to reduce sedimentation and non-point source pollution on range and forest lands. An excellent model, the Fish Friendly Farming Certification Program (see *Additional Resources*) run by the California Land Stewardship Institute provides for voluntary, self-directed compliance with the rigorous standards of state and federal water quality laws, federal Endangered Species Act, and state pesticide laws as well as local regulations.

**c. Coordinate public education campaigns.** The 2007 *Comprehensive Conservation and Management Plan Update* advocates a high-visibility media campaign to make the general public aware of the CCMP and its objectives. The plan also encourages locally-based campaigns such as storm drain stenciling and creek cleanups. While the effectiveness of these programs can be difficult to measure, they can be a valuable component of public education. The City of Oakland conducted polling around its storm drain stenciling program and the results indicated a 75% awareness level of the problems associated with dumping in storm drains (Estes pers. comm. July 2010).

## **7. Secure seasonal water releases to benefit native fishes, especially coho salmon and rearing and smolting steelhead.**

Seasonal water releases are vitally important to anadromous fish as well as to most native fish, particularly for the many segments that go dry in the summer. Recovery actions for both coho and steelhead recommend working with the State Water Quality Control Board to alter diversion dates and allow releases at critical times. Becker *et al.* 2007 recommends completing analyses to provide quantitative estimates of adequate water supply for rearing habitat and processes that implement these in-stream flow provisions.

## **8. Improve the stewardship of streams and riparian areas on public and private land.**

Good stewardship on both public and private lands is integral to restoring riparian ecosystems. The recovery actions for coho and steelhead advocate improved agricultural and forestry management practices to protect water quality and preserve riparian vegetation. Unfortunately, public land managers often lack funding to manage lands optimally for fish and wildlife resources. Increased funding for public land stewardship is essential and long overdue.

Private landowners play an important role in restoring and maintaining stream health; this is especially true of the ranchers and forestland owners in the Bay Area. Large tracts of riparian habitat are found on ranches and forestland in the outer reaches of the study area. Numerous public programs offer technical assistance and matching funds to implement habitat enhancement, erosion control, fencing, and other stream protection projects and are a cost-effective means to improve stream health.

The Natural Resources Conservation Service, US Wildlife Service, and CAL FIRE all offer technical and financial assistance to improve resource management on private lands. Links for these programs can be found in *Additional Resources*.

## Data Gaps

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During the process of establishing goals for riparian and fish resources, the Riparian/Fish Focus Team identified several important data gaps, and recommended the following steps to address them:

1. Develop a comprehensive map of riparian habitat in the San Francisco Bay Area. When complete, the Bay Area Aquatic Resource Inventory (BAARI) of the San Francisco Estuary Institute should fill this data gap.
2. Complete a restoration strategy for native fish assemblages similar to that employed by Becker *et al.* 2007 but using the data from Leidy 2007.
3. Complete in-stream flow analyses to determine quantitative estimates of adequate water supply for rearing habitat and processes to implement increases in in-stream flows.
4. Map existing easements held by public agencies for flood management, groundwater recharge, and other public purposes, and evaluate the contribution of these easements to conservation.

These and other data gaps are discussed further in Chapter 13, *Research Needs, Measuring Success, and Conservation Lands Network 2.0*.

## Additional Resources

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### Watershed Plans and Planning

Alameda County Watershed Forum (includes list of creek and watershed organizations) – [www.alamedacountywatersheds.org](http://www.alamedacountywatersheds.org)

The California Watershed Network – [www.watershednetwork.org](http://www.watershednetwork.org)

*Comprehensive Conservation and Management Plan, 2007 Update* – [www.sfestuary.org/userfiles/ddocs/Final\\_CCMP.pdf](http://www.sfestuary.org/userfiles/ddocs/Final_CCMP.pdf)

*San Francisco Bay Area Integrated Regional Water Management Plan* – [www.bairwmp.org](http://www.bairwmp.org)

San Francisco Bay Regional Water Quality Control Board, Watershed Management – [www.swrqb.ca.gov/rwqcb2/water\\_issues/programs/watershed/watershed.shtml](http://www.swrqb.ca.gov/rwqcb2/water_issues/programs/watershed/watershed.shtml)

US EPA *Handbook for Developing Watershed Plans to Restore and Protect Our Waters*, March 2008, EPA reference number EPA 841-B-08-002 – [water.epa.gov/polwaste/nps/handbook\\_index.cfm](http://water.epa.gov/polwaste/nps/handbook_index.cfm)

The Watershed Portal, California Department of Conservation – [www.conservation.ca.gov/dlrp/watershedportal/Pages/Index.aspx](http://www.conservation.ca.gov/dlrp/watershedportal/Pages/Index.aspx)

### Policy

Fishery Network of the Central California Coastal Counties (FishNet 4C) – [www.fishnet4c.org/policies\\_plans.html](http://www.fishnet4c.org/policies_plans.html)

San Francisco Bay Regional Water Quality Control Board, Stream and Wetlands Protection – [www.swrqb.ca.gov/rwqcb2/water\\_issues/programs/stream\\_and\\_wetland\\_protection.shtml](http://www.swrqb.ca.gov/rwqcb2/water_issues/programs/stream_and_wetland_protection.shtml)



## Public Education

Alhambra Creek Care Guide, Friends of Alhambra Creek – [www.nps.gov/pwso/rtca/page1.htm](http://www.nps.gov/pwso/rtca/page1.htm)

*Caring for Creeks in Napa County: Management Tips for Streamside Property Owners*, Napa County Resource Conservation District – [www.napawatersheds.org/files/managed/Document/3817/Creek%20Care%20FINAL.pdf](http://www.napawatersheds.org/files/managed/Document/3817/Creek%20Care%20FINAL.pdf)

*Creek Care Guide: A Guide for Residents in the San Lorenzo Creek Watershed*, Alameda County Clean Water Program – [www.cleanwaterprogram.org/uploads/CreekCareGuide.pdf](http://www.cleanwaterprogram.org/uploads/CreekCareGuide.pdf)

## Stewardship Incentives and Technical Assistance for Landowners

Fish Friendly Farming Certification Program – [www.fishfriendlyfarming.org](http://www.fishfriendlyfarming.org)

Natural Resources Conservation Service – [www.ca.nrcs.usda.gov/programs](http://www.ca.nrcs.usda.gov/programs)

US Fish and Wildlife Service Partners for Wildlife – [www.fws.gov/cno/partners](http://www.fws.gov/cno/partners)

Forest Stewardship Program and California Forest Improvement Program – [www.ceres.ca.gov/foreststeward/index.html](http://www.ceres.ca.gov/foreststeward/index.html)

## Forestry and Grazing Best Management Practices

Forest Stewardship Council Forest Management Standards – [www.fscus.org/standards\\_criteria/forest\\_management.php](http://www.fscus.org/standards_criteria/forest_management.php)

*Grazing Handbook: A Guide for Resource Managers in Coastal California*, Soyotome Resource Conservation District – [sotoyomercd.org/GrazingHandbook.pdf](http://sotoyomercd.org/GrazingHandbook.pdf)

NMFS, Salmonid Guidelines for Forestry Practices in California – [www.swr.noaa.gov/psd/sgfpc.htm](http://www.swr.noaa.gov/psd/sgfpc.htm)

UC Extension California Rangelands – [californiarangeland.ucdavis.edu](http://californiarangeland.ucdavis.edu)

USDA Forest Service, Water Quality Management for National Forest System Lands in California – [www.fs.fed.us/r5/publications/water\\_resources/waterquality/](http://www.fs.fed.us/r5/publications/water_resources/waterquality/)

## Fish

Central California Coast Steelhead DPS Recovery Outline – [www.swr.nmfs.noaa.gov/recovery/Steelhead\\_CCCS.htm](http://www.swr.nmfs.noaa.gov/recovery/Steelhead_CCCS.htm)

National Marine Fisheries Service, Southwest Regional Office – [www.swr.noaa.gov](http://www.swr.noaa.gov)

*Public Draft Recovery Plan for the Ecologically Significant Unit of the Central California Coast Coho Salmon* – [www.swr.noaa.gov/recovery/Coho\\_Recovery\\_Plan\\_031810.htm](http://www.swr.noaa.gov/recovery/Coho_Recovery_Plan_031810.htm)

*Steelhead Restoration and Management Plan for California* – [www.dfg.ca.gov/fish/Administration/Grants/FRGP/Moreinfo.asp](http://www.dfg.ca.gov/fish/Administration/Grants/FRGP/Moreinfo.asp)

## Priority 1 and 2 Streams List

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See Appendix E.

Jonathan Koehler





## CHAPTER

# 6

## Fine Filter: Mammals



Bob Gunderson / www.flickr.com/photos/bobgunderson

### Introduction

The Mammals Focus Team of the Upland Habitat Goals Project met three times from January 2008 through March 2008. The focus team included biologists with expertise ranging from mountain lions to badgers to bats. Focus team members developed a list of mammal conservation targets in accordance with the Target Selection Criteria (Figure 3.6). They then evaluated how effectively the Coarse Filter Conservation Lands Network covered habitat needs for each target species. For species where there was some question about adequate coverage, the project team used range maps and habitat preferences from the California Wildlife Habitat Relationships model to complete habitat suitability analyses. Lastly, focus team members described viability factors, stewardship, and management recommendations specific to the target species.

### Mammals Focus Team Members

Eric Abelson, PhD candidate, Stanford University  
Reginald Barrett, PhD, University of California, Berkeley  
Henry Colletto, California Department of Fish and Game  
Rick Hopkins, PhD, Live Oak Associates, Inc.  
Dave Johnston, PhD, H.T. Harvey & Associates  
Bill Lidicker, PhD, University of California, Berkeley  
Jesse Quinn, PhD candidate, University of California, Davis  
Martha Schauss, California Department of Fish and Game

Mammals, besides being our close relatives and frequent conservation favorites, also play key ecological roles up and down the food chain. Ground squirrels, for example, are a keystone species in grasslands, where they provide a prey base for raptors, badgers, coyotes, and other predators, and – importantly – provide burrows for Burrowing Owls, California Tiger Salamanders, and other animals. Mountain lions play an especially important role as top predators by keeping deer populations in check, and reducing over-browsing of vegetation. Maintaining viable populations of mountain lion is therefore especially important to biodiversity conservation.

Charismatic megafauna such as tule elk and mountain lion are obvious conservation targets, but the focus team considered the full range of mammal fauna using available data sources and expert opinion. Some surprising conservation targets emerged because of local rarity, range limits, particular threats, and key roles in the ecosystem. The mammal conservation targets proved to be a good test of the coarse filter analysis results because of diverse habitat use and often large area requirements. It also became apparent that much more survey work and monitoring is necessary to fully inventory and assess the conservation of Bay Area mammals.

## Mammals in the San Francisco Bay Area

Bay Area uplands are rich in native mammal species, including cryptic (seldom seen) shrews, moles, and mice, arboreal voles, bats, chipmunks, river otters, porcupines, badgers, coyotes, bobcats, mountain lions, black bears, and tule elk. Mammalian diversity is a reflection of the region's climate and vegetation diversity, as well as its location at the intersection of the southern range limit of mammals typical of wet Pacific Northwest coniferous forests and the northern and western range limit of species typical of the arid Central Valley.

Except for grizzly bear, fisher, and two species of kangaroo rat, nearly all mammal species native to upland habitats in the Bay Area are present in at least small numbers within the study area. The San Joaquin kit fox is federally listed as endangered, and more than 10 other mammals are on the California Species of Special Concern list (Figure 6.10). Some formerly widespread species, such as western spotted skunk, have been reduced to small remnant populations. Mammals face a range of threats, especially the loss and fragmentation of habitat, poor connectivity, and disease. Several introduced mammals, such as wild pigs, feral cats, and red fox, threaten native biodiversity.

## Mammals Focus Team Methodology

### Selection of Mammal Conservation Targets

The Mammals Focus Team was presented with a draft list of mammal targets taken from the California Natural Diversity Database (CNDDDB) and the California Wildlife Habitat Relationships database (CWHR) to facilitate the selection of mammal conservation targets. After reviewing the Target Selection Criteria (Figure 3.6), the focus team edited the draft list, recommended using the UC Berkeley Museum of Vertebrate Zoology (MVZ) occurrence data, and established seven categories of mammal conservation targets that underscore the justification for a species' inclusion on the list.

### Mammal Conservation Target Categories

1. Endemic / At Risk or Species of Concern
2. Not Endemic / Species of Concern (not necessarily a California Species of Special Concern) / Globally Rare
3. Locally Rare / Unique
4. Regionally Extinct
5. Top Predator / Widespread but Inherently Low Population
6. Prey Species / Game Animal
7. Widespread / Native, Keystone Species, Species of Management Concern
8. Non-Native Species of Management Concern

A few species are listed in two categories; for example, the tule elk is both Locally Rare/Unique, and a Prey Species/Game Animal. Figure 6.10 is the final list of mammal conservation targets; the figure also lists species that were initially included but later removed from consideration by the Mammals Focus Team. A more detailed list of mammal conservation targets can be found in Appendix E.

### Compilation of Mammal Data

The focus team used a number of data sources to review the Coarse Filter Conservation Lands Network coverage for target mammal species, including CNDDDB, CWHR, and MVZ. Species accounts from CWHR were also reviewed. The occurrence data were not filtered, stratified by date, or sorted by any variable.



## Review of the Coarse Filter Conservation Lands Network Coverage

Once consensus was reached on the list of mammal target species and the project team had compiled relevant data, the Mammals Focus Team members visually reviewed the Coarse Filter Conservation Lands Network for each target species to determine whether the coverage of suitable habitat was sufficient for viability or if habitats or areas needed to be added to the CLN.

To facilitate the review, the group considered the following questions:

1. Is the habitat of the species well covered by the Coarse Filter Conservation Lands Network?
2. Are there special habitat features not covered by the coarse filter? Specific habitats, such as cliffs (important for bats), may require special attention, and should be incorporated as fine-filter targets.
3. For area-sensitive species, such as American badger and bobcat, is there enough area of suitable habitat in the landscape unit to support a locally viable population without explicit connections to other landscape units?
4. Are the connections among landscape units sufficient to support the species?
5. Has the species been extirpated from significant parts of its historical range, despite there being sufficient habitat to support a viable population? For example, some species, such as porcupine and western spotted skunk, have been locally extirpated even though their general habitat requirements are met by the Coarse Filter Conservation Lands Network.
6. Are the habitat requirements met for a species for which there is very little occurrence data? What additional information would be necessary to make a determination of adequate conservation? Ringtail is a good example of a species that may be widely distributed, but very little occurrence data exists to support that conclusion.
7. Are there special management requirements to conserve the species even if its habitat requirements appear to be met?

Appendix E includes notes for each species regarding how well its habitat requirements are met by the coarse filter Conservation Lands Network and management requirements.

A thorough visual inspection of the Coarse Filter CLN revealed that it included sufficient habitat for most of the target species. However, 13 target species required further analysis to confirm whether the CLN provided adequate habitat (Figure 6.1).

**Figure 6.1 ■ Mammal Target Species Requiring Additional Review.** A visual inspection of the Coarse Filter Conservation Lands Network indicated that the habitat requirements for all but thirteen mammal target species were sufficiently covered.

American badger ( <i>Taxidea taxus</i> )	Porcupine ( <i>Erethizon dorsatum</i> )
Bobcat ( <i>Lynx rufus</i> )	Red tree vole ( <i>Arborimus pomo</i> )
Brush mouse ( <i>Peromyscus boylii</i> )	San Joaquin pocket mouse ( <i>Perognathus inornatus inornatus</i> )
California kangaroo rat ( <i>Dipodomys californicus</i> )	Sonoma chipmunk ( <i>Neotamias sonomae</i> )
Fog shrew ( <i>Sorex sonomae</i> )	Shrew mole ( <i>Neurotrichus gibbsi</i> )
Heermann's kangaroo rat ( <i>Dipodomys heermanni</i> )	Western red-backed vole ( <i>Clethrionomys californicus</i> )
Mountain lion ( <i>Puma concolor</i> )	

Habitat suitability analyses were completed for each of these target species except bobcat, which has the same habitat requirements as mountain lion. Additionally, preliminary population analyses were performed for mountain lion, bobcat, and American badger, because these species have large range requirements and can be area-limited.



Bob Gunderson

## Habitat Suitability Analysis

The team conducted habitat suitability analyses using CWHR range and habitat suitability values. CWHR provides habitat suitability values by vegetation type for wildlife species. The first step was to correlate, or crosswalk, the CWHR vegetation types with the Upland Habitat Goals Coarse Filter vegetation types (Figure 6.2) so that CWHR habitat suitability values (the average suitability across all stages of each vegetation type) could be assigned to Upland Habitat Goals vegetation types.

**Figure 6.2 ■ Crosswalk of California Wildlife Habitat Relationships (CWHR) and Upland Habitat Goals Coarse Filter Vegetation Types.** This table shows the relationships between CWHR vegetation types and those used in the Upland Habitat Goals Project.

California Wildlife Habitat Relationships Vegetation Type	Upland Habitat Goals Coarse Filter Vegetation Type
Annual Grassland	Cool Grasslands
	Hot Grasslands / Serpentine Grassland
	Moderate Grasslands
	Serpentine Grassland
	Warm Grasslands
Barren	Barren / Rock
	Serpentine Barren
Blue Oak-Foothill Pine	Blue Oak / Foothill Pine Woodland
Blue Oak Woodland	Blue Oak Forest / Woodland
Chamise-Redshank Chaparral	Chamise Chaparral
Closed-Cone Pine-Cypress	Bishop Pine Forest
	Knobcone Pine Forest
	McNab Cypress
	Monterey Cypress Forest
	Monterey Pine Forest
	Pygmy Cypress
	Sargent Cypress Forest / Woodland
	Serpentine Knobcone
Coastal Oak Woodland	California Bay Forest
	Coast Live Oak Forest / Woodland
	Valley Oak Forest / Woodland
Coastal Scrub	Coastal Scrub
Desert Scrub	Semi-Desert Scrub / Desert Scrub
	Serpentine Scrub
Douglas-Fir	Douglas-Fir Forest
	Grand Fir
Fresh Emergent Wetland	Permanent Freshwater Marsh
Juniper	Juniper Woodland and Scrub / Cismontane Juniper Woodland and Scrub
Mixed Chaparral	Mixed Montane Chaparral
	Mixed Chaparral
	Serpentine Leather Oak Chaparral

California Wildlife Habitat Relationships Vegetation Type	Upland Habitat Goals Coarse Filter Vegetation Type
Montane Hardwood	Black Oak Forest / Woodland
	Canyon Live Oak Forest
	Interior Live Oak Forest / Woodland
	Montane Hardwoods
	Oregon Oak Woodland
	Serpentine Hardwoods
	Tanoak Forest
Montane Hardwood-Conifer	Coulter Pine Forest
	Serpentine Conifer
Perennial Grassland	Coastal Terrace Prairie
	Native Grassland
Ponderosa Pine	Ponderosa Pine Forest (Non-maritime)
Redwood	Redwood Forest
Saline Emergent Wetland	Coastal Salt Marsh / Coastal Brackish Marsh
Sierran Mixed Conifer	Mixed Conifer / Pine
Valley Foothill Riparian	Central Coast Riparian Forest
	Serpentine Riparian
	Sycamore Alluvial Woodland
Wet Meadow	Wet Meadows

CWHR habitat suitability values range from 0 to 1, with higher values representing vegetation types of higher suitability for the target species. The Project Team created maps for twelve target species showing habitat suitability for the CWHR range, and CNDDB and MVZ records. A second map was derived by overlaying the Coarse Filter CLN on the first map to expose gaps in suitable habitat coverage.

The habitat suitability maps and results for three target species illustrating suitable habitat and coverage by the Coarse Filter CLN are shown in Figures 6.3 – 6.5. In these figures, the first map (left) shows CWHR habitat suitability clipped to the species CWHR range (if not found throughout the entire Bay Area), CNDDB records (purple dots), and MVZ records (green dots). The second map (right) is the Coarse Filter Conservation Lands Network (blue) over the first map and suitable habitat not covered by the Coarse Filter CLN is shown in red. The exposed red areas suggest where adjustments might be made to ensure sufficient coverage by the coarse filter CLN. Habitat suitability analyses maps for American badger, red tree vole, and mountain lion are presented and discussed below. Habitat suitability maps and discussions for the remaining nine target species are in Appendix B (*Data and Methods*, Chapter 6).

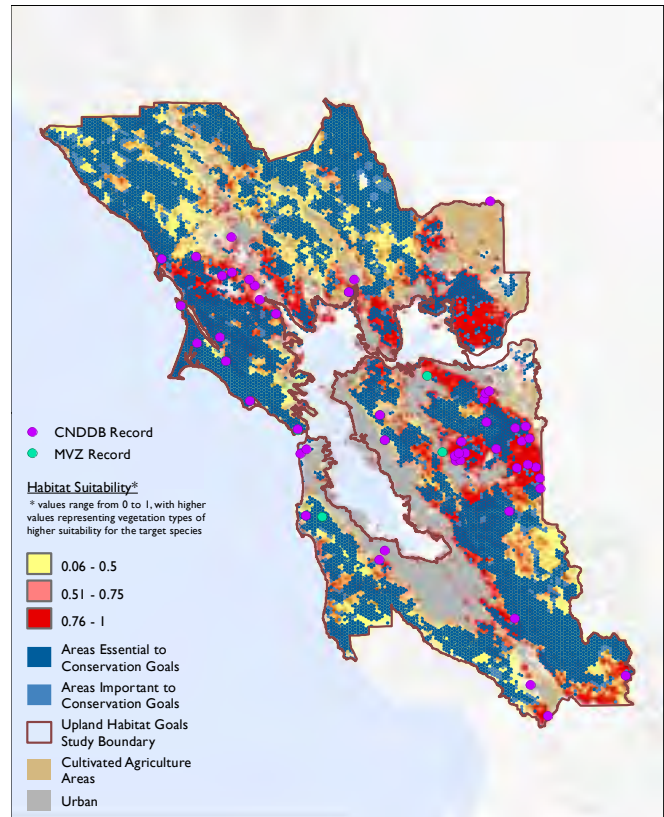
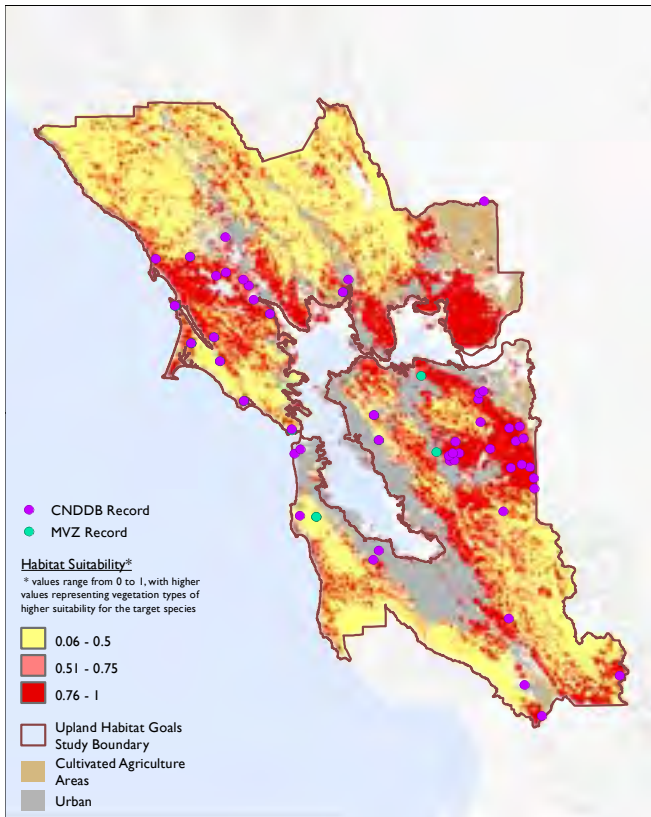
## American Badger Habitat Suitability Analysis

The maps in Figure 6.3 indicate that the Coarse Filter CLN provides adequate coverage of suitable habitat and occurrences for American badger, ranked as a Category 2 species (Not Endemic / Species of Concern (not necessarily a CA Species of Special Concern) / Globally Rare). Focus team members noted that badgers at Point Reyes could pose problems for another conservation target, Point Reyes jumping mouse, which is a prey species for badgers.

**Figure 6.3 ■ Habitat Suitability Analysis for American Badger (*Taxidea taxus*).**

Habitat Suitability

Coarse Filter Conservation Lands Network Coverage





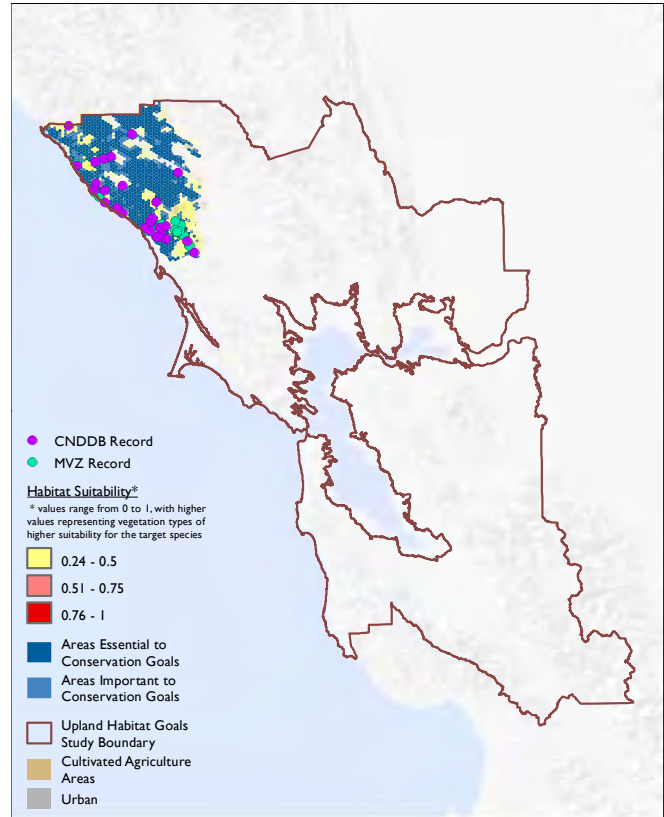
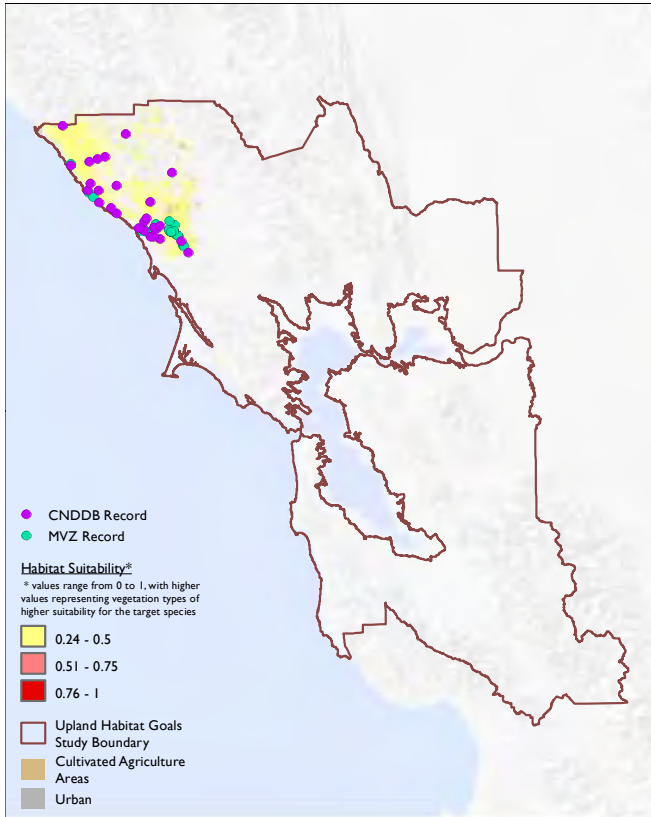
## Red Tree Vole Habitat Suitability Analysis

Figure 6.4 illustrates that the Coarse Filter CLN includes sufficient areas of higher habitat suitability for red tree vole, rated as a Category 2 species (Not Endemic/Species of Concern (not necessarily a CA Species of Special Concern) / Globally Rare).

**Figure 6.4 ■ Habitat Suitability Analysis for Red Tree Vole (*Arborimus pomo*).**

Habitat Suitability

Coarse Filter Conservation Lands Network Coverage



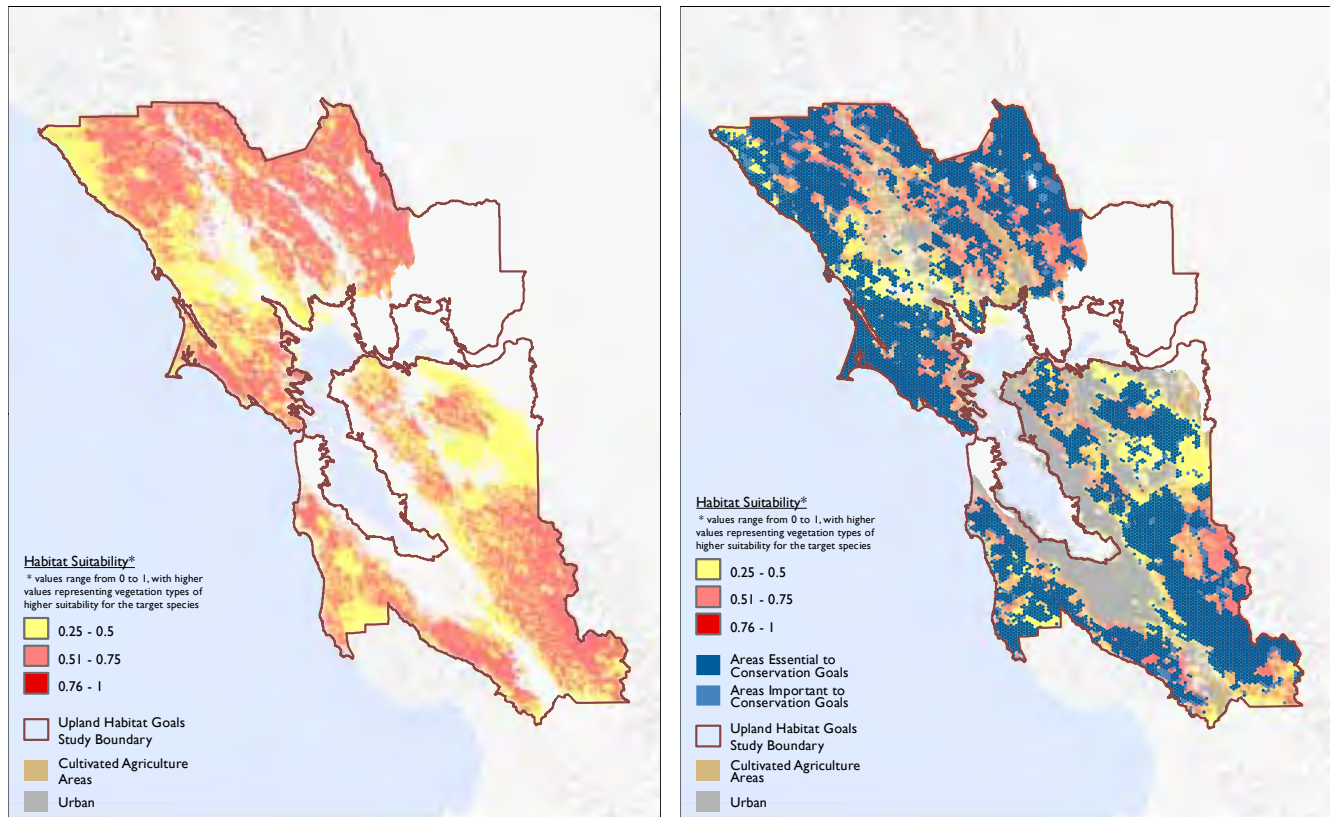
## Mountain Lion Habitat Suitability Analysis

Figure 6.5 shows the Coarse Filter CLN adequately includes suitable mountain lion habitat, provided that key linkages are protected. Mountain lion is classified as a Category 5 (Top Predator / Widespread but Inherently Low Population). Suitable habitat for bobcat, another target species, is very similar to that for mountain lions, so the team determined that the Coarse Filter CLN also sufficiently covers bobcat habitat.

**Figure 6.5 ■ Habitat Suitability Analysis for Mountain Lion (*Puma concolor*).**

Habitat Suitability

Coarse Filter Conservation Lands Network Coverage



Careful review of the habitat suitability analyses for the other nine conservation targets (included in Appendix B, *Data and Methods*, Chapter 6) demonstrates that the Coarse Filter Conservation Lands Network provides sufficient coverage for these targets as well.

## Preliminary Population Analysis

The Upland Habitat Goals Project conducted preliminary population analyses to estimate the distribution and abundance of three target mammals that have the potential to be area-limited – American badgers, mountain lions, and bobcats. The analysis focused on females of the species because they are the population-limiting sex. All three are territorial and maintain large home ranges contributing to low population density, and require connectivity between landscape units to persist. All three are also top predators, and changes in their populations cascade down the food chain. For example, mountain lions create wariness among deer, its primary prey, and keep deer moving so that local vegetation is not over-browsed. Bobcats play the same role with rabbits and smaller prey, as do badgers with ground squirrels and pocket gophers.

The main purpose of the population analysis is to estimate the order of magnitude of population size, and thus qualitatively consider the vulnerability of populations to demographic, genetic, and environmental stochasticity, or random variation.



Demographic stochasticity in sex ratios, births, deaths of individuals (especially breeding females), migration, and other processes can rapidly deplete small populations. Genetic drift (the random loss of genetic variation) and inbreeding lead to loss of genetic diversity and fitness, especially in small populations. Environmental stochasticity, such as drought, affects large areas and can reduce populations to the point at which they are vulnerable to demographic and genetic processes.

Some rough rules of thumb for the effects of population size on viability of relatively long-lived mammals have been developed (Gilpin and Soulé 1986, Beissinger *et al.* 2002):

1. Populations with fewer than 20 individuals are vulnerable to demographic and genetic variability, and highly vulnerable to environmental variability. Demographic variability risks decline sharply between 20 and 50 individuals.
2. Populations of 50 or more can maintain genetic diversity for the short-term, but are vulnerable in the longer term. The effective population size for genetic processes is usually far smaller than the census population size because of demographic factors such as skewed sex ratios, non-breeding individuals, and differential mating success by males.
3. Environmental variability, such as changes in weather and prey base, is the major short-term threat even for larger populations from 50 to more than 500 individuals.
4. Populations of 500 or more are necessary for long-term genetic viability and security from environmental variability, but may still be vulnerable to environmental catastrophes such as epidemic disease.
5. A network of subpopulations connected by migration is essential to conserve subpopulations below the critical threshold size of 500 individuals. Such connections can ameliorate the perils of small population sizes; even relatively low levels of interchange between subpopulations can counter genetic drift and demographic stochasticity. Migration between subpopulations is a key component of metapopulation viability.

6. Interconnected populations spanning thousands of individuals across diverse habitats provide the best insurance against local and regional extinction. Connectivity to the rest of California – large tracts of wildlands in the North and South Coast Ranges – is important to maintain for many target species.
7. Maintaining connectivity between landscape units, beyond identifying obvious choke points, requires fine-scale planning. *Critical Linkages: The Bay Area and Beyond*, described in Chapter 3, is conducting a detailed analysis of these linkages, which will be incorporated into the Conservation Lands Network.

### American Badger Preliminary Population Analysis

Because badgers are found in open grasslands, population estimates were derived by taking the area of all grassland vegetation types of each landscape unit and dividing by three estimates of female home range size: 4, 8, and 12km<sup>2</sup> (CWHR, Quinn pers. comm. 2007); this produced a range of population estimates assuming that territories are largely non-overlapping. Figure 6.6 shows female badger population estimates by landscape unit for three different estimates of home range.

Even under the most optimistic home range estimate, no landscape unit can support more than approximately 200 badgers. The Mt. Hamilton Range Landscape Unit has the most grasslands and the highest potential population sizes ranging from 65 to 210. But, importantly, this landscape unit is part of a much bigger physiographic unit extending into Stanislaus and Merced Counties. The connection across Pacheco Pass, both in Santa Clara and adjacent counties, is an important regional linkage. The Mt. Diablo Range Landscape Unit badger estimates range from 50 to 150, and the I-580 corridor at Altamont Pass is especially critical to connect to populations further south. Other relatively larger landscape units include Coastal Grasslands, Marin Coast Range, and Point Reyes, which are adjacent and function as one badger unit.

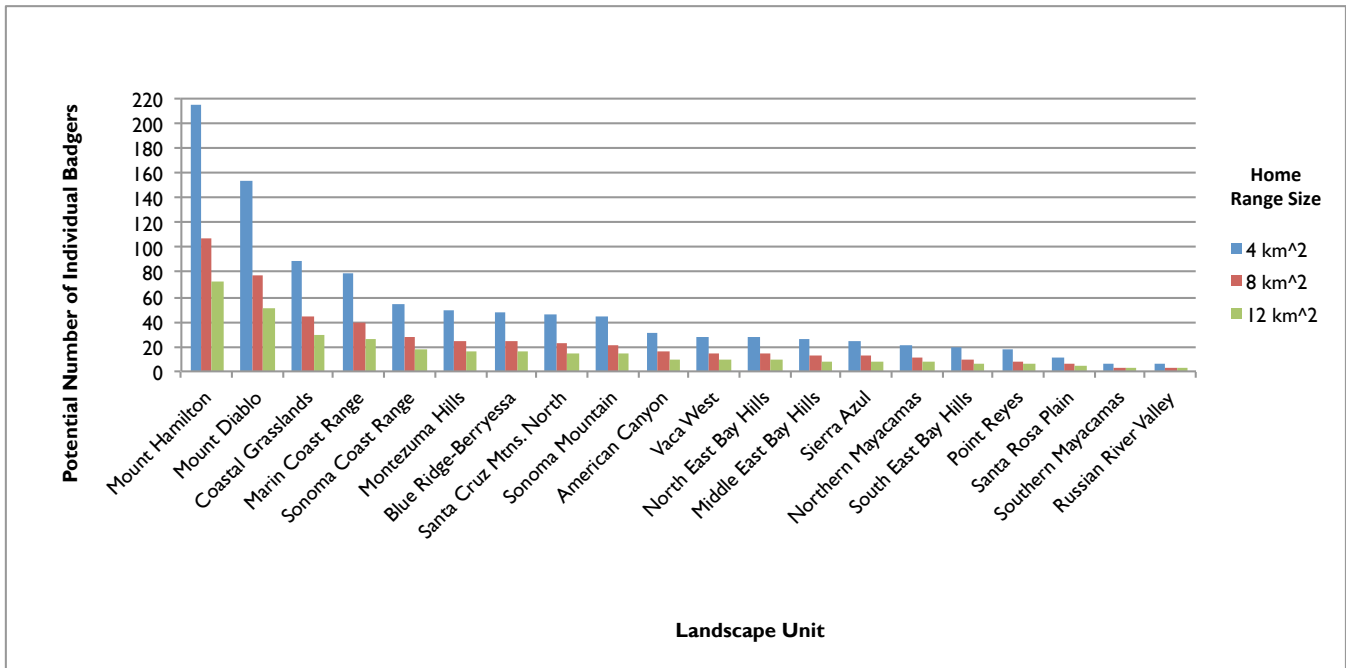
The smaller landscape units may only support populations of fewer than 10 to 40 badgers; these units require connectivity within and between landscape units and beyond the study area to maintain healthy populations. The Santa Cruz Mountains North and Sierra Azul Landscape Units need to be connected to the south or east; the Coarse Filter CLN does not include a linkage in this area, but this is being addressed by the Critical Linkages project. There is evidence that badgers are present in the Sonoma Mountain Landscape Unit (roadkill observations by Gillogly pers. comm. 2009). Sonoma Mountain needs to be connected across the Highway 101 corridor between Petaluma and Cotati through rural residential areas.

Within some landscape units, such as the Santa Cruz Mountains North, badgers occupy islands of grasslands within the matrix of scrub and forest vegetation types. Dispersal within the landscape unit among grassland patches is essential to maintain local population viability, and the Coarse Filter CLN captures these connections. Badgers are capable of dispersing through several kilometers of non-grassland areas if the vegetation is not too dense. The Coastal Grassland-Marin-Point Reyes population of badgers appears to be effectively isolated from the rest of California by large tracts of dense forests to the north and east.



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**Figure 6.6 ■ Badger Preliminary Population Analysis (Females).**



It is clear from this analysis that even if the available habitat supports a high density of badgers (4km<sup>2</sup> home range), badgers will be maintained in the Bay Area only if connectivity within and outside the nine counties is maintained and enhanced. Connectivity to areas outside the Bay Area appears adequate in the Mt. Hamilton Range and in the far North Bay (where there are few badger records). The Conservation Lands Network will require adjustments for specific connectivity chokepoints within the region; these will be determined by the Critical Linkages project. For now, some key linkages have been identified as Areas for Further Consideration, portions of which will be added to the CLN when additional information is gathered about the best configuration for these connections.

### Mountain Lion Preliminary Population Analysis

The mountain lion preliminary population analysis shown in Figure 6.7 followed the same logic as that used for female badgers. Suitable habitat for mountain lions – a mix of open grassland, brush, woodland, and forest – was identified, and five estimates of female home range size ranging from 50km<sup>2</sup> to 250km<sup>2</sup> (from CWHR and the Mammals Focus Team experts) were used.

All local population estimates are well below thresholds for environmental variability, and many are well below thresholds for genetic and demographic issues. The potential for small population sizes makes it imperative that any mountain lion subpopulation is connected to others by dispersal, and connectivity beyond the Bay Area is absolutely essential. The Santa Cruz Mountains as a whole are similar in scale to the Santa Ana Mountains in southern California, where extensive studies of a small resident mountain lion population

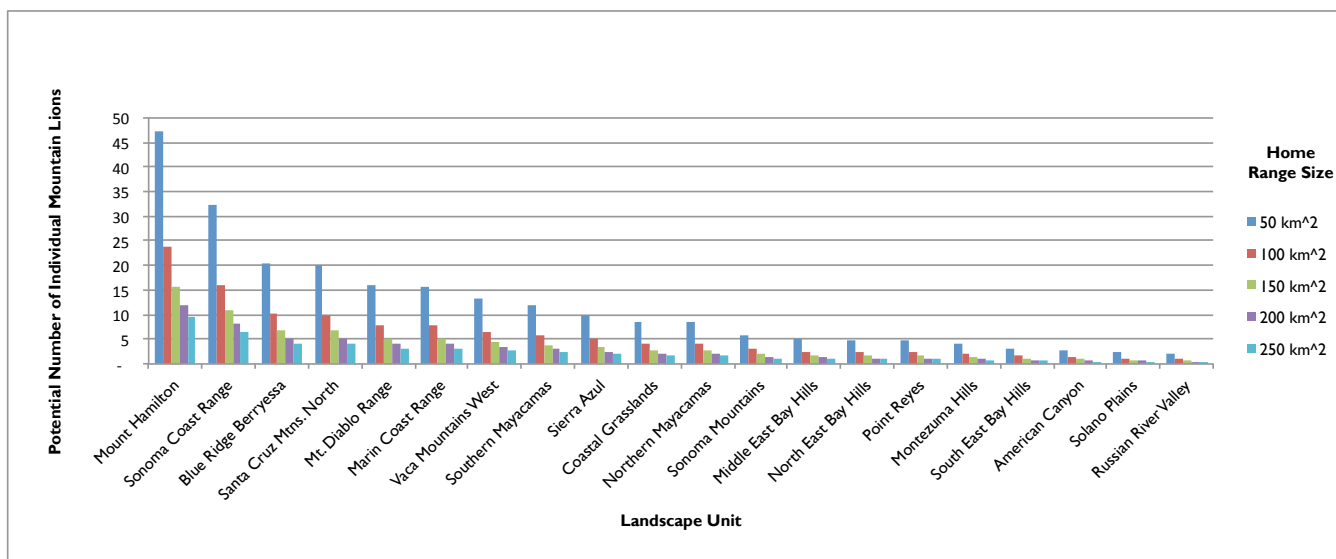


Bob Gunderson / www.flickr.com/photos/bobgunderson

indicate vulnerability to random demographic and genetic variability (Beier 1993). The appearance of juvenile male mountain lions in urban areas indicates some level of population saturation in areas such as the Santa Cruz Mountains and the North East Bay Hills Landscape Units.

As with the badger population analysis, connectivity to regions beyond the study area boundary appears adequate in the Mt. Hamilton Range and in the far North Bay. The CLN will require adjustments for specific connectivity choke points within the region; detailed consideration will be determined by the Critical Linkages project.

**Figure 6.7 ■ Mountain Lion Preliminary Population Analysis (Females).**



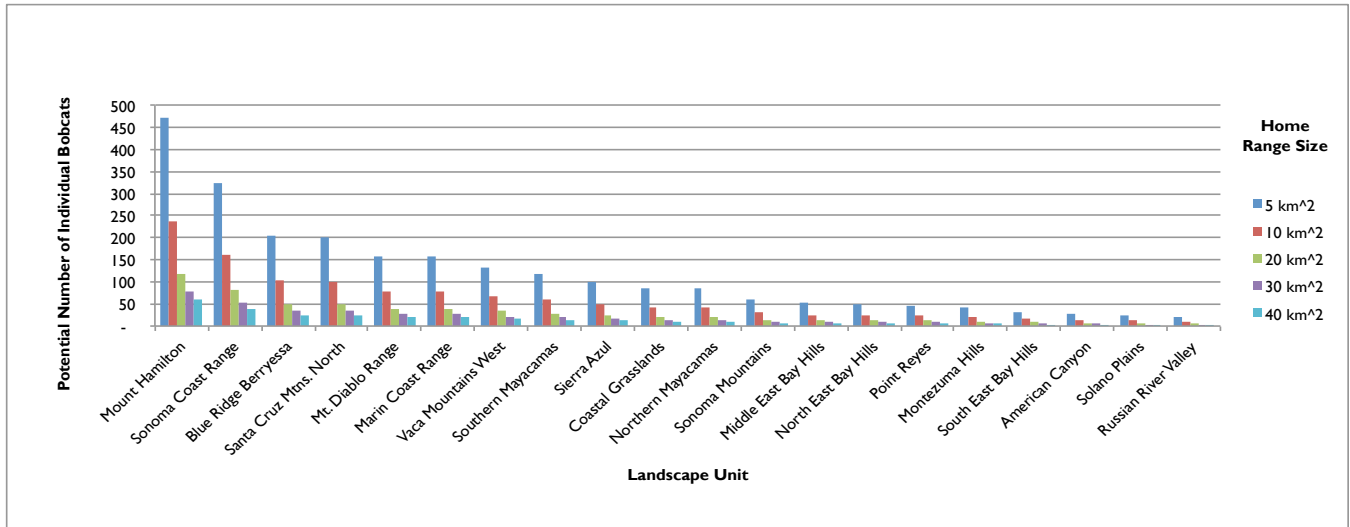
Wayne Dumbleton, www.flickr.com/photos/tracobotanicus



### Bobcat Preliminary Population Analysis

The same analysis was conducted for bobcat, which has the same habitat requirements as mountain lion – a mix of open grassland, brush, woodland, and forest – but a smaller female home range size (5- 40km<sup>2</sup> per CWHR). In the Bay Area, home range sizes for female bobcats range from 1.5km<sup>2</sup> in more urban zones to 6.33km<sup>2</sup> in rural zones, and males ranged from 6.4km<sup>2</sup> (urban) to 14.5km<sup>2</sup> (rural) (Riley 2006), so the lower home range values appear to be appropriate for this analysis. Figure 6.8 shows the analysis results for the home range size estimates. The analysis indicates that the larger complexes of adjoining landscape units could support populations in the low hundreds. The higher estimates for the Mt. Hamilton Landscape Unit (475 females) and the Sonoma Coast Range Landscape Unit (320 females) may approach viability, especially since these units are well connected to areas outside the study area. The Santa Cruz Mountains North and Sierra Azul Landscape Units, along with Santa Cruz County, may support a few hundred bobcats, which approaches the margin of independent long-term viability. Many of the smaller landscape units (e.g., East Bay Hills, Mt. Diablo) need to maintain already tenuous connections to the larger populations in adjacent landscape units.

**Figure 6.8 ■ Bobcat Preliminary Population Analysis (Females).**



Linkages beyond the study area appear adequate in the Mt. Hamilton Range, and in the far North Bay. The Critical Linkages project will provide much-needed information about specific areas to be added to the CLN in other parts of the study area.

## Coarse Filter Conservation Lands Network Review Conclusions

After careful visual inspection and the preceding analyses, the Mammals Focus Team determined that the Coarse Filter Conservation Lands Network sufficiently covers the habitat requirements of the vast majority of mammals in the Bay Area. No additional areas were added to the CLN for mammal conservation targets. The high goals for common vegetation types (Rarity Rank 3 with a 50% goal), coupled with the geographic stratification of the landscape unit, ensured that tens of thousands of acres of contiguous diverse habitats were provided within each landscape unit, and that locally viable populations of key mammal species are included.

More detailed analyses for several target species, using CWHR and expert opinion, revealed that mountain lions, bobcats, and badgers have special issues because of their large area requirements. The primary issue is the need for connectivity between landscape units: most of the landscape units do not have sufficient habitat for these species to avoid demographic, genetic, and environmental risks. A detailed connectivity analysis was beyond the scope of the Upland Habitat Goals Project, but the Critical Linkages project will provide this much-needed data for inclusion in the Conservation Lands Network.

Some species, such as American badger and San Joaquin pocket mouse, will benefit from additional conserved grassland areas that are part of wind farms and currently identified as Areas for Further Consideration that require more study to determine which lands should be added to the CLN (Chapter 10).

## Assessing the Viability of Mammal Conservation Targets

Mammals have suffered impacts from the long list of viability factors covered in detail in Chapter 9 (*Conservation Target Viability*). The focus team identified several viability issues of particular concern for mammal targets. The loss of habitat and habitat fragmentation have contributed to impaired connectivity so essential for many mammal species. Roadkill takes many individuals, especially at key chokepoints along major roads (California Roadkill Observation System 2011, [www.wildlifecrossing.net/california](http://www.wildlifecrossing.net/california)). Disease is an ever-present threat to local populations – various carnivore diseases (e.g., distemper, leukemia, viruses) are transmitted to and from domestic animals. Because of the importance of connectivity, it is discussed in more detail here; other viability factors are addressed under *Recommended Conservation Actions*.

### Connectivity

As with other species, connectivity is vital to the viability of many mammal conservation targets. The CLN incorporates two levels of connectivity – connectivity within landscape units and connectivity between landscape units. Marxan was configured to capture local

networks, or within landscape unit connectivity, by locking in protected lands and using settings in the software (the Boundary Length Modifier feature; see Chapter 3 and Appendix B, Chapter 3 for more details), but some key local linkages were explicitly considered, and were included as Areas for Further Consideration. Chapter 10 provides descriptions of each Area for Further Consideration emphasizing potential linkages where relevant.

Connectivity between landscape units is equally important. Mountain lions, in particular, will not persist in the more isolated landscape units (Santa Cruz Mountains, Mount Diablo) without occasional immigration, based on research on cougars in the Santa Ana Mountains in Southern California (Beier 1993). Riparian areas provide important connectivity for many wildlife species and are included in the CLN. There is

ample evidence that culverts, bridges, and other passages under major freeways are used by a variety of wildlife (Penrod *et al.* 2006), but constrained narrow corridors can lead to problems for some species.

Some specific linkage issues were identified across the region (Figure 6.9). There are a series of obvious choke points on several major freeways:

- Highway 580 between the South and Middle East Bay Hills Landscape Units.
- Altamont Pass area (also Highway 580) between the Mt. Diablo and Mt. Hamilton Ranges.
- Caldecott Corridor located above the tunnel between the Middle and North East Bay Hills.
- Coyote Valley between Sierra Azul and the Mt. Hamilton Range Landscape Units.
- Various crossings of Highway 101 in Sonoma County.

Key linkages from the study area to beyond the boundaries include:

- Chittenden Gap at the south end of the Sierra Azul Landscape Unit connecting to the Gabilan Range.
- Across the Soap Lake Basin south of Gilroy.
- The Sonoma Coast Range to the Northern Mayacamas across Highway 101 and the Russian River north of Cloverdale.



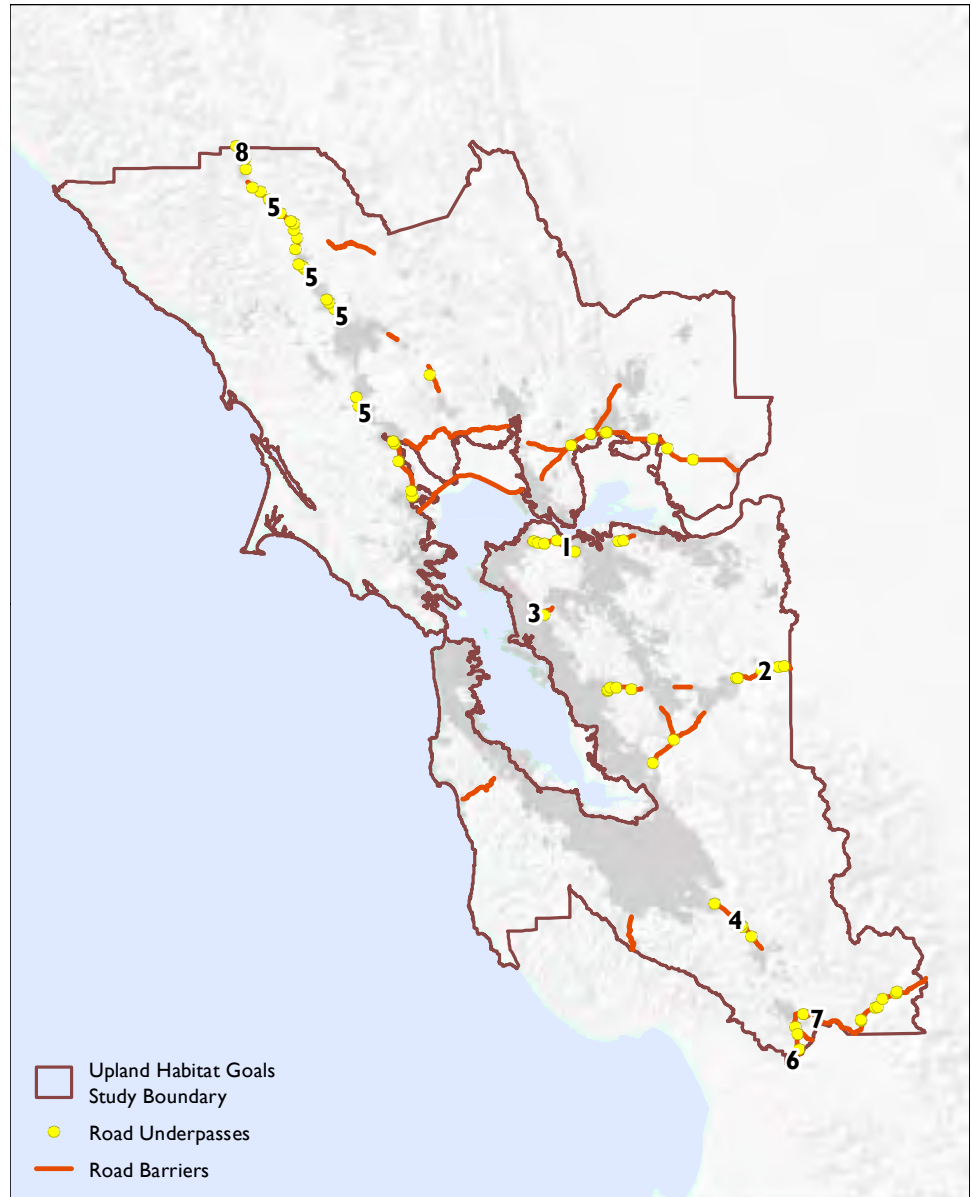
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To begin to address the linkage issues noted above, the team used aerial photography and maps to conduct an initial analysis of bridges and other potential wildlife crossing areas. The exercise also identified areas that require more detailed investigation. Figure 6.9 presents the results of the analysis showing barriers to wildlife crossings in red and underpasses that might allow safe passage in yellow. These areas were also included as Areas for Further Consideration.

**Figure 6.9 ■ Wildlife Connectivity on Major Highways in the San Francisco Bay Area.**

Red areas indicate barriers to wildlife crossing that will require more detailed review. Yellow areas are underpass locations that may offer safe wildlife crossings. The numbers correspond to the linkage issues described above.



## Recommended Conservation Actions

Many viability factors impacting mammals can be addressed through stewardship and management. Best management practices (BMPs) for wildlife management are provided by the California Department of Fish and Game and groups such as the Wildlife Society (see *Additional Resources* at the end of the chapter). Unless otherwise cited, the information below came from members of the Mammals Focus Team. A full discussion is not feasible here, but important actions are highlighted:

**1. Connectivity.** Providing for connectivity and wildlife passage across major highways and other impediments is essential for the health of mammal populations.

**2. Succession.** The provision of diverse vegetation mosaics and successional stages of vegetation will provide for the multiple habitat requirements of most mammals.

**3. Fire.** Well-managed fire regimes can provide many benefits for local mammals by providing fresh forage and diverse successional stages; short-term effects of intense large fires may be negative, as in the case of the Point Reyes mountain beaver (Fellers *et al.* 2004).

**4. Invasive Weeds.** Control of key invasive weeds improves habitat for native mammals by providing quality forage.

**5. Grazing Management.** Good grazing management can contribute to diverse healthy mammal populations. Tule elk, in particular, seem to coexist with (and to some degree may depend upon) cattle grazing. Healthy populations of ground squirrels on grazing land provide habitat and prey for numerous other species, including Burrowing Owl, American badger, and California Tiger Salamander. Ranches also provide water sources important for native mammals: wildlife-friendly fences, stock ponds, and watering troughs should be encouraged throughout the region.

**6. Forest Management.** Some mammals require complex older forests for habitat features such as snags and downed wood (CWHR). Forest management practices that develop such features in conjunction with timber harvesting hold great promise in coastal Douglas-fir and redwood forests.

**7. Non-Native Animals.** Wild pigs uproot and destroy native vegetation, and compete with native animals for food sources such as acorns. Local eradication is difficult to achieve and maintain, but controlled hunting and depredation permits can help keep populations below damage thresholds. Pig hunting may supply additional income to ranchers. Young pigs may provide alternate prey for mountain lions.

**8. Deer Overpopulation.** Deer populations provide a prey base for mountain lions, but overpopulation of deer can have negative impacts on vegetation and particular plant species.

**9. Disease.** Diseases transmitted from domestic dogs and cats threaten many native carnivores. For example, feline leukemia, transmitted by domestic cats, has decimated the western spotted skunk population. Encouraging high vaccination levels in domestic animal populations will reduce this threat. Large habitat areas far from human habitation provide some buffer, but epidemics can spread rapidly into remote areas.

Diseases that affect humans, such as rabies and Lyme disease, are endemic in certain wildlife populations, such as skunks, raccoons and bats (rabies), and deer and mice (Lyme disease). Any control measures should be highly focused where and when actual problems exist, rather than wholesale persecution of animals such as bats.

**10. Mountain Lion Perception Problem.** Coexistence of mountain lions and people will be an ongoing issue, primarily because of fear. Public education about appropriate human behavior in mountain lion habitat can minimize the already-small risks.



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**11. Wind Farms.** Wind farms pose local risks to some bat species (as well as birds) (Johnston pers. comm. 2007), and best management and design practices should be implemented to minimize risks. Much work is being done in this area by wildlife regulatory agencies. A reference for wind farm best management practices is included under *Additional Resources*.

**12. Poisoning.** Deliberate and inadvertent poisoning of wildlife is a local and even regional threat. Programs to poison ground squirrels decades ago greatly reduced populations of this keystone species across parts of the East Bay, reducing the prey base of many predators, as well as burrows used by many species. Inadvertent poisoning of mammals from anticoagulant rodenticides can have serious impacts on wildlife in urban/agricultural/wildland interfaces (Riley *et al.* 2007).

## Data Gaps

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The largest data gaps are the paucity of recent survey data for many of the smaller, more obscure mammal species – even at the level of presence-absence in selected landscape units. A thorough mammal survey at or below the level of landscape units would provide a modern distribution baseline to guide conservation actions.

Population-level monitoring of species abundance can provide important insights into population viability, movements of individuals, and responses to management actions.

These and other data gaps are discussed further in Chapter 13 (*Research Needs, Measuring Success, and Conservation Lands Network 2.0*).

## Additional Resources

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California Department of Fish and Game Big Game Management Program – [www.dfg.ca.gov/wildlife/hunting/biggame.html](http://www.dfg.ca.gov/wildlife/hunting/biggame.html)

California Department of Fish and Game Nuisance and Exotic Wildlife Species – [www.dfg.ca.gov/wildlife/nongame/nuis\\_exo](http://www.dfg.ca.gov/wildlife/nongame/nuis_exo)

California Guidelines for Reducing Impacts to Birds and Bats From Wind Energy Development – [www.energy.ca.gov/windguidelines/index.html](http://www.energy.ca.gov/windguidelines/index.html)

California Roadkill Observation System (CROS) 2011 – [www.wildlifecrossing.net/california](http://www.wildlifecrossing.net/california)

Critical Linkages: Habitat Connectivity Planning for the Bay Area and Beyond – [www.scwildlands.org/projects/bayarea.aspx](http://www.scwildlands.org/projects/bayarea.aspx)

USFWS 2011. Links to Worldwide Wind Energy/Wildlife Guidance Documents and Information – [www.fws.gov/windenergy/docs/Links\\_Worldwide\\_Wind\\_Energy\\_Wildlife\\_Guidance\\_Docs\\_Info.pdf](http://www.fws.gov/windenergy/docs/Links_Worldwide_Wind_Energy_Wildlife_Guidance_Docs_Info.pdf)

Wildlife Society Position Statements on Hunting, Wildlife Damage, Urban Wildlife, and Alteration of Streams, Riparian, and Wetlands – [joomla.wildlife.org/index.php?option=com\\_content&task=view&id=117&Itemid=299](http://joomla.wildlife.org/index.php?option=com_content&task=view&id=117&Itemid=299)

**Figure 6.10 ■ Mammal Conservation Target Species.** For a detailed list with more information about each species, see Appendix E.

Common Name	Scientific Name	Legal Status*
<b>Category 1 - Endemic / At Risk or Species of Concern</b>		
pallid bat	<i>Antrozous pallidus</i>	CA SSC, BLM S USFS S
Point Reyes mountain beaver	<i>Apodontia rufa phaea</i>	CA SSC
Townsend's big-eared bat	<i>Corynorhinus townsendii</i>	CA SSC, BLM S USFS S
Berkeley kangaroo rat	<i>Dipodomys heermanni berkeleyensis</i>	FE, CE, CA FP
Point Reyes jumping mouse	<i>Zapus trinotatus orarius</i>	CA SSC
<b>Category 2 - Not Endemic / Species of Concern / Globally Rare</b> (not necessarily listed as a CA Species of Special Concern)		
red tree vole	<i>Arborimus pomo</i>	CA SSC
ringtail	<i>Bassariscus astutus</i>	CA FP
western red bat	<i>Lasiurus blossevillii</i>	USFS S, CA SSC
fringed myotis	<i>Myotis thysanodes</i>	BLM S, proposed CA SSC but denied
long-legged myotis	<i>Myotis volans</i>	proposed CA SSC but denied
San Francisco dusky-footed woodrat	<i>Neotoma fuscipes annexens</i>	CA SSC
Sonoma Chipmunk	<i>Neotamias sonomae</i>	--
western grey squirrel	<i>Sciurus griseus</i>	--
American badger	<i>Taxidea taxus</i>	CA SSC
San Joaquin kit fox	<i>Vulpes macrotis mutica</i>	FE, CE
<b>Category 3 - Locally Rare / Unique</b> (not necessarily listed as a CA Species of Special Concern)		
pronghorn	<i>Antilocarpa americana</i>	--
tule elk	<i>Cervus elaphus nannodes</i>	--
western red-backed vole	<i>Clethrionomys californicus</i>	--
California kangaroo rat	<i>Dipodomys californicus</i>	--
Heermann's kangaroo rat	<i>Dipodomys heermanni</i>	--
porcupine	<i>Erethizon dorsatum</i>	--
Merriam chipmunk	<i>Eutamias merriami</i>	--
river otter	<i>Lontra canadensis</i>	CA SSC, BLM S
long-tailed weasel	<i>Mustela frenata</i>	--
American mink	<i>Mustela vison</i>	--
San Joaquin pocket mouse	<i>Perognathus inornatus inornatus</i>	BLM S
brush mouse	<i>Peromyscus boylii</i>	--
shrew mole	<i>Neurotrichus gibbsi</i>	--
marsh shrew	<i>Sorex bendirii</i>	--
fog shrew	<i>Sorex sonomae</i>	--
western spotted skunk	<i>Spilogale gracilis</i>	--
grey fox	<i>Urocyon cinereocargenteus</i>	--
black bear	<i>Ursus americana</i>	--
<b>Category 4 - Regionally Extinct</b>		
Santa Cruz kangaroo rat	<i>Dipodomys venustus venustus</i>	--
fisher	<i>Martes pennanti</i>	BLM S, USFS S
grizzly bear	<i>Ursus horribilis</i>	FT (in current range)
<b>Category 5 - Top Predator / Widespread but Inherently Low Population</b>		
bobcat	<i>Lynx rufus</i>	CA FP
mountain lion	<i>Puma concolor</i>	CA FP

Common Name	Scientific Name	Legal Status*
<b>Category 6 - Prey Species / Game Animal</b>		
tule elk	<i>Cervus elaphus nannodes</i>	--
mule deer	<i>Odocoileus hemionus</i>	--
wild pig	<i>Sus scrofa</i>	--
<b>Category 7 - Widespread / Native / Management Concern / Keystone Species</b>		
coyote	<i>Canis latrans</i>	--
hoary bat	<i>Lasiurus cinereus</i>	CA SSC
silver-haired bat	<i>Lasionycteris noctivagans</i>	--
long-tailed weasel	<i>Mustela frenata</i>	--
California myotis	<i>Myotis californicus</i>	--
long-eared myotis	<i>Myotis evotis</i>	--
grey fox	<i>Urocyon cinereoargenteus</i>	--
<b>Category 8 - Non-Native Species of Management Concern</b>		
Axis deer	<i>Axis axis</i>	--
Fallow deer	<i>Dama dama</i>	--
feral cat	<i>Felis catus</i>	--
wild pig	<i>Sus scrofa</i>	--
red fox	<i>Vulpes vulpes</i>	--
<b>REMOVED from original draft mammal targets list</b>		
Suisun shrew	<i>Sorex ornatus sinuosus</i>	FE, CE, CAFP
Salt-marsh harvest mouse	<i>Reithrodontomys raviventris</i>	FE, CE, CAFP
Salt-marsh wandering shrew	<i>Sorex vagrans halicoetes</i>	FE, CE, CAFP
San Pablo vole	<i>Microtus californicus sanpabloensis</i>	FE, CE, CAFP
striped skunk	<i>Mephitis mephitis</i>	
big free-tailed bat	<i>Nyctinomops macrotis</i>	CA SSC
Mexican free-tailed bat	<i>Tadarida brasiliensis mexicanus</i>	
long-eared myotis	<i>Myotis evotis</i>	BLM S
western pipistrellus	<i>Parastrellus hesperus</i>	
big brown bat	<i>Eptesicus fuscus</i>	--
California mastiff bat	<i>Eumops perotis californicus</i>	CA SSC, BLM S
Yuma myotis	<i>Myotis yumanensis</i>	BLM S
little brown myotis	<i>Myotis lucifugus</i>	--
western small-footed myotis	<i>Myotis ciliolabrum</i>	BLM S

### Legal Status Descriptions

BLM S - BLM Sensitive

CA C - California Candidate

CA FP - California Fully Protected

CA SSC - California Species of Special Concern

CE - California Endangered

CT - California Threatened

FC - Federal Candidate

FE - Federal Endangered

FT - Federal Threatened

FSC - Federal Species of Concern

USFS S - US Forest Service Sensitive



## CHAPTER

# 7

## Fine Filter: Birds

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### Introduction

The Birds Focus Team met three times between February and April 2008 and included biologists from nine agencies, nonprofit organizations, and environmental consulting firms. The members developed a list of 85 bird conservation targets in accordance with the Target Selection Criteria (Figure 3.6), evaluated how effectively the Coarse Filter Conservation Lands Network met target species habitat requirements, identified viability issues of special concern for birds, and made management and stewardship recommendations.

### Birds Focus Team Members

Gina Barton, San Francisco Bay Bird Observatory  
Allen Fish, Golden Gate Raptor Observatory  
Tom Gardali, PRBO Conservation Science  
Sherry Hudson, San Francisco Bay Bird Observatory  
Robin Leong, Napa Solano Audubon Society  
Bill Merkle, National Park Service  
Mike Perlmutter, Audubon California  
Tania Pollak, The Presidio Trust  
Steve Rottenborn, PhD, H.T. Harvey & Associates  
Sandra Scoggin, San Francisco Bay Joint Venture  
Diana Strahlberg, PRBO Conservation Science

The Bay Area is a major stopover and wintering area for waterfowl and shorebirds migrating along the Pacific Flyway; these birds rest and feed in the bays, tidal marshes, and mudflats. For the most part, these species are found in the Bay and baylands which, as the focus of the Baylands Ecosystem Habitat Goals, are habitats not included in the Upland Habitat Goals Project. There are a few exceptions, such as Wood Duck (found in stream habitats), Aleutian Goose (found in non-tidal areas), and Western Snowy Plover (nests on coastal beaches). Because wintering waterfowl and geese use adjacent upland areas for foraging, the connections from the baylands to upland areas are an important consideration for bird conservation. Team members gave great weight to these connections as they reviewed the Coarse Filter Conservation Lands Network.

Flight distinguishes birds from other fine filter targets, bestowing an advantage for escaping some stressors and adapting to climate change. It also means that some of the bird target species are not year-round residents. Waterfowl range northward to Alaska and Canada to breed, and winter in the Bay Area and other parts of California. Neotropical migrants, such as the tiny Allen's Hummingbird, breed in the area and winter in Mexico, the Caribbean, and Central and South America. The Upland Habitat Goals Project reviewed coverage by the Coarse Filter Conservation Lands Network for the divergent bird life histories – including breeding, wintering/stopover, and foraging habitats.

Many bird species in the Bay Area depend on riparian habitats. Because riparian habitat issues and recommendations were addressed by the Riparian/Fish Focus Team and are covered in Chapter 5, they are not recounted here. However, two recommendations emerged from the Riparian/Fish Focus Team that are highly relevant to birds and worth reiterating:

1. All streams are conservation targets, elevating the importance of restoring riparian forests and stream channels.
2. Riparian buffers should be as wide as possible.

Unlike the other fine filter species groups, birds in the San Francisco Bay Area are covered by several national and international conservation planning processes. The goals and objectives of these various plans have been stepped down to regional plans that are focused on or include the San Francisco Bay Area. The Upland Habitat Goals Project drew from these documents but did not attempt to reiterate all of their recommendations. These plans are discussed briefly here; links to these plans are included in the Additional Resources listed at the end of the chapter.

## Birds and Bird Conservation in the San Francisco Bay Area

The San Francisco Bay Area is home to more than 200 bird species found in every ecosystem of the region. The estuary, which holds more wintering and migrating shorebirds than any other coastal wetland on the US Pacific Coast, has been designated a Western Hemispheric Shorebird Reserve Network ([www.whsrn.org](http://www.whsrn.org)) – the highest possible ranking for a wetland ecosystem. It is also one of the most important wintering and migration areas for waterfowl (PRBO 2004). Many migrating and resident birds depend on the region’s wetlands and adjoining watersheds. Many upland bird species (for example, Swainson’s Thrush and Black-headed Grosbeak) need riparian areas for breeding habitat (PRBO 2004). It is estimated that roughly 10% of the population of Pacific Coast Western Snowy Plover (a federally-listed threatened species) breeds in the San Francisco Bay salt ponds (PRBO 2004).

Impacts to and loss of certain habitats such as old-growth forests, wetlands, and riparian zones have reduced the distribution and abundance of numerous species dependent on these habitats. Species such as Marbled Murrelet, Northern Spotted Owl, and Western Snowy Plover are listed under the Endangered Species Act. Another ten or so species, including Burrowing Owl, Vaux’s Swift, and Peregrine Falcon, are listed as California Species of Special Concern (Shuford and Gardali 2008). In spite of these impacts, the large tracts of wildlands and vegetative diversity of the Bay Area continue to support healthy bird communities.

The Bay Area’s diversity of bird species and significance to the Pacific Flyway have resulted in the region’s inclusion in numerous international, national, statewide, and regional multi-partner bird conservation initiatives and plans. Figure 7.1 highlights the plans covering the Bay Area and the species groups covered. These plans contain conservation goals, priorities, recommendations for stewardship, monitoring and research, and other information directly relevant to bird conservation in the San Francisco Bay region. A brief overview is provided here; more detailed descriptions of each initiative as it relates to the Bay Area can be found in *Conservation Objectives for the San Francisco Bay Estuary as Outlined in Planning Documents of North American’s Major Bird Conservation Initiatives* (PRBO 2004).

**North American Waterfowl Management Plan.** The *North American Waterfowl Management Plan*, drafted in 1986, was the first of the international initiatives. The plan established habitat protection and restoration goals to increase waterfowl populations, and called for the creation of 18 joint ventures – public/private partnerships – around the country to achieve the goals.



Peter LaTourrette / www.birdphotography.com



**Figure 7.1 ■ Species Groups Covered by the North American Bird Conservation Initiatives and Regional Conservation Plans (PRBO 2004).**

Species Group	Bird Conservation Initiative				Regional/State Bird Conservation Plan
	North American Waterbird Conservation Plan	US Shorebird Conservation Plan	North American Landbird Conservation Plan	North American Waterfowl Management Plan	
Loons and Grebes	yes				CCS Plan <sup>a</sup>
Albatrosses, Petrels, Shearwaters, Storm-Petrels, and Pelecaniformes	yes				CCS Plan
Wading Birds (e.g., ibises, herons, egrets)	yes				none
Swans, Geese, and Ducks				yes	SFBJV <sup>b</sup>
Diurnal Raptors			yes		RBCP <sup>c</sup> GBCP <sup>c</sup>
Upland Game Birds			yes <sup>d</sup>		CSCBCP <sup>c</sup> covers the Mountain Quail
Gruiformes (e.g., coots, cranes, rails)	yes			covers cranes	none
Shorebirds		yes			SPSCP <sup>e</sup> / CCS Plan covers phalaropes; RBCP covers the Spotted Sandpiper
Jaegers, Skuas, Gulls, Terns, Skimmers, and Alcids	yes				CCS Plan <sup>f</sup>
Pigeons and Doves through Cuckoos and their Allies			yes		RBCP CSCBCP SNBCP <sup>c</sup>
Owls			yes		SNBCP <sup>c</sup>
Goatsuckers through Woodpeckers			yes		CSCBCP CFBCP <sup>c</sup> SNBCP OWBCP <sup>c</sup>
Passerines			yes		All CalPIF plans <sup>c</sup>

**a** CCS Plan = *California Current System Marine Bird Conservation Plan*

**b** SFBJV = San Francisco Bay Joint Venture

**c** California Partners in Flight (CalPIF) Bird Conservation Plans:  
 CSCBCP = *Coastal Scrub and Chaparral Bird Conservation Plan*  
 CFBCP = *Coniferous Forest Bird Conservation Plan*  
 GBCP = *Grassland Bird Conservation Plan*  
 OWBCP = *Oak Woodland Bird Conservation Plan*  
 RBCP = *Riparian Bird Conservation Plan*  
 SNBCP = *Sierra Nevada Bird Conservation Plan*

**d** Some species also covered by Upland Game Bird Initiative

**e** SPSCP = *Southern Pacific Shorebird Conservation Plan*

**f** CCS Plan covers species foraging at sea and breeding colonies on rocky outcroppings or islands – not breeding colonies within baylands

**San Francisco Bay Joint Venture Implementation Strategy.** One of the original joint ventures under the *North American Waterfowl Management Plan*, the San Francisco Bay Joint Venture (SFBJV) completed its Implementation Strategy, *Restoring the Estuary: A Strategic Plan for the Restoration of Wetlands and Wildlife in the San Francisco Bay*, in 2001. The Implementation Strategy was drafted to meet the plan goals established as well as those of the Baylands Ecosystem Habitat Goals. The SFBJV states the implementation of the acreage goals developed by the Baylands Ecosystem Habitat Goals as one of its goals. Ten years later, the SFBJV is moving toward integrating the goals of all the bird initiatives, and has prepared *Conservation Objectives for the San Francisco Bay Estuary as Outlined in Planning Documents of North American's Major Bird Conservation Initiatives* (PRBO 2004) as a first step in the process.

**North American Landbird Conservation Plan.** Of most relevance to the Upland Habitat Goals Project is the *North American Landbird Conservation Plan* (Rich *et al.* 2004). Completed by Partners in Flight, the plan's goal is to conserve resident, short distance, and neotropical migrant landbirds in the US, Canada, Mexico, Caribbean, and Central America. California Partners in Flight (CalPIF) used this plan to develop bird conservation plans for the major habitat types in California: Coniferous Forests, Coastal Scrub and Chaparral, Desert, Grasslands, Oak Woodlands, Sagebrush, Sierra Nevada Range, and Riparian. The habitat-based plans contain recommendations for habitat protection, restoration, research, monitoring, management, and policy. The riparian plan was prepared by the Riparian Habitat Joint Venture in cooperation with CalPIF. These plans will be continually updated to incorporate the latest scientific monitoring and research data, and form a foundation for adaptive management. PRBO Conservation Science maintains a CalPIF study areas database and focal species breeding status database to facilitate adaptive management (see *Additional Resources*).

**Riparian Bird Conservation Plan.** A habitat-based plan under the *North American Landbird Conservation Plan*, the *Riparian Bird Conservation Plan* asserts that riparian habitats are the most important to landbird species in California, and are critical habitat for neotropical migrants and resident birds. Riparian areas function as dispersal corridors and are important breeding, wintering, and stopover habitats for migratory species. Riparian habitats have been severely degraded and their loss is suspected to be the most important cause of landbird population declines in western North America (RHJV 2004). Figure 7.2 lists the focal species and criteria for selection in the CalPIF *Riparian Bird Conservation Plan*. All except two of the focal species are found in the Bay Area.

**US Shorebird Conservation Plan.** The *US Shorebird Conservation Plan* addresses declining shorebird populations throughout the country (Brown *et al.* 2001). The *Southern Pacific Shorebird Conservation Plan* (Hickey *et al.* 2003), completed in 2003, is a regional implementation plan covering shorebirds along the coast – including San Francisco Bay – and in the Central Valley.

**North American Waterbird Conservation Plan.** The North American Waterbird Initiative prepared the *North American Waterbird Conservation Plan* in 2002 (Kushlan *et al.* 2002) to address seabirds, coastal waterbirds, wading birds, and marshbirds dependent on aquatic habitats throughout the Americas, and the Pacific and Atlantic Oceans. To meet the goals of this plan at a regional scale, PRBO Conservation Science developed the *California Current System Marine Bird Conservation Plan* (Mills *et al.* 2005), and the US Fish and Wildlife Service completed the *USFWS Pacific Region Seabird Conservation Plan* (USFWS 2005a). The California Current plan covers species dependent on this large marine ecosystem that stretches from British Columbia to Baja California. The USFWS plan covers the coastal and offshore areas of California, Oregon, Washington, Hawaii, and the US Pacific Island commonwealths, territories, and possessions. It includes a review of seabird resources and habitats, description of issues and threats, and summary of current monitoring, management, and outreach efforts.



PRBO photo by Katie Fehring

**Figure 7.2 ■ Focal Species and Selection Criteria for the Riparian Bird Conservation Plan** (RHJV 2004). All riparian focal species are found in the Bay Area except for Yellow-billed Cuckoo and Bell's Vireo (both extirpated).

Focal Species	Riparian breeder	Special status	Reduction in breeding range	Abundant breeder in CA	Nest site location
Swainson's Hawk	X	X	X		Canopy
Spotted Sandpiper	X			X	Gravel bar
Yellow-billed Cuckoo	X	X	X		Midstory to canopy
Willow Flycatcher	X	X	X		Understory
Warbling Vireo	X		X	X	Canopy
Bell's Vireo	X	X	X		Understory
Bank Swallow	X	X	X		Sandy banks
Tree Swallow	X			X	Secondary cavity
Swainson's Thrush	X		X	X	Understory
Yellow Warbler	X	X	X	X	Midstory
Common Yellowthroat	X	X	X	X	Understory
Wilson's Warbler	X			X	Understory
Yellow-breasted Chat	X	X	X		Understory
Song Sparrow	X		X	X	Understory
Black-headed Grosbeak	X			X	Midstory
Blue Grosbeak	X	X	X		Understory
Tricolored Blackbird	X	X	X		Understory

**North American Bird Conservation Initiative.** The numerous bird conservation initiatives led to the establishment of the North American Bird Conservation Initiative (NABCI). The role of NABCI is to coordinate, integrate, and increase the effectiveness of the existing bird conservation plans throughout North America. NABCI also provides a forum for addressing gaps in coverage of species, habitats or monitoring, integrating objectives within ecosystems, and coordinating efforts to meet various bird conservation objectives.

**California Bird Species of Special Concern.** The 2008 *California Bird Species of Special Concern: A Ranked Assessment of Species, Subspecies, and Distinct Populations of Birds of Immediate Conservation Concern in California* (Shuford and Gardali 2008) engaged experts from agencies and organizations to identify conservation and research priorities for declining and vulnerable species to be implemented in concert with the national bird initiatives. Prepared jointly by the California Department of Fish and Game and Western Field Ornithologists, the document designates 74 birds as Species of Special Concern and provides a wealth of information in species accounts that also prescribe management and research recommendations. Not all 74 Species of Special Concern occur in the Bay Area.

**Important Bird Areas.** Using the best available science, Audubon California identified and mapped Important Bird Areas (IBAs) for all regions of the state including the San Francisco Bay Area. Local experts nominated areas that were then selected for inclusion on the list if they met any of the following criteria:

- The area supports over 1% of the global or 10% of the state population of one or more sensitive species
- The area supports more than nine sensitive bird species
- The area has 10,000 or more observable shorebirds in one day
- The area has 5,000 or more observable waterfowl in one day

## Birds Focus Team Methodology

### Selection of Bird Conservation Targets

The Birds Focus Team developed a preliminary list of bird conservation targets drawn from the California Natural Diversity Database records (CNDDDB), California Wildlife Habitat Relationships (CWHR), and California Partners in Flight (CalPIF) habitat-based bird conservation plans for Coniferous Forests, Coastal Scrub and Chaparral, Grasslands, Oak Woodlands, and Riparian Habitats. PRBO Conservation Science range maps were used to eliminate species not found in the study area.

Focus team members were asked to consider the following questions when refining the list of bird conservation target species:

1. Does the proposed species occur in the study area?
2. Is the proposed species an important conservation target?
3. Are there additional species that should be conservation targets?
4. Are there other reasons to include or exclude a species?

The Birds Focus Team reviewed and refined the preliminary list, developing a final list of 85 bird conservation target species (see Figure 7.4; Appendix E contains additional detail). The team also sorted the target species using the following criteria:

1. The species is a conservation target and its habitat is adequately covered by the Coarse Filter Conservation Lands Network.
2. The species is a conservation target but requires further evaluation to determine if its habitat is adequately covered by the Coarse Filter Conservation Lands Network.
3. The species is not a conservation target and should be removed from the list.

Many of the bird conservation plans described above use population targets for goals; it is important to note that the Upland Habitat Goals Project did not. Instead, the project reviewed the Coarse Filter CLN to make sure that it included sufficient habitat for bird conservation targets.



Bob Gunderson / www.flickr.com/photos/hobgunderson

### Compilation of Bird Data

Once the target species were identified, the team compiled the following data sources for use in review of Coarse Filter Conservation Lands Network coverage and/or inclusion as a fine filter target for Marxan.

1. The CNDDDB provided spatially explicit, although incomplete, information on a number of special status bird species. Bird occurrence data were used to review coverage by the Coarse Filter CLN.
2. The habitat-based conservation plans of California Partners in Flight (CalPIF) provided lists of indicator species according to major habitat types (along with recommended conservation actions), but did not provide spatially explicit information. Plans for Coniferous Forests, Coastal Scrub and Chaparral, Grasslands, Oak Woodlands, and Riparian Habitats were reviewed.
3. PRBO Conservation Science provided Northern Spotted Owl territory locations that were used as fine filter targets in Marxan.
4. CWHR range and suitable habitat data were used to evaluate coverage by the Coarse Filter Conservation Lands Network.

5. Audubon Breeding Bird Atlases for Santa Clara, Napa, Sonoma, San Mateo, and Marin Counties provided information about the distribution of target bird species, but the 5km squares used in the atlases were too coarse to be of use as explicit targets. The distribution maps were very useful for evaluation of coverage by the Coarse Filter CLN.
6. The Audubon Important Bird Areas Map for the San Francisco Bay Area was reviewed for coverage by the Coarse Filter CLN.
7. Audubon Christmas Bird Count data have been used by some researchers to track trends and identify declining species, but cover such broad areas that the data could not be used as occurrences for evaluating coverage by the Coarse Filter CLN, or as explicit targets for Marxan.

## Review of the Coarse Filter Conservation Lands Network Coverage

When reviewing the Coarse Filter Conservation Lands Network to determine whether it covered the breeding, stopover/overwintering, and/or foraging habitat for target species, the team considered the following questions:

1. Are the target species’ required habitats (primarily breeding, but also foraging and wintering where applicable) common vegetation types that would be readily captured by the coarse filter goals?
2. Are the species and their habitats widely distributed across many landscape units, and thus fairly secure?
3. Does the species have locally high population densities and/or a small home range, either of which could expose it to risks from demographic, genetic, and environmental variability?
4. Does the species’ habitat include special features such as cliffs or rookeries that may require special attention?
5. Does the species have other special ecological requirements that may require management in addition to habitat protection?

The first step was a visual inspection of the Coarse Filter CLN for coverage of bird conservation targets required breeding, stopover/overwintering, and/or foraging habitats. Focus team member expertise was supplemented with data from CNDDDB, CWHR, and CalPIF. Breeding Bird Atlases (BBAs) were consulted where available using the “confirmed” and “probable” data categories. The Coarse Filter CLN was also compared to Audubon’s Important Bird Areas for the San Francisco Bay Area. Key facts and considerations for each target species are included in the Bird Conservation Targets List in Appendix E.

Out of the 85 target bird species, visual inspection was insufficient to determine whether the Coarse Filter CLN adequately covered habitat requirements for the thirteen species in Figure 7.3. These species required further research and consultation with experts.

**Figure 7.3 ■ Bird Conservation Target Species Requiring Additional Research.**

Bank Swallow	Peregrine Falcon
Blue Grosbeak	Burrowing Owl
Great Blue Heron	Sage Sparrow
Great Egret	Swainson’s Hawk
Lewis’s Woodpecker	Western Snowy Plover
Marbled Murrelet	Yellow-billed Magpie
Northern Spotted Owl	

## Coarse Filter Conservation Lands Network Review Conclusions

The extensive collective knowledge of Bay Area bird experts participating on the focus team provided a solid basis for evaluating the Coarse Filter CLN. The team concluded that the Coarse Filter CLN was very effective in capturing habitat – breeding, wintering, foraging, and migratory – for the target species as well as the vast majority of upland birds.

For the thirteen birds requiring further evaluation (Figure 7.3), review of available data (CWHR, Breeding Bird Atlases, PRBO Conservation Science) and consultation with focus team experts – in particular, Tom Gardali of PRBO Conservation Science and Steve Rottenborn, PhD, of H.T. Harvey & Associates – concluded that habitat and area requirements were covered for most of these species. Coverage results were inconclusive for Peregrine Falcon, Great Blue Heron, Great Egret, Bank Swallow, Lewis’s Woodpecker, Swainson’s Hawk, Burrowing Owl, and Marbled Murrelet; more research and data are needed to confirm whether these species’ requirements are covered by the CLN. The Bird Conservation Target List in Appendix E presents more detail for these species.

A summary of the Coarse Filter Conservation Lands Network review is below:

1. The Coarse Filter CLN is very effective in capturing the habitat requirements for the majority of the target species.
2. A number of the Audubon San Francisco Bay Area IBAs fall within the baylands, and thus are outside of the study area. The IBAs in Napa County are well covered, as are those in Solano County – with the exception of a portion of the IBA (Jepson Grasslands) that falls within Cultivated Agriculture areas. The Mount Hamilton IBA in southern Alameda and Santa Clara Counties is extensive; much, but not all of it is covered by the Coarse Filter CLN. Only the northern tip of the Upper Pajaro River IBA falls within the study area boundary, and this falls within Rural Residential areas or the Pajaro Connection Area for Further Consideration. The sections of IBAs not covered by the Coarse Filter CLN were not added to the CLN because the mapping was too general. The CLN covers many of the habitat types included in the IBAs – both within and outside of the IBAs.
3. Swainson’s Hawks use Cultivated Agriculture areas for foraging that, as with all Converted Lands, are not included in the Conservation Lands Network. The significance of these areas to raptors, as well as to waterfowl and geese, is noted in Recommended Conservation Actions.
4. In addition to cliffs, their typical habitat, Peregrine Falcons have adapted to urban areas using building, bridges, and other structures. Urban areas (as part of Converted Lands) were not included in the CLN. Peregrines in urban areas generally require management of individual occurrences.
5. Northern Spotted Owl territory locations from PRBO Conservation Science were incorporated as fine filter targets with a 75% goal in Marxan so that these areas are explicitly included in the CLN.
6. Burrowing Owl habitat in the Tassajara Hills grasslands was not added to the CLN due to the paucity of data on the specific areas providing important habitat. Instead, the area is included in the Tassajara Hills Areas for Further Consideration (see Chapter 10) for addition to the CLN once more research determines the specific lands most appropriate for inclusion.



PRBO photo by Dave Gardner

7. Bank Swallows nest in beach cliffs and stream banks which are not easily covered by the CLN. However, riparian areas are targeted for protection and restoration so the species requirements are probably met.
8. Marbled Murrelets nest in old-growth forests but distribution data were not available. Since old-growth forests are Rarity Rank 1 with a 90% conservation goal, their habitat requirements are probably met.
9. Great Blue Herons and Great Egrets nest in rookeries. Audubon Canyon Ranch maintains data on rookery sites but this information was not incorporated. The next version of the CLN will incorporate this dataset.
10. Lewis's Woodpeckers are found in eastern Santa Clara County, which is the western edge of that species' range. More review is needed to determine if the species' oak savanna habitat is adequately covered.

Although several of these species may be inadequately covered by Conservation Lands Network, many are afforded specific protections under various laws such as the Federal and California Endangered Species Acts including Marbled Murrelet, Swainson's Hawk, Peregrine Falcon, and Bank Swallow.

## Assessing the Viability of Bird Conservation Targets

Bird populations in California have been impacted by many of the same viability factors as other fine filter target species, but habitat loss and fragmentation are by far the biggest factors causing declines (Shuford and Gardali 2008). The design of the CLN cannot address all viability factors; some fall into the realm of stewardship and management. However, network connectivity is specifically designed to address habitat fragmentation, and the project emphasizes the restoration of stream corridors and associated riparian vegetation that is especially important breeding habitat for many bird species.

Chapter 9 (*Conservation Target Viability*) provides detailed descriptions of viability factors. The Birds Focus Team singled out several key factors impacting bird populations.

1. **Predator control.** Poison baits and residual poisons in carcasses can cause bird mortality.
2. **Human settlement.** Commercial and residential development converts and fragments habitat, disrupts ecological processes, and changes hydrology.
3. **Domestic pets.** Domestic and feral cats prey on birds in suburban and exurban areas. Off-leash dogs can impact ground-nesting birds.
4. **Wind farms.** The wind farms at Altamont Pass and elsewhere have caused mortality of many birds, especially raptors. These issues continue to be the focus of stakeholders and federal, state, and local officials to redesign wind turbines and implement measures to minimize bird mortality.
5. **Landfills.** Landfills attract predatory birds such as gulls, ravens, and crows, providing a food source that contributes to unnaturally dense populations of these species, which then prey on other birds' nests. Control of birds at landfills is an ongoing issue.
6. **Night lighting.** Birds migrating at night are attracted to artificial light, particularly during storms, leading them to collide with towers, tall buildings, and other structures. According to FLAP (Fatal Light Awareness Program, [www.flap.org](http://www.flap.org)), hundreds and even thousands of birds can be killed in a single night's storm. A secondary threat is predation: birds can be reluctant to leave lighted areas, flapping around in a beam of light until exhausted and vulnerable.
7. **Non-native birds.** Predation and parasitism on songbird nests by Brown-headed Cowbirds may reduce the reproductive success of many birds (Gardali *et al.* 1998). The proliferation of wild turkeys forces native species to compete for food.
8. **Disease.** West Nile virus has devastated Yellow-billed Magpie populations in parts of the Central Valley, and is present in the Bay Area at the bird's western range limit.



## Recommended Conservation Actions

The San Francisco Bay Joint Venture (SFBJV) has taken a leadership role meeting the goals of international bird conservation initiatives in the Bay Area, and is integrating the goals for all birds into its Implementation Strategy. SFBJV brings together public and private agencies, conservation groups, development interests, and others to restore wetlands and wildlife habitat in San Francisco Bay watersheds and along the Pacific coasts of San Mateo, Marin, and Sonoma counties. Conservation practitioners are encouraged to work collaboratively with SFBJV to identify and implement conservation and restoration priorities.

The numerous bird conservation plans described in this chapter contain many recommendations for management, stewardship, policy, research, and monitoring. California Bird Species of Special Concern (Shuford and Gardali 2008) provides general recommendations as well as species-specific recommendations for management, research, and monitoring. Only a brief summary is presented here; resource managers are encouraged to consult the many sources cited in Additional Resources at the end of the chapter.

**1. Support reproductive success.** Reproductive success contributes directly to population size and viability, and is influenced by a number of factors, including availability of food and habitat for nest sites, predation, and nest parasitism (from, for example, Brown-headed Cowbird).

- Prioritize potential sites for conservation according to current indicators of avian population health.
- Prioritize restoration sites according to their proximity to existing high-quality sites.
- Protect and restore riparian areas that are adjacent to intact upland habitats.
- Ensure that the patch size, configuration, and connectivity of restored riparian habitats adequately support the desired populations of riparian-dependent species.
- Conserve nesting sites near foraging areas (and vice versa). For example, Swainson's Hawks nest in small groves of trees and forage in agricultural areas. See [www.prbo.org/calpif/htmldocs/species/riparian/swainsons\\_hawk.htm](http://www.prbo.org/calpif/htmldocs/species/riparian/swainsons_hawk.htm) and [www.camigratorybirds.org](http://www.camigratorybirds.org).
- Avoid the construction or use of facilities and pastures that attract and provide foraging habitat for Brown-headed Cowbirds.

**2. Provide diverse habitats to meet diverse nesting habitat requirements.**

Different bird species place their nests in different locations – from directly on the ground to the tops of trees – but most nest within 5m of the ground. Habitat must be managed to accommodate this diversity.

- For ground nesters, grass and forbs should be greater than 6in high.
- Low- to mid-height nesters require a structurally diverse shrub and tree layer.
- Dead trees and snags should be retained for cavity nesters.
- Older tall trees should be retained for birds that nest in the canopy.

**3. Restore and manage forests to promote structural diversity and volume of understory habitats.** A healthy and diverse understory with plenty of ground cover offers well-concealed nesting and foraging sites.

- Manage riparian and adjacent habitats to maintain a diverse, vigorous understory and herbaceous layer, particularly during the breeding season.
- Manage or create “soft” edges with hedgerows at field margins that match historical vegetation patterns.



PRBO photo by Rich Stallcup





**4. Minimize disturbances during the breeding season.** In the San Francisco Bay Area, most birds nest during spring and early summer. Nestlings are particularly sensitive to changes in the environment and high survival rates of nestlings are indicators of ecosystem health. Predators such as cats, skunks, and jays can decimate breeding populations.

- Limit restoration activities and disturbance events such as grazing, disking, burning, herbicide application, and high water events to the non-breeding season.
- Prioritize sites for protection and restoration according to surrounding land uses to minimize disturbances.
- Implement wildlife-friendly farming techniques to minimize impacts of farming operations (pesticide use, season of cultivation, etc.).

**5. Protect and restore native plants.** Native bird populations evolved with native vegetation and depend on particular species for forage and nest sites. Introduced plant species may not provide the same nutrition, insect food, or quality nest sites, and can become invasive.

- Control and eradicate non-native plant species, preferably at the watershed level, so that native plants can thrive.
- Encourage the use of native plants for residential landscaping.

**6. Minimize impacts from non-native species.**

- Control non-native animal species, including domestic and feral cats.
- Prioritize sites for conservation and restoration according to surrounding land uses to reduce predation by non-native predators or a surplus of natural predators.

**7. Restore ecological processes, such as flood and fire, which are integral to a healthy ecosystem.** Ecological processes provide natural disturbances needed to maintain the high vegetative diversity important for birds.

- Prioritize sites with intact natural processes or the potential to restore the natural processes of the system.

**8. Restore riparian corridors that are essential for many bird species.**

- For riparian-dependent species, the width of riparian corridors should be restored to the fullest extent.
- Riparian habitat should be managed at the watershed level when possible, to minimize impacts from adjacent lands.

## Data Gaps

During the course of the work on bird conservation targets, the Birds Focus Team identified the following data gaps; work to address these gaps will help improve future updates of the Conservation Lands Network.

Breeding Bird Atlases should be digitized into a GIS format so they can be incorporated into future versions of the Conservation Lands Network.

The quality and quantity of available bird data should be improved by encouraging the systematic collection of observations for selected species where data are sparse or not available, and uploading that data to websites such as eBird ([www.ebird.org](http://www.ebird.org)), developed by the Cornell Lab of Ornithology and the National Audubon Society, or iNaturalist, a website encouraging volunteer naturalists to upload observations to increase occurrence data.

These and other data gaps are discussed further in Chapter 13 (*Research Needs, Measuring Success, and Conservation Lands Network 2.0*).

## Additional Resources

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Burrowing Owl Network - [www.burrowingowlconservation.org](http://www.burrowingowlconservation.org)

California Partners in Flight Conservation Plans:

Coniferous Forests - [www.prbo.org/calpif/htmldocs/conifer.html](http://www.prbo.org/calpif/htmldocs/conifer.html)

Coastal Scrub and Chaparral - [www.prbo.org/calpif/htmldocs/scrub.html](http://www.prbo.org/calpif/htmldocs/scrub.html)

Grasslands - [www.prbo.org/calpif/htmldocs/grassland.html](http://www.prbo.org/calpif/htmldocs/grassland.html)

Oak Woodlands - [www.prbo.org/calpif/htmldocs/oaks.html](http://www.prbo.org/calpif/htmldocs/oaks.html)

California Partners in Flight species accounts -  
[www.prbo.org/calpif/htmldocs/riparian.html](http://www.prbo.org/calpif/htmldocs/riparian.html)

California Riparian Habitat Restoration Guide - [www.rhju.org](http://www.rhju.org)

California Wildlife Habitat Relationship Life Histories and Range Maps -  
[www.dfg.ca.gov/biogeodata/cwhr/cawildlife.aspx](http://www.dfg.ca.gov/biogeodata/cwhr/cawildlife.aspx)

FLAP (Fatal Light Awareness Program) - [www.flap.org/flap\\_home.htm](http://www.flap.org/flap_home.htm)

North American Bird Conservation Initiative (NABCI) - [www.nabci-us.org](http://www.nabci-us.org)

North American Waterbird Conservation Plan - [www.pwrc.usgs.gov/nacwcp/nawcp.html](http://www.pwrc.usgs.gov/nacwcp/nawcp.html)

North American Waterfowl Management Plan -  
[www.fws.gov/birdhabitat/NAWMP/index.shtm](http://www.fws.gov/birdhabitat/NAWMP/index.shtm)

Partners in Flight North American Landbird Conservation Plan -  
[www.pwrc.usgs.gov/pif/cont\\_plan](http://www.pwrc.usgs.gov/pif/cont_plan)

PRBO Conservation Science and the California Avian Data Center -  
[www.prbo.org](http://www.prbo.org) and [www.data.prbo.org/cadc](http://www.data.prbo.org/cadc)

PRBO distribution and range data compiled with climate change impact assessment data  
- [prbo.org/cadc2/index.php?page=climate-change-distribution](http://prbo.org/cadc2/index.php?page=climate-change-distribution)

Recovery Plan for the Pacific Coast Population of the Western Snowy Plover -  
[www.westernsnowyplover.org/recovery\\_plan.html](http://www.westernsnowyplover.org/recovery_plan.html)

Riparian Habitat Joint Venture and Riparian Bird Conservation Plan - [www.rhju.org](http://www.rhju.org)

San Francisco Bay Joint Venture - [www.sfbayjv.org](http://www.sfbayjv.org)

Southern Pacific Shorebird Conservation Plan - [www.prbo.org/cms/212](http://www.prbo.org/cms/212)

US Shorebird Conservation Plan - [www.fws.gov/shorebirdplan](http://www.fws.gov/shorebirdplan)



Bob Gunderson / [www.flickr.com/photos/bobgunderson](http://www.flickr.com/photos/bobgunderson)

**Figure 7.4 ■ Bird Conservation Target Species.** For a detailed list with more information about each species, see Appendix E.

Common Name	Scientific Name	Legal Status*	Targeted Habitat Type
<b>Coastal Scrub-Chaparral</b>			
Black-chinned Sparrow	<i>Spizella atrogularis</i>	--	breeding
California Thrasher	<i>Toxostoma redivivum</i>	--	breeding and wintering
Greater Roadrunner	<i>Geococcyx californianus</i>	--	breeding and wintering
Mountain Quail	<i>Oreortyx pictus</i>	--	breeding and wintering
Nuttall's White-crowned Sparrow	<i>Zonotrichia leucophrys nuttalli</i>	--	breeding and wintering
Rufous-Crowned Sparrow	<i>Aimophila ruficeps</i>	CA SSC	breeding and wintering
Sage Sparrow	<i>Amphispiza belli</i>	CA SSC	breeding and wintering
Wrentit	<i>Chamaea fasciata</i>	--	breeding and wintering
<b>Coastal Strand</b>			
Western Snowy Plover	<i>Charadrius alexandrinus nivosus</i>	FT, CA SSC	breeding and wintering
<b>Coniferous Forest</b>			
Golden-crowned Kinglet	<i>Regulus satrapa</i>	--	breeding
MacGillivray's Warbler	<i>Oporornis tolmiei</i>	--	breeding
Northern Saw-Whet Owl	<i>Aegolius acadicus</i>	--	breeding and wintering
Pileated Woodpecker	<i>Dryocopus pileatus</i>	--	breeding and wintering
Purple Martin	<i>Progne subis</i>	--	breeding
Pygmy Nuthatch	<i>Sitta pygmaea</i>	--	breeding and wintering
Red-breasted Nuthatch	<i>Sitta canadensis</i>	--	breeding and wintering
Sharp-shinned Hawk	<i>Accipiter striatus</i>	--	breeding and wintering
Vaux's Swift	<i>Chaetura vauxi</i>	CA SSC	breeding
<b>Coniferous Forest / Oak Woodland</b>			
Band-tailed Pigeon	<i>Patagioenas fasciata</i>	--	breeding and wintering
Black-throated Gray Warbler	<i>Dendroica nigrescens</i>	--	breeding and wintering
Brown Creeper	<i>Certhia americana</i>	--	breeding and wintering
Northern Spotted Owl	<i>Strix occidentalis caurina</i>	FT, CA SSC	breeding and wintering
Olive-sided Flycatcher	<i>Contopus cooperi</i>	CA SSC	breeding
Western Tanager	<i>Piranga ludoviciana</i>	--	breeding
<b>Grassland</b>			
Burrowing Owl	<i>Athene cunicularia</i>	FC, CA SSC	breeding and wintering
California Horned Lark	<i>Eremophila alpestris actia</i>	--	breeding and wintering
Ferruginous Hawk	<i>Buteo regalis</i>	--	wintering
Grasshopper Sparrow	<i>Ammodramus savannarum</i>	CA SSC	breeding and wintering
Loggerhead Shrike	<i>Lanius ludovicianus</i>	CA SSC	breeding and wintering
Mountain Plover	<i>Charadrius montanus</i>	CA SSC	wintering
Northern Harrier	<i>Circus cyaneus</i>	CA SSC	breeding and wintering
Prairie Falcon	<i>Falco mexicanus</i>	--	breeding and wintering
Savannah Sparrow	<i>Passerculus sandwichensis</i>	--	breeding
Swainson's Hawk	<i>Buteo swainsoni</i>	CT	breeding
Western Meadowlark	<i>Sturnella neglecta</i>	--	breeding and wintering
White-tailed Kite	<i>Elanus leucurus</i>	CA FP	breeding and wintering
<b>Oak Woodland</b>			
Acorn Woodpecker	<i>Melanerpes formicivorus</i>	--	breeding and wintering
Ash-throated Flycatcher	<i>Myiarchus cinerascens</i>	--	breeding
Blue-gray Gnatcatcher	<i>Poliottila caerulea</i>	--	breeding and wintering

Common Name	Scientific Name	Legal Status*	Targeted Habitat Type
Cooper's Hawk	<i>Accipiter cooperii</i>	--	breeding and wintering
Golden Eagle	<i>Aquila chrysaetos</i>	--	breeding and wintering
Lark Sparrow	<i>Chondestes grammacus</i>	--	breeding and wintering
Lawrence's Goldfinch	<i>Carduelis lawrencei</i>	--	breeding
Lazuli Bunting	<i>Passerina amoena</i>	--	breeding
Lewis's Woodpecker	<i>Melanerpes lewis</i>	--	breeding and wintering
Nuttall's Woodpecker	<i>Picoides nuttalli</i>	--	breeding and wintering
Oak Titmouse	<i>Baeolophus inornatus</i>	--	breeding and wintering
Western Bluebird	<i>Sialia mexicana</i>	--	breeding and wintering
Western Screech-Owl	<i>Megascops kennicottii</i>	--	breeding and wintering
Western Scrub-Jay	<i>Aphelocoma californica</i>	--	breeding and wintering
Yellow-billed Magpie	<i>Pica nuttalli</i>	--	breeding and wintering
<b>Old-growth Redwood</b>			
Marbled Murrelet	<i>Brachyramphus marmoratus</i>	FT, CE	breeding
<b>Riparian</b>			
Allen's Hummingbird	<i>Selasphorus sasin</i>	--	breeding
American Dipper	<i>Cinclus mexicanus</i>	--	breeding
Bank Swallow	<i>Riparia riparia</i>	CT	breeding
Belted Kingfisher	<i>Megaceryle alcyon</i>	--	breeding
Black-headed Grosbeak	<i>Pheucticus melanocephalus</i>	--	breeding
Blue Grosbeak	<i>Passerina caerulea</i>	--	breeding
Bullock's Oriole	<i>Icterus bullockii</i>	--	breeding
Cassin's Vireo	<i>Vireo cassinii</i>	--	breeding
Common Yellowthroat	<i>Geothlypis trichas</i>	--	breeding
Northern Pygmy-Owl	<i>Glaucidium gnoma</i>	--	breeding
Song Sparrow	<i>Melospiza melodia</i>	CA SSC	breeding and wintering
Swainson's Thrush	<i>Catharus ustulatus</i>	--	breeding
Tricolored Blackbird	<i>Agelaius tricolor</i>	CA SSC	breeding and wintering
Warbling Vireo	<i>Vireo gilvus</i>	--	breeding
Wilson's Warbler	<i>Wilsonia pusilla</i>	--	breeding
Yellow Warbler	<i>Dendroica petechia brewsteri</i>	CA SSC	breeding
Yellow-breasted Chat	<i>Icteria virens</i>	CA SSC	breeding
<b>Rock Outcrops</b>			
Canyon Wren	<i>Catherpes mexicanus</i>	--	breeding and wintering
Peregrine Falcon	<i>Falco peregrinus</i>	federally delisted in 1999, CA SSC	breeding and wintering
Rock Wren	<i>Salpinctes obsoletus</i>	--	breeding and wintering
White-throated Swift	<i>Aeronautes saxatilis</i>	--	breeding
<b>Rookeries</b>			
Great Blue Heron	<i>Ardea herodias</i>	--	breeding and wintering
Great Egret	<i>Ardea alba</i>	--	breeding and wintering
<b>Wetlands / Lakes / Open Water</b>			
Bald Eagle	<i>Haliaeetus leucocephalus</i>	federally delisted in 2007, CE	breeding and wintering
Cackling (Aleutian Canada) Goose	<i>Branta hutchinsii leucopareia</i>	federally delisted in 2001	breeding and wintering
Clark's Grebe	<i>Aechmophorus clarkii</i>	--	breeding and wintering
Double-crested Cormorant	<i>Phalacrocorax auritus</i>	--	breeding and wintering
Osprey	<i>Pandion haliaetus</i>	--	breeding and wintering

Common Name	Scientific Name	Legal Status*	Targeted Habitat Type
Tree Swallow	<i>Tachycineta bicolor</i>	--	breeding
Yellow-Headed Blackbird	<i>Xanthocephalus xanthocephalus</i>	CA SSC	breeding and wintering
Western Grebe	<i>Aechmophorus occidentalis</i>	--	breeding and wintering
<b>Streams/Reservoir Edges</b>			
Common Merganser	<i>Mergus merganser</i>	--	breeding and wintering
Wood Duck	<i>Aix sponsa</i>	--	breeding and wintering
<b>REMOVED from list</b>			
Varied Thrush	<i>Ixoreus naevius</i>	--	
Saltmarsh Common Yellowthroat	<i>Geothlypis trichas sinuosa</i>	--	
Least Bell's Vireo	<i>Vireo bellii pusillus</i>	FE, CE	
Fox Sparrow	<i>Passerella iliaca</i>	--	
Dark-eyed Junco	<i>Junco hyemalis</i>	--	
Alameda Song Sparrow	<i>Melospiza melodia pusillula</i>	CA SSC	
San Pablo Song Sparrow	<i>Melospiza melodia samuelis</i>	CA SSC	
Suisun Song Sparrow	<i>Melospiza melodia maxillaris</i>	CA SSC	
Black Swift	<i>Cypseloides niger</i>	--	
California Black Rail	<i>Laterallus jamaicensis coturniculus</i>	CT	
California Clapper Rail	<i>Rallus longirostris obsoletus</i>	FE, CE	
Lesser Nighthawk	<i>Chordeiles acutipennis</i>	--	
Long-Eared Owl	<i>Asio otus</i>	--	
Western Yellow-Billed Cuckoo	<i>Coccyzus americanus occidentalis</i>	FC, CE	

### Legal Status Descriptions

BLM S - BLM Sensitive

CA C - California Candidate

CA FP - California Fully Protected

CA SSC - California Species of Special Concern

CE - California Endangered

CT - California Threatened

FC - Federal Candidate

FE - Federal Endangered

FT - Federal Threatened

FSC - Federal Species of Concern

USFS S - US Forest Service Sensitive



## CHAPTER

# 8

# Fine Filter: Amphibians, Reptiles, and Invertebrates



Bob Gunderson

## Introduction

The Amphibians, Reptiles, and Invertebrates Focus Team was the last to meet, and combined several species groups for simultaneous review. This focus team was able to meet only twice – in February 2009 and January 2010. The Project Team compensated for fewer focus team meetings by contacting species experts directly for input.

The focus team developed a list of conservation targets in accordance with the Target Selection Criteria (Figure 3.6), reviewed coverage by the Coarse Filter Conservation Lands Network (CLN) for the habitat requirements of selected target species, highlighted viability issues, and recommended management and stewardship actions. The focus team ultimately selected 126 target species from amphibians, arachnids, crustaceans, mollusks, butterflies, other insects, and reptiles.

Many amphibians, reptiles, and invertebrates in the Bay Area are dependent on streams and riparian habitat for at least some part of their life histories. The Riparian/Fish Focus Team described stream and riparian habitat issues and recommendations, covered in Chapter 5, and those will not be recounted here. Two recommendations to emerge from the Riparian/Fish Focus Team are highly relevant to the viability of many amphibians, reptiles, and invertebrates:

1. All streams are conservation targets, elevating the importance of restoring riparian forests and stream channels.
2. Riparian buffers should be as wide as possible.

## Amphibians, Reptiles, and Invertebrates Focus Team Members

Steve Bobzien, East Bay Regional Park District  
John Hafernik, PhD, San Francisco State University  
Alan Launer, PhD, Stanford University  
Michael Marangio, Endangered Species Wildlife Consultant  
Diane Renshaw, Consulting Ecologist  
Tim Stevens, Department of Fish and Game  
Karen Swaim, Swaim Biological Inc.

## Amphibians, Reptiles, and Invertebrates in the San Francisco Bay Area

Like other taxonomic groups, the reptiles and amphibians of the Bay Area reflect the climatic and physiographic diversity of the region. Desert species, such as Western Spadefoot Toad, Glossy Snake, Coachwhip, and Western Whiptail, are found along the arid fringes of the Central Valley in eastern Alameda, Contra Costa, and Santa Clara Counties. Some Pacific Northwest species, such as Northwestern Salamander and Red-bellied Newt, reach their southern range limits in Sonoma County. California Giant Salamander is virtually endemic to the Coast Ranges of San Mateo, Marin, and Sonoma Counties, Alameda Whipsnake is endemic to the East Bay, and San Francisco Garter Snake is endemic to the San Francisco Peninsula. Some of the healthiest metapopulations

of California Red-legged Frog and California Tiger Salamander, both federally listed as threatened, are found in the Mt. Diablo and Mt. Hamilton ranges, and persist in networks of ranch ponds along with Western Pond Turtle, a federal and state Species of Concern. These species once thrived in lowland riparian and vernal pool habitats that have largely been eliminated by development.

Cait Hutnik / LightofMorn.com



The invertebrates of the Bay Area are bewilderingly diverse and encompass many poorly-known taxonomic groups. Colorful butterflies, vernal pool-dwelling fairy shrimp, ants, beetles, bees, flies, and other insects, arachnids, and mollusks are integral to ecosystem function. The butterflies are the best known, and eight subspecies in the region are listed as threatened or endangered. The coarse filter approach should be particularly effective in conserving invertebrate species, which generally have small-scale, though often specific, habitat requirements within large tracts of diverse vegetation. The strategy of high goals for rare vegetation types, such as serpentine types, that are rich in unique species captures localized rarities (both known and unknown), while the provision of large diverse vegetation mosaics helps ensure that many populations of common invertebrates are conserved within the CLN in proportion to the conserved vegetation. Species with known limited distributions/specific habitat requirements then become potential fine-filter targets for consideration of coverage by the coarse filter vegetation.

## Amphibians, Reptiles, and Invertebrates Focus Team Methodology

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### Selection of Amphibian, Reptile, and Invertebrate Conservation Targets

An initial list of potential amphibian, reptile, and invertebrate conservation targets was created by the Project Team using the California Natural Diversity Database (CNDDDB) and the Department of Fish and Game's California Wildlife Habitat Relationships (CWHHR) System. CWHHR range maps were consulted to find local endemics, range limits, restricted distributions, and other factors that suggested potential conservation issues. The focus team experts reviewed and revised the list of targets for completeness, and added several species in accordance with the Target Selection Criteria (Figure 3.6). A total of 126 conservation targets were selected for amphibians, reptiles, arachnids, crustaceans, mollusks, and insects. The diversity of the targets covered by this focus team prompted the members to recommend additional experts to consult for other potential target species.

The following experts were consulted for potential target species and to review the Coarse Filter CLN for coverage of target species:

1. **Dave Kavanaugh, PhD, California Academy of Sciences.** March 2009. Carabid beetles. Dr. Kavanaugh indicated that the beetles listed in CNDDDB are sufficient; none should be added as conservation targets. The Coarse Filter CLN captures the necessary landscape-level diversity to conserve the high diversity of beetles in the Bay Area.
2. **Norm Penny, PhD, California Academy of Sciences.** March 2009. Lacewings. Dr. Penny felt that the Coarse Filter CLN covers lacewings in the Bay Area. The only identified rare species of concern is associated with urban Monterey cypress in San Francisco and Oakland, which are urban areas and thus not included in the CLN.
3. **Brian Fisher, PhD, California Academy of Sciences.** March 2009. Ants. Dr. Fisher's review of a map of ant diversity hotspots for the Bay Area indicated that ant species should be well covered by the Coarse Filter CLN. Most of the identified hotspots are already protected such as the San Francisco Public Utilities Commission watershed lands on the San Francisco Peninsula. Ongoing mapping through AntWeb and the Bay Area Ant Survey (a citizen science effort, [www.antweb.org](http://www.antweb.org)), will lead to more complete inventories of ant species across the region. Invasive Argentine ants are the biggest threat to ant diversity.



4. **Claire Kremen, PhD University of California, Berkeley.** January 2010. Native bees. Dr. Kremen noted that native bees in the large tracts of wildlands should be well conserved under the Coarse Filter CLN.

These experts did not recommend any additional conservation targets. The final list of conservation targets for this focus team is shown in Figure 8.10.

Because of the significance of pond habitat to many amphibians and reptiles, ponds were also identified as conservation targets. The vast majority of Bay Area ponds are stock ponds associated with ranching, but other pond types in the region are used for agricultural storage, fire protection, and recreation. To ensure that the CLN included a sufficient number of ponds, a general goal of 50% of pond occurrences (not pond area) was set for most landscape units as a fine filter target in Marxan. Because of low absolute numbers of ponds, a 75% goal was set for several smaller landscape units – American Canyon, Montezuma Hills, Middle, and South-East Bay Hills. Ponds occurring in Urban, Cultivated Agriculture, and Rural Residential areas (collectively, *Converted Lands*) are not included in the CLN because these areas were removed from the CLN 1.0, as described in Figure 3.9.

### Compilation of Amphibian, Reptile, and Invertebrate Data

Data on the selected target species came from several sources; CNDDDB was the primary source, but other references included UC Berkeley Museum of Vertebrate Zoology, Alameda Whipsnake occurrences (Karen Swaim of Swaim Biological Inc.), and CWHR.

A nine-county pond layer was created by combining two data sources. The US Fish and Wildlife Service’s National Wetland Inventory covered the majority of the study area, and the US Geologic Service’s National Hydrography Database (NHD) was used for northern Sonoma and Napa Counties. The pond numbers in the NHD areas appear to be underestimates, so caution is warranted in these areas.

## Review of the Coarse Filter Conservation Lands Network Coverage

Three approaches were employed to evaluate coverage for amphibian, reptile, and invertebrate target species. First, a visual inspection of the Coarse Filter Conservation Lands Network overlaid with CNDDDB records was used to identify any obvious gaps in coverage for conservation targets. Second, a pond gap analysis (augmented by pond occupancy rate estimates) was used to assess coverage for two key conservation targets – California Red-legged Frog and California Tiger Salamander. Third, a watershed-scale gap analysis was used to assess coverage for another key target, Foothill Yellow-legged Frog, which lives in streams and should be well covered by the inclusion of the stream network in the CLN as recommended by the Riparian/Fish Focus team (Chapter 5).

### Visual Inspection of the Coarse Filter Conservation Lands Network

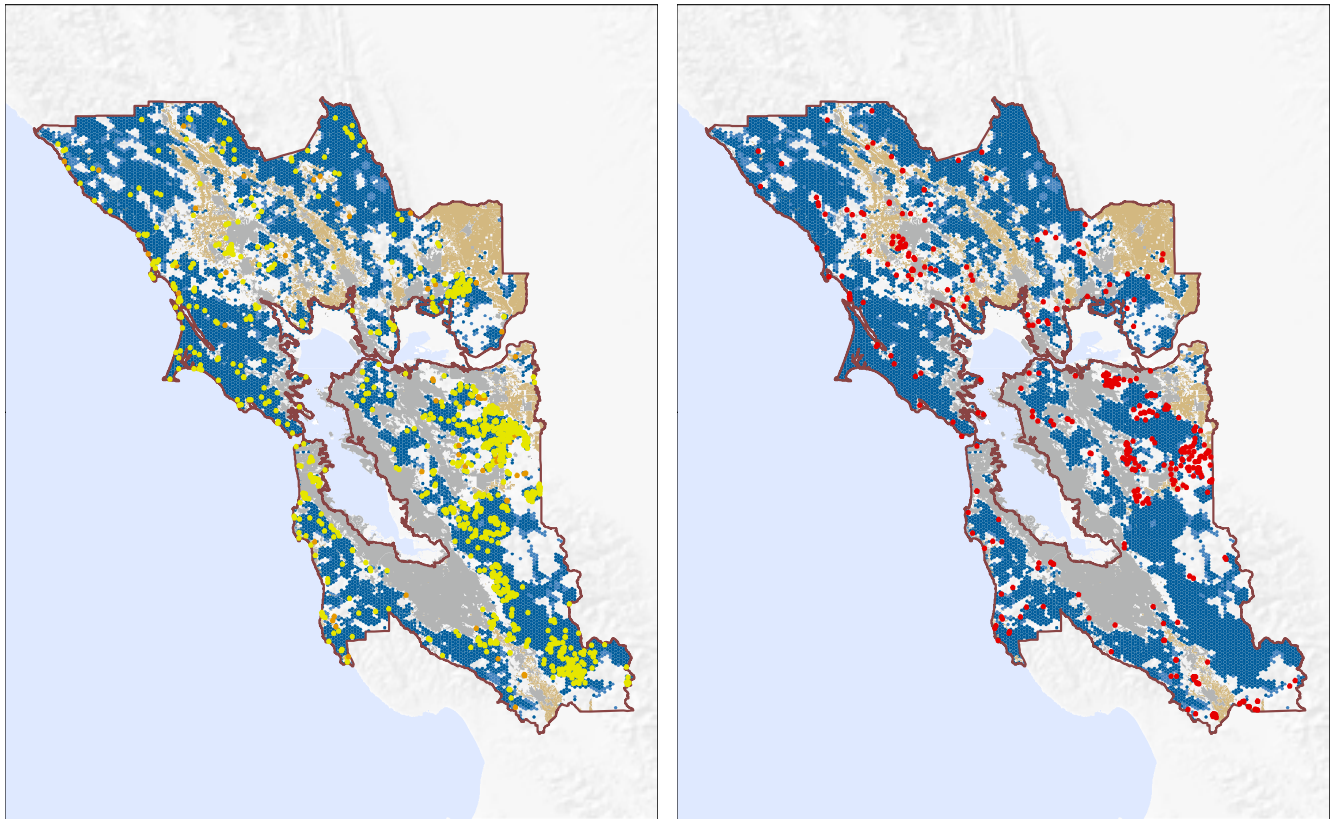
Occurrence records from CNDDDB were overlaid on the Coarse Filter Conservation Lands Network (Figure 8.1) to facilitate visual inspection for coverage. CNDDDB data were deemed useful for establishing regional and subregional presence of protected species (such as California Red-legged Frog and California Tiger Salamander) in landscape units. For the visual inspection, all CNDDDB records were used without consideration of date or quality because they were used to establish whether taxa are (or were) present within landscape units – not as explicit targets. However, dates and quality of CNDDDB records were considered when evaluating coverage of the Coarse Filter CLN for specific targets.

As shown in Figure 8.1, many of the CNDDDB occurrences not captured by the Coarse Filter CLN are located in Urban or Cultivated Agriculture areas (shown in dark gray and light gray, respectively, on the map), which are generally not selected by Marxan because of lower ecological integrity (densely populated, many roads). This gap analysis indicates good coverage by the Coarse Filter CLN so no adjustments were made based on this first review.



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**Figure 8.1 ■ Gap Analysis for Visual Inspection of Coarse Filter Conservation Lands Network Coverage for Amphibian, Reptile, and Invertebrate Conservation Targets.** On the map on the left, the yellow and pink dots are target species CNDDDB occurrences that fall within the Coarse Filter Conservation Lands Network (yellow dots are in Essential Areas, pink dots are in Important Areas). The red dots on the map on the right are CNDDDB occurrences of target species that fall outside of the Coarse Filter Conservation Lands Network.



### Pond Gap Analysis

Upland ponds are key habitats for several target species, including California Red-legged Frog (CLRF), California Tiger Salamander (CTS), and Western / Northwestern Pond Turtle (WPT). The absolute number of ponds in the CLN for each landscape unit is assumed to be a first-order determinant of potential metapopulation (spatially separated subpopulations) persistence for these species. Data on occupancy rates from multi-year surveys by the East Bay Regional Park District provided further insights into metapopulation persistence.

The purpose of the pond gap analysis is to determine whether pond networks in each landscape unit within the Coarse Filter CLN are sufficient to support a viable metapopulation of each target species. The following specific data and analyses were used to evaluate coverage of ponds:

1. The number of ponds per landscape unit was calculated using the pond layer developed by the Project Team.
2. A pond gap analysis was completed for both current protected lands (BPAD 2010) and the Coarse Filter CLN to gauge both the additional protection provided by the CLN and the adequacy of that coverage. Only the Coarse Filter CLN results are presented here; the full analysis can be found in Appendix B (*Data and Methods*, Chapter 8).
3. CNDDDB distributions of key target species were used to establish presence or absence in the landscape units and – in some cases – subareas of large landscape units.
4. Pond occupancy rates were estimated for California Red-legged Frog and California Tiger Salamander, based on systematic surveys by the East Bay Regional Park District

(Bobzien and DiDonato 2007). The report includes ancillary information on pond suitability.

5. A combination of pond number, local distribution, occupancy rates, suitability factors, and some qualitative rules of metapopulations were used to estimate the potential for pond networks to support viable metapopulations. These qualitative rules include:
  - More ponds are better than fewer ponds.
  - Ponds within dispersal range of target species are more likely to be occupied.
  - The occupancy rate over time is a measure of metapopulation stability or instability.

Further background on metapopulation ecology can be found in Hanski and Gilpin 1997.

The combination of available data provides a preliminary assessment of pond networks in the CLN, but a much more detailed analysis (beyond the project's current scope) would yield a more accurate picture of metapopulation viability.

Figure 8.2 shows the results of the pond gap analysis for each landscape unit, along with the known presence of CLRF, CTS, and WPT. A total of 8,785 ponds were mapped from the available data sources. Ponds located in Urban and Cultivated Agriculture areas in some heavily developed valley floors (the 691 ponds highlighted in Figure 8.2) pose very different conservation challenges, and generally were not selected by Marxan for inclusion in the CLN. As a result, the following gap analysis discussion focuses on the 8,094 ponds located in the major mountain range landscape units and some agricultural valleys. Agricultural valleys (Solano Delta, Solano Plains) that have some CLRF and CTS records require a level of detail that is beyond the scope of this project. Also, the WPT is more widely distributed than either of the amphibians, and is not considered in as much detail.



Alameda County Conservation Partnership staff

**Figure 8.2 ■ Pond Gap Analysis for Landscape Units.** Gap analysis was completed for ponds within existing protected lands (BPAD) and the Coarse Filter Conservation Lands Network (CLN) for all landscape units except those designated as urban.

Landscape Unit*	Total Ponds	Protected Ponds BPAD	Unprotected Ponds BPAD	Protected Ponds inside CLN	Unprotected Ponds outside CLN	% of Ponds Protected in CLN	Species present		
							CLRF	CTS	WPT
American Canyon	126	35	91	73	53	58%	X		X
Blue Ridge Berryessa	541	75	466	309	232	57%	X		X
Coastal Grasslands	641	99	542	299	342	47%	X	X	X
<b>Contra Costa Delta</b>	113	6	107	18	95	16%	X		X
Marin Coast Range	418	157	261	329	89	79%	X		X
Middle East Bay Hills	129	49	80	65	64	50%	X		X
Montezuma Hills	54	10	44	39	15	72%		X	
Mount Hamilton	1882	485	1397	1023	859	54%	X	X	X
Mt. Diablo Range	722	199	523	377	345	52%	X	X	X
<b>Napa Valley</b>	223	12	211	23	200	10%			X
<b>N. Contra Costa Valley</b>	42	12	30	4	38	9.5%		X	X
North East Bay Hills	170	84	86	97	73	57%	X		X
Northern Mayacamas	146	16	130	72	74	49%			X
Point Reyes	209	175	34	183	26	87.5%	X		X
<b>Russian River Valley</b>	145	8	137	57	88	39%			X
<b>San Francisco</b>	34	22	12	19	15	56%			
<b>Santa Clara Valley</b>	112	29	83	27	85	24%			X
Santa Cruz Mountains N	484	168	316	273	211	56%	X	X	X
Santa Rosa Plain	122	18	104	39	83	32%		X	
Sierra Azul	309	40	269	161	148	52%	X	X	X
Solano Delta	66	11	55	39	27	59%	X		X
Solano Plains	138	6	132	36	102	26%	X		X
Sonoma Coast Range	261	20	241	100	161	38%	X		X
Sonoma Mountains	285	39	246	116	169	41%	X		X
<b>Sonoma Valley</b>	101	7	94	22	79	22%			X
South East Bay Hills	157	62	95	100	57	64%	X	X	X
Southern Mayacamas	585	44	541	232	353	40%	X		X
<b>Tri-Valley</b>	66	11	55	12	54	18%	X	X	X
Vaca Mountains West	504	59	445	242	262	48%	X?		X
<b>TOTALS</b>	<b>8,785</b>	<b>1,958</b>	<b>6,827</b>	<b>4,386</b>	<b>4,399</b>	<b>50%</b>	<b>19</b>	<b>10</b>	<b>26</b>

\* Landscape units in blue have heavily-developed valley floors.

CLRF – California Red-legged Frog, CTS – California Tiger Salamander, WPT – Western Pond Turtle

X = species present in landscape unit, as per CNDDDB and expert opinion

**Figure 8.3 ■ Pond Protection Levels Under the Coarse Filter Conservation Lands Network.** The Coarse Filter Conservation Lands Network increases the protection level of ponds in all landscape units.

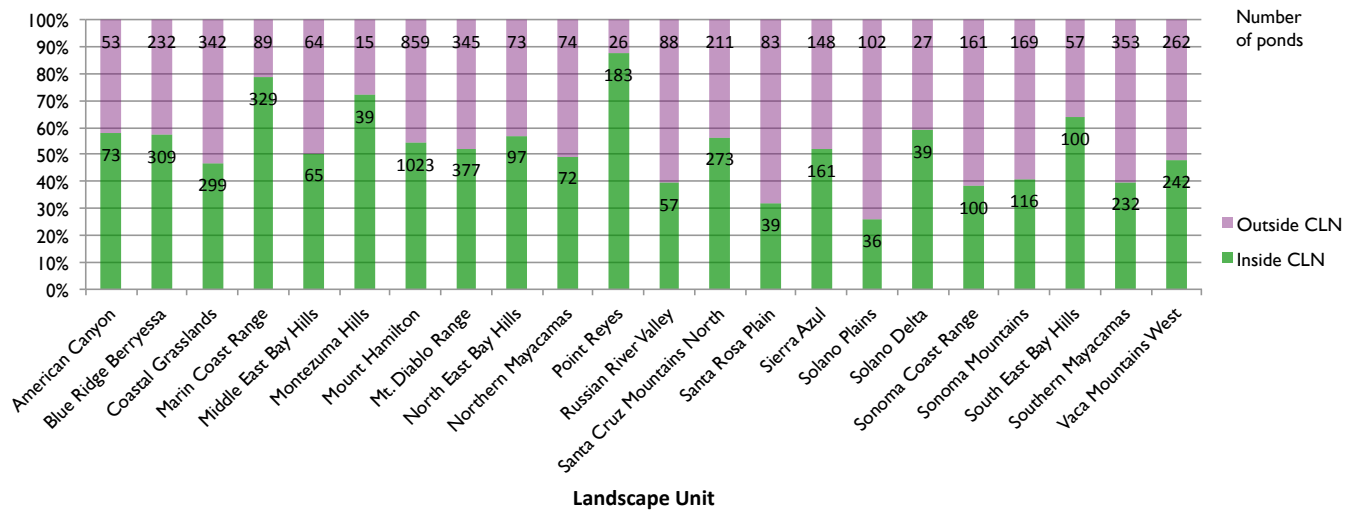
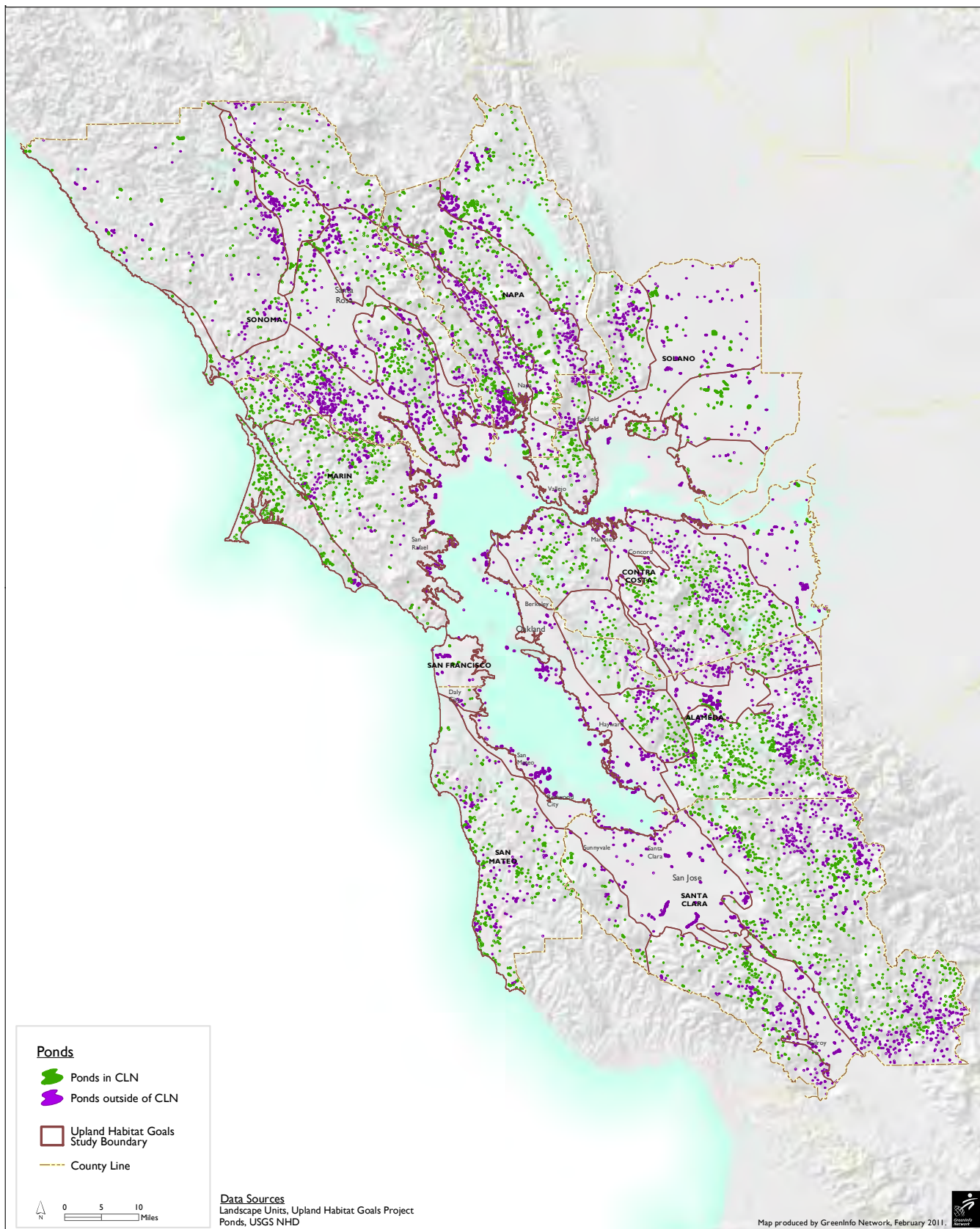


Figure 8.3 illustrates that the Coarse Filter CLN protects 50% of total ponds, compared to 22% protected by existing protected lands (Appendix B, *Data and Methods*, Chapter 8). Pond numbers (Figure 8.3) inside the CLN were greater than 200 in eight landscape units, between 100 and 200 in five landscape units, and between 36 and 99 in another nine landscape units (four of which are agricultural valley floors). Note again (and throughout the discussion) that pond numbers in the Sonoma Coast Range and Northern Mayacamas Landscape Units are underestimated because of the reliance on NHD pond data.

Figure 8.4 plots ponds within the Coarse Filter CLN (green), and outside of the Coarse Filter CLN (purple), to graphically illustrate the number of ponds covered by the Conservation Lands Network. Significantly, a careful review of Figure 8.4 by Stuart Weiss, PhD, Project Science Advisor, showed that the Coarse Filter CLN captured coherent pond networks, and that inter-pond distances are generally within the known dispersal ranges of 1-5km for California Red-legged Frog, California Tiger Salamander, and Western Pond Turtle. Exceptions include heavily cultivated agricultural areas such as the Solano Plains, Solano Delta, Santa Rosa Plain, and Russian River Valley Landscape Units. These fragmented landscapes have numerous farm ponds located in Cultivated Agriculture use, but the fine-scale conservation planning required in these areas is beyond the scope of the CLN.

Potential problem areas were noted on Sonoma Mountain where the Coarse Filter CLN includes a large pond network in the north and a smaller network in the south, but many ponds in between that would provide important linkages are not included. The pond network in the Tassajara Hills (southwest of Mt. Diablo) is similarly poorly represented, even though the region supports key conservation targets (California Red-legged Frog, California Tiger Salamander, and Western Pond Turtle). Because of potential shortfalls in pond number and connectivity, these areas were included as the Southern Sonoma Mountain and Tassajara Hills Areas for Further Consideration, which are potential future additions to the CLN requiring more detailed analysis (see Chapter 10). Several other Areas for Further Consideration were added specifically for amphibian ponds, and are described in Chapter 10 (*The Conservation Lands Network: Summary and Conclusions*).

**Figure 8.4 ■ Distribution of Ponds Protected by the Coarse Filter Conservation Lands Network.** Green ponds represent those in the Coarse Filter Conservation Lands Network. Purple ponds are outside of the CLN.





## Pond Occupancy Rate Estimates

Because not all ponds are occupied by target species, the gap analysis was accompanied by an estimate of occupancy rates. Occupancy rates are one indicator of the viability of pond-dwelling metapopulations, integrating pond suitability, distance between ponds, and the recent history of metapopulation dynamics. Metapopulation viability is a significant issue for California Red-legged Frog since this species breeds in ponds and may move from one pond to another seasonally as metamorphs disperse (Bulger *et al.* 2003). This behavior underscores the importance of terrestrial habitat in addition to ponds (Fellers and Kleeman 2007).

Pond occupancy was estimated for two key target species – California Red-legged Frog (CRLF) and California Tiger Salamander (CTS) – using data from the East Bay Regional Park District (EBRPD) for Alameda and Contra Costa Counties. The surveys represent the only available data consistently sampled in three different years; the inconsistent CNDDDB data do not represent true occupancy data. As other agencies develop systematic sampling regimes, those data will supplement future analyses.

The EBRPD conducted surveys of nearly all ponds on their lands in 1996, 2000, and 2004 (Bobzien and DiDonato 2007). These lands cover part of the CRLF and CTS ranges. According to CNDDDB data, CRLF are in all three East Bay Hills landscape units and CTS are present in the Mt. Diablo Range, Mt. Hamilton, and Tri-Valley landscape units, but not in the North and Middle East Bay Hills landscape units.

The EBRPD surveys cover parts of the North, Middle, and South East Bay Hills, Tri-Valley, Mt. Diablo Range, and Mt. Hamilton Landscape Units, and indicate that overall occupancy rates for CRLF varied from 28-34% over the three sampling periods (Figure 8.5). Breeding occupancy – the presence of eggs and tadpoles – ranged from 21-30%. This small range in breeding occupancy rates indicates relative stability of the CRLF metapopulation within the survey period. Data on local extirpation and colonization (turnover) could not be extracted from the data presented in the report, nor could the data be broken down into geographic subunits, so no further analysis was done.

**Figure 8.5 ■ Pond Occupancy Estimates for California Red-legged Frog (CRLF) based on East Bay Regional Park District Survey Data.**

Year	Total Ponds Surveyed	CRLF Occupancy	% CRLF Occupancy	CRLF Breeding Occupancy	% CRLF Breeding Occupancy
1996	179	51	28%	38	21%
2000	219	73	33%	65	30%
2004	186	64	34%	47	25%

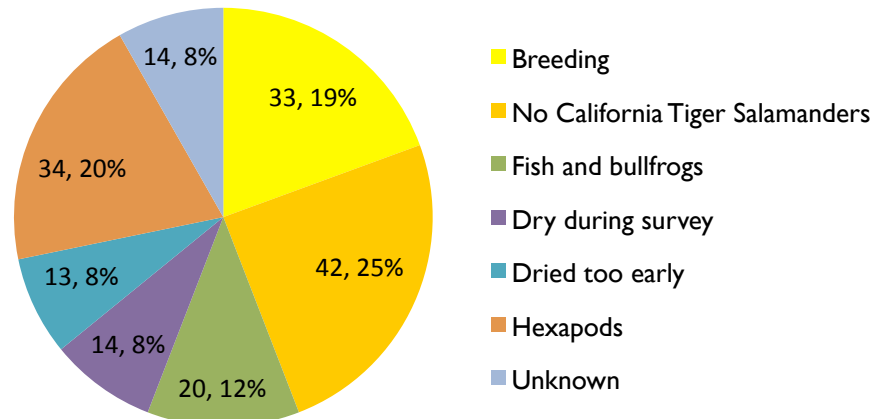
EBRPD data was also used to estimate occupancy rates for CTS (Figure 8.6). Ponds were categorized as potential ponds, defined as those ponds within the known geographic range of CTS (a total of 170 ponds), and available ponds, defined as those with suitable breeding habitat and reproduction documented in previous years (61-75 ponds, depending on the survey year). Ponds considered unsuitable for CTS – because they are too dry or support predatory fish, bullfrogs, or hexapods (predaceous insects) – were not included in the EBRPD analysis. Of all the potential ponds, only about 30-40% were available, and of these available ponds, only 44-50% were occupied by breeding CTS in any given year. These figures yield an occupancy rate among all potential ponds of 17-21% for the years surveyed. The small range in occupancy rates between sample years indicates relative stability of the metapopulation as a whole over the eight-year survey period.

**Figure 8.6 ■ Pond Occupancy Estimates for California Tiger Salamander (CTS), based on East Bay Regional Park District Survey Data.**

Year	# Potential ponds	# Available ponds	# Available ponds with CTS breeding	# Available ponds with no CTS	% Available Ponds	% CRLF Breeding Occupancy
1996	170	61	29	32	48%	17%
2000	170	70	35	35	50%	21%
2004	170	75	33	42	44%	19%

The drivers of pond suitability offer insight into expected occupancy rates and the potential to increase available ponds through management. Ponds are unsuitable for CTS due to a number of reasons, as illustrated in Figure 8.7. In the EBRPD study, 12% of the ponds surveyed (20 ponds) had bullfrogs or fish, another 16% were dry or dried too early for successful reproduction. These issues can be addressed by management (predator removal, pond modifications to increase water residence times). Another 20% had predatory hexapods (insects such as dragonfly larvae), and 8% were unsuitable for unknown reasons. In these cases, management is unlikely to increase pond availability.

**Figure 8.7 ■ Suitability of Ponds for California Tiger Salamander.** Of the 170 potential ponds, only 33 (19%) had breeding California Tiger Salamander (CTS) present in 2004. The rest were unsuitable for a number of reasons. Unsuitable ponds are categorized under the primary cause of unsuitability. The first number in each section is the number of ponds in that category; the second represents the percentage of ponds affected (Bobzien and DiDonato 2007).



### Pond Gap Analysis Conclusions

Does the Coarse Filter Conservation Lands Network capture enough ponds within each landscape unit to support local metapopulations of CRLF and CTS? A definitive answer is beyond the scope of this report, but the following points should be considered:

1. A metapopulation model of these species has not been completed, so reliance on qualitative principles informed by the available data are the best that can be done at present.
2. There are thousands of ponds across the region, and the vast majority are human-made for livestock and agricultural storage.
3. The Coarse Filter CLN encompasses more than 200 ponds in each of eight larger mountain landscape units, 100-200 ponds in another five landscape units, and 39-99 ponds in the remaining landscape units.
4. The developed valley floors and agricultural valleys are excluded from consideration in this version of the CLN because of the fine-scale planning needed to determine ponds for inclusion.





5. Inter-pond distances are generally within the dispersal range of CRLF and CTS (1-5km, Fellers and Kleeman 2007, Trenham *et al.* 2000).
6. From the EBRPD data, expected occupancy of pond networks is on the order of 30% for CRLF, and 20% for CTS. A network of 100 ponds in a landscape unit would therefore support around 30 CRLF and 20 CTS breeding sites.
7. Because ponds are not evenly distributed across the landscape, smaller sub-networks of ponds occupied by CRLF and CTS are often found in portions of landscape units. These smaller networks suggest that the species have persisted in networks smaller than 100 ponds.
8. The fate of these pond networks relies on proper management, generally as part of grazing operations. A small well-maintained and managed pond network is better than a larger, unmaintained network. If properly managed to reduce predatory fish and bullfrogs, pond networks could likely support higher occupancy rates and more robust metapopulations.
9. To augment existing ponds, additional ponds could be created, as has been done successfully in many areas (see *Additional Resources*).
10. Future metapopulation studies of CRLF and CTS using the EBRPD data and additional surveys are desirable to guide landscape-scale pond management, restoration, and creation, and to provide better estimates of metapopulation viability.

In conclusion, the Coarse Filter CLN has high potential for including robust, viable metapopulations of these species in local pond networks. Capturing existing ponds in sufficient numbers is the first step, increasing pond availability through management, and increasing pond numbers where necessary are second steps. Management is especially critical for the viability of pond dwellers.

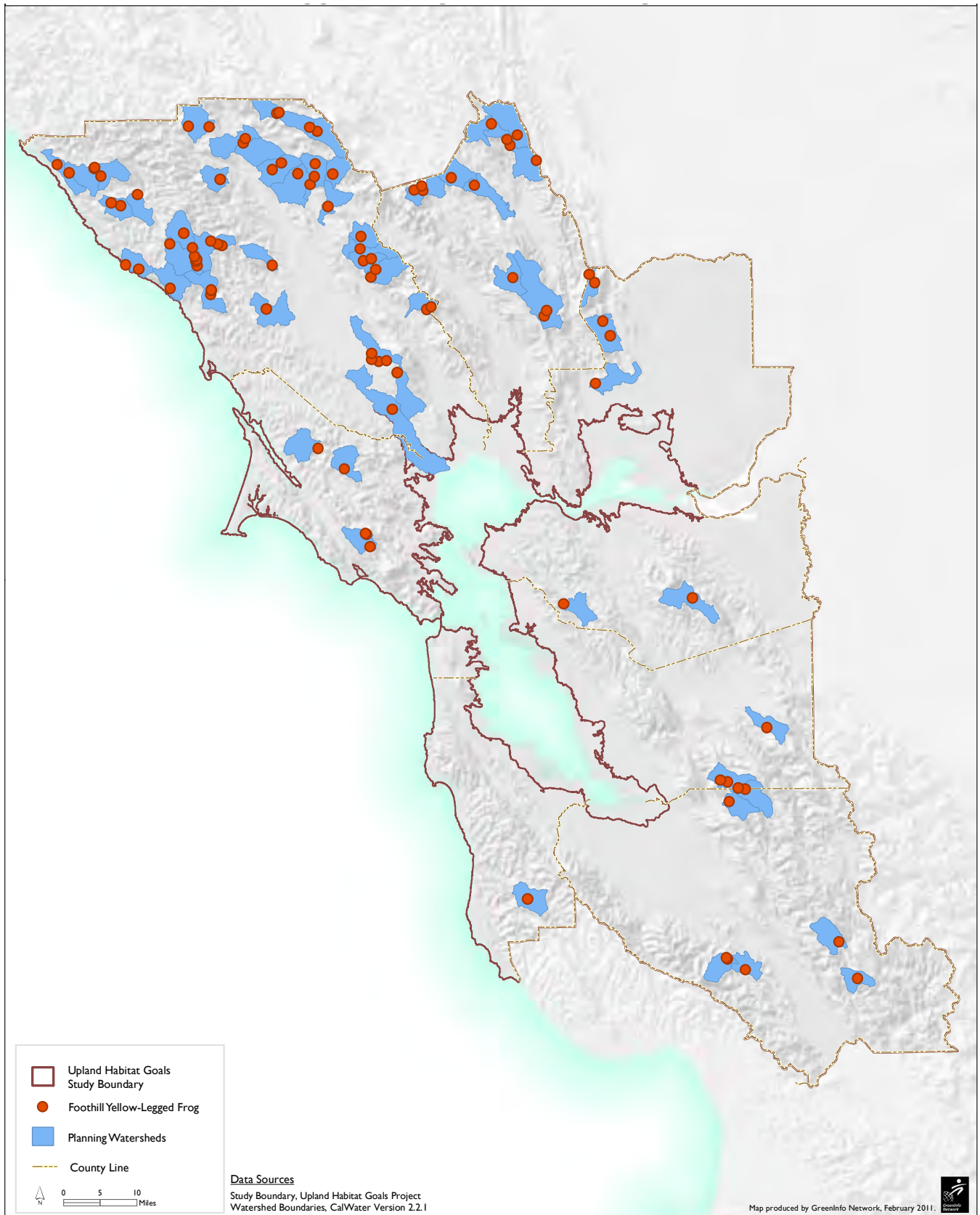
### **Foothill Yellow-Legged Frog Distribution Gap Analysis**

Because the Foothill Yellow-legged Frog (FYLF) is a California Species of Special Concern, and a stream-dwelling species, a distribution gap analysis was performed to evaluate Coarse Filter CLN coverage of its habitats. Watersheds were used for the gap analysis because FYLF is a riparian-dependent species.

The analysis contained the following elements:

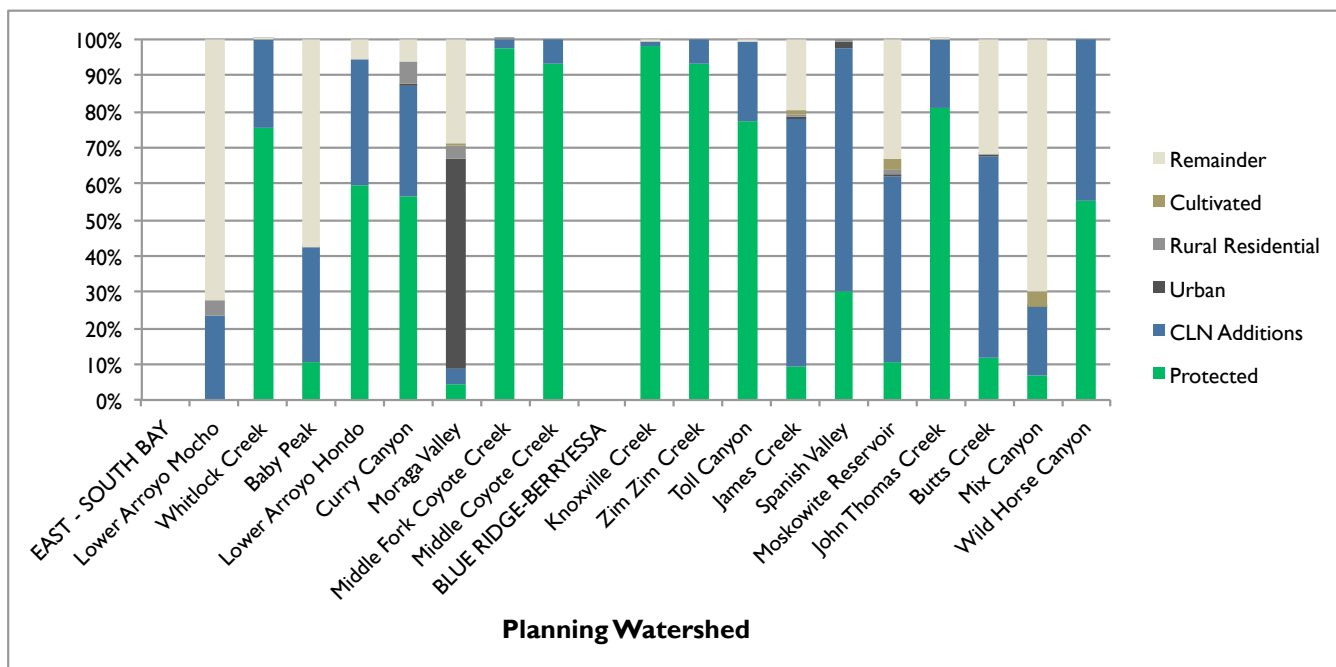
1. CNDDDB records were used to identify streams occupied by FYLF.
2. CalWater 2.2.1 Planning Watersheds were overlaid onto CNDDDB records to identify the watersheds contributing to the occupied streams (Figure 8.8).
3. A gap analysis of the occupied Planning Watersheds identified the area covered by a) currently protected lands (BPAD 2010); b) the Coarse Filter CLN; and c) Urban, Cultivated, Rural Residential, and the remainder (Other Lands).

**Figure 8.8 ■ CalWater 2.2.1 Planning Watersheds with Foothill Yellow-Legged Frog CNDDB Occurrences.** CNDDB records for Foothill Yellow-legged Frog are shown within the Planning Watersheds where they occur.



For each of the occupied Planning Watersheds, estimates were made of the acreage available for inclusion in the CLN and the acreage included in the CLN. Figure 8.9 presents results for the South and East Bay and the Blue Ridge Berryessa areas. The graphs stack the fraction of the Planning Watersheds in each land use category, so the total area to be conserved is represented by the Protected BPAD (green) plus the CLN additions (blue) gives the total area to be conserved. The combined Urban, Rural Residential (RR10), and Cultivated give the Converted Lands fraction, with the remaining lands in gray.

**Figure 8.9 ■ Gap Analysis of Foothill Yellow-Legged Frog Distribution.** CNDDDB Occurrences in CalWater 2.2.1 Planning Watersheds in the South Bay, East Bay, and Blue Ridge Berryessa Regions were used in the analysis. Green indicates the portion of the Planning Watershed in protected lands; blue shows the additional lands proposed for conservation by the Conservation Lands Network.



**Remainder:** Percentage of Planning Watershed in unprotected land that could contribute to biodiversity goals.

**Cultivated:** Percentage of Planning Watershed in Cultivated Agriculture from FMMP Agriculture.

**Rural Residential:** Percentage of Planning Watershed composed of Rural Residential uses (parcels <10ac).

**Urban:** Percentage of Planning Watershed in Urban lands uses from FMMP Urban.

**CLN Additions:** Percentage of Planning Watershed in unprotected lands in the Coarse Filter Conservation Lands Network.

**Protected:** Percentage of Planning Watershed currently protected (BPAD 2010).

In the East and South Bay, eight Planning Watersheds have FYLF records from CNDDDB. Lower Arroyo Mocho and Baby Peak are the least protected under the Coarse Filter CLN. The sole occurrence in the Mt. Diablo Landscape Unit is Curry Canyon, which is highly protected under the Coarse Filter CLN. There are likely more FYLF present in the upper watersheds of Alameda Creek (S. Bobzien pers. comm. 2010) and in the Coyote Creek watershed. In the Blue Ridge Berryessa region, Mix Canyon is the only Planning Watershed with less than 50% protection under the Coarse Filter CLN; all of the others are well protected at levels between 60-100%.

Gap analyses were completed for the Planning Watersheds of the Gualala, Lower and Middle Russian River Hydrologic Areas (CalWater 2.2.1), North Bay, Marin Coast, and Santa Cruz Mountains. Graphs and more detailed discussions of the results are included in Appendix B (*Data and Methods*, Chapter 8).

In the Gualala and Lower Russian River Hydrologic Areas gap analysis, the majority of the Planning Watersheds were protected at more than 60% under the Coarse Filter CLN and

all of the occupied Planning Watersheds are protected at levels higher than 75%. In the Middle Russian River Hydrologic Area gap analysis, five Planning Watersheds have high Coarse Filter CLN protection (>75%), with the rest between 40 and 70%.

The gap analysis for the North Bay Planning Watersheds protection levels under the Coarse Filter Conservation Lands Network ranges from 30% to 80%. In the Santa Cruz Mountains, all three Planning Watersheds with FYLF records are protected at levels greater than 70%. The Marin Coast Planning Watersheds are very well protected at levels over 90%.

### Foothill Yellow-legged Frog Distribution Gap Analysis Conclusions

The gap analysis results indicate that Foothill Yellow-legged Frog habitat is generally well covered in most areas. But some gaps remain, and further adjustments to the CLN should be made in the first update by adding fine filter targets for specific watersheds, or Areas for Further Consideration (Chapter 10). Riparian restoration and expansion of the frog's range is desirable where possible, especially around the isolated occurrences in the East Bay, South Bay, Peninsula, and Marin. These decisions should be based on much more thorough field and watershed assessments than are possible at the regional scale.

It is worth noting that the Riparian/Fish Focus Team added all streams to the Conservation Lands Network and established that maintaining watershed integrity, particularly in the upper watersheds, is an important objective. Both actions will benefit Foothill Yellow-legged Frog.

### Review of the Coarse Filter Conservation Lands Network Coverage for other Amphibians and Reptiles of Interest

Careful review of Coarse Filter CLN coverage for the following species was done because of special status, endemism, and local rarity:

1. **San Francisco Garter Snake.** This federally endangered species occupies ponds and wetlands on the San Francisco Peninsula. Because of this species' sensitive status, explicit spatial data cannot be presented here. According to Karen Swaim and Midpeninsula Regional Open Space District staff, the snake is well distributed within the network of ponds in the Santa Cruz Mountains North Landscape Unit. The pond gap analysis indicates that 168 ponds are presently protected in that landscape unit, and the additions to the CLN raise this number to 273. Like the other pond-dwellers, appropriate management of ponds can increase populations of this species. In addition, the San Francisco Garter Snake receives protections under the Endangered Species Act even where it occurs outside of the CLN.
2. **Alameda Whipsnake.** This federally threatened species occupies grasslands and open shrublands in Alameda and Contra Costa Counties. The Project Team added it as an explicit fine filter target with a 75% goal in each landscape unit where it occurs (North, Middle, and South East Bay Hills, Mt. Diablo Range, and Mt. Hamilton Range). The CLN achieved these goals, in addition to capturing large swaths of unsurveyed suitable habitat.
3. **Western/Northwestern Pond Turtle.** Our only native turtle is a Species of Special Concern that lives in ponds, wetlands, and streams. The turtle is found in 26 out of 29 landscape units. Populations are well distributed, and the number of protected ponds and riparian zones in the CLN appear sufficient to maintain this species.
4. **California Giant Salamander.** A Bay Area near-endemic, this salamander occupies moist forests and streams in the coastal mountains, and appears well covered by the Coarse Filter CLN.

John Sullivan / Ribbit Photography



The Amphibians, Reptiles, and Invertebrates Conservation Targets List (Appendix E) includes brief assessments of all the amphibians and reptiles (as well as other species) selected as conservation targets.

## Review of the Coarse Filter Conservation Lands Network Coverage for Invertebrates

Assessing coverage by the Coarse Filter Conservation Lands Network for the full range of invertebrates at any level of detail is not feasible due to extensive data gaps for this taxonomic group. Visual inspection indicates that the vast majority of invertebrates appear covered by the Coarse Filter CLN because their habitat requirements coincide with those of several other fine filter targets. The notes in the Amphibians, Reptiles, and Invertebrates Conservation Targets list in Appendix E address what little is known about many of these taxa.

Coverage and management issues for the following species are highlighted because of their special status as federally Threatened or Endangered, or as California Species of Special Concern:

1. **Bay Checkerspot Butterfly.** This insect's habitat, serpentine grassland, is a Rarity Rank 1 vegetation type, and its major habitat areas fall almost entirely in the Coarse Filter CLN. Appropriately managed cattle grazing is essential in Santa Clara County where nitrogen deposition is high and non-native grasses can outcompete the Bay Checkerspot's larval food plant (Weiss 1999).
2. **Callippe Silverspot Butterfly.** The population on San Bruno Mountain is protected and managed. The populations in the grasslands of the American Canyon Landscape Unit are largely unprotected, so the American Canyon Area for Further Consideration was added (see Chapter 10 for a full description). In the Pleasanton area, Callippe Silverspot overlaps with another subspecies, Comstock's Silverspot, so the Vallecitos Area for Further Consideration was added. As with Bay Checkerspot Butterfly, appropriately managed cattle grazing is essential for healthy populations, because dense grass overgrows the larval hostplants (native violets).
3. **Myrtle's Silverspot Butterfly.** Secure populations are found at Point Reyes, the cool grasslands on the east side of Tomales Bay, and north to Bodega Bay; these are captured by the Coarse Filter CLN. The species is known to be extant on both grazed and ungrazed grasslands, but dense swards of grass can suppress the larval host plants (native violets). Management needs are unclear in the absence of more studies.
4. **Mission Blue, Pheres Blue, and San Bruno Elfin Butterflies.** Virtually all populations of these species are in areas already protected and managed; no additions to the CLN are needed. Management and restoration of these areas should be continued.
5. **Lange's Metalmark Butterfly.** This critically endangered species (along with many other endemic insects) is restricted to remnant sand dunes within and adjacent to the Antioch Dunes National Wildlife Refuge. Atmospheric nitrogen deposition appears to be driving weed invasions that degrade the habitat. The butterfly is being captively reared and released. Restoration and management of the dune habitat along with propagation of the hostplants is essential, as described in the US Fish and Wildlife Service *Lange's Metalmark Butterfly Action Plan* (see *Additional Resources*).
6. **Monarch Butterfly.** Monarchs use certain small, isolated coastal groves of eucalyptus and Monterey pines that should be added to the CLN in future updates. These groves should be assessed for microclimate conditions, and appropriately managed through tree planting and selective removal, while simultaneously preventing the spread of eucalyptus into adjacent native habitats. The California Coastal Commission regards the Monarch Butterfly as a sensitive coastal resource.
7. **Fairy Shrimp and Delta Green Ground Beetle.** Various species of fairy shrimps (*Branchinecta* spp.) and the Delta Green Ground Beetle are captured by the vernal pool fine filter targets, and no adjustments to the Coarse Filter CLN are needed to encompass their habitats. These species are also covered by the *Recovery Plan for Vernal Pool Ecosystems of California and Southern Oregon* (see *Additional Resources*).
8. **California Freshwater Shrimp.** This species occupies the lower reaches of North Bay streams, all of which are Priority 1 or 2 streams and included in the Coarse Filter CLN. The US Fish and Wildlife Service completed a Recovery Plan for this species in 1998 (see *Additional Resources*).



Stuart B. Weiss

## Coarse Filter Conservation Lands Network Review Conclusions

The review indicates that the Coarse Filter Conservation Lands Network provides sufficient coverage for the amphibian, reptile, and invertebrate conservation targets with only a few adjustments. However, adjustments should be made in future updates to include the Foothill Yellow-legged Frog and the Monarch Butterfly as fine filter targets. Several more specific conclusions can also be made:

1. The Coarse Filter Conservation Lands Network captures viable networks of ponds in each landscape unit, using a minimum goal of 50% of ponds (not pond area) as a fine filter target in Marxan.
2. In the smaller American Canyon, Montezuma Hills, Middle-, and South-East Bay Hills landscape units, a 75% goal for ponds was needed to ensure that Marxan created viable pond networks.
3. The pond gap analyses demonstrate that in most landscape units, there appear to be sufficient pond numbers and spatial configuration at a 50% goal to support viable metapopulations of key conservation targets, particularly for the special status species: California Red-legged Frog, California Tiger Salamander, and Foothill Yellow-legged Frog.
4. Invertebrates appear to be well covered by the Coarse Filter CLN due to the high goals for serpentine vegetation types, fine filter targets for vernal pools, and stream and riparian habitat targets. Management of habitat for invertebrates is particularly important.
5. Alameda Whipsnake occurrences (Swaim Biological Inc.) in the East Bay Hills, Mt. Diablo range, and Mt. Hamilton range were included in the final Marxan run with a conservation goal of 75% to ensure high coverage of this endemic threatened species.
6. In some landscape units, future adjustments to the CLN will likely be necessary to capture key pond complexes that support CNDDDB occurrences of California Red-legged Frog and California Tiger Salamander. These areas have been included in the Tassajara Hills, Vallecitos, Diablo Northwest-Concord, Northern Mt. Hamilton Connectivity, and Shingle Valley Areas for Further Consideration where future additions to the CLN should be made once studies have determined the most important areas.
7. Connectivity of the pond network (minimum distances between protected ponds) is less than desired on Sonoma Mountain. For this reason, potential additions to the CLN were included in the Southern Sonoma Mountain Area for Further Consideration.
8. With occupancy rates for California Red-legged Frog and California Tiger Salamander among all potential ponds on the order of 15-35% (according to EBRPD data), a high proportion of unoccupied ponds will always be a feature of the CLN. However, management actions to improve habitat in these ponds could increase occupancy rates.
9. The watershed gap analyses for Foothill Yellow-legged Frog indicated that the species is well distributed in Sonoma and Napa Counties, but limited to isolated watersheds in Marin, the East, and South Bay (with the exception of Henry Coe State Park). Surveys are needed to determine whether remote watersheds in the Mt. Hamilton Range support more populations. Many of the occupied watersheds throughout the species range are well protected by the Coarse Filter CLN, but more detailed surveys are needed in some less-protected watersheds in the North Bay.
10. Management and maintenance of ponds will be critical for increasing numbers of suitable ponds within pond networks. Removal of fish and bullfrogs, management of emergent vegetation, alteration of wet and dry periods, assurance of structural integrity, and other activities will be necessary over the long run. Guidelines for pond management have been developed by the Natural Resources Conservation Service, US Fish and Wildlife Service, and California Department of Fish and Game (see *Additional Resources*).
11. Finer-scale conservation planning will be necessary in places such as the Santa Rosa Plain where key species and habitats exist in a mosaic of developed and fragmented habitats. The Santa Rosa Plain Conservation Strategy (USFWS 2005b) offers an approach for such planning (see *Additional Resources*).



Stuart B. Weiss



## Assessing the Viability of Amphibian, Reptile, and Invertebrate Conservation Targets

The Coarse Filter Conservation Lands Network is designed to minimize factors that diminish viability such as habitat fragmentation and loss, as well as degradation of vernal pools, ponds, and riparian habitat. It also is intended to provide a network of ponds and other important habitats that supports metapopulation viability. Gap analyses results suggest that these goals have been mostly met, but this can be confirmed only with monitoring and adaptive management.

Additional key viability factors impacting amphibians, reptiles, and invertebrates called out by the focus team are highlighted below. More detail about each of these viability factors can be found in Chapter 9 (*Conservation Target Viability*).

1. **Climate change.** Sea level rise threatens to inundate San Francisco Garter Snake habitat. Coastal populations are especially at risk because shoreline development leaves very little room. Drought conditions could reduce the number and depth of ponds and stream pools that many species require for breeding habitat and summer refugia. Changing salinity may also be an issue for some amphibian and reptile species.
2. **Nitrogen deposition.** Because nitrogen acts as a fertilizer, it contributes to overgrown annual grasses, crowding out important habitat for several butterfly species. Changes in vegetation composition and structure can have important negative impacts on habitat for these target species.
3. **Ecological succession.** Alameda Whipsnake is very sensitive to grassland loss and a lack of cattle grazing to maintain short grass and open habitats.
4. **Flood and drought.** Many ponds are stock ponds found in rangeland, and it is important that they be managed and maintained. However, regulatory oversight can make it difficult for private landowners to maintain these ponds as aging dams fail. Additionally, water extraction for domestic supply, irrigation, and crop protection can reduce critical summer stream flows.
5. **Invasive plants.** Invasive plants can cause a loss of native forage and habitat type conversions. Additionally, some activities undertaken to manage invasive plants (e.g., mowing and use of herbicides) can impact native plant and animal species.
6. **Non-native animals.** A number of non-native animals threaten the viability of numerous native species.
  - Bullfrogs prey on and outcompete many native amphibians. Some areas may require killing adult bullfrogs and/or water management for the elimination of their tadpoles. Water management is complicated, and requires attention to any overwintering tadpoles of target species, such as California Red-legged Frog.
  - Sliders (non-native turtles) compete with and displace native pond turtles.
  - Soft-shelled turtles compete with Western Pond Turtle at Crystal Springs.
  - African Clawed Frog (*Xenopus laevis*) is a disease vector and competitor to native frogs.
  - Fire ants displace native ants.
  - Invasive Argentine ants displace native ants that are food for Silvery Legless Lizards and Coast Horned Lizards (both conservation targets), and have negative impacts on other arthropods.
7. **Grazing land management.** Grazing needs to be managed to provide grassland habitat for butterflies and other insects and to minimize impacts on aquatic and riparian habitat. The maintenance of stock ponds in rangelands is especially important to many amphibians.
8. **Pathogens and disease.** The chytrid fungus has devastated frog populations worldwide and is present in the Bay Area. The fungus may be affecting some populations of California Red-legged Frog as well as those of more common frogs.



## Recommended Conservation Actions

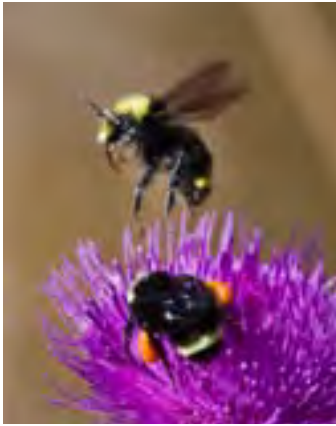
Recommended conservation actions for amphibians, reptiles, and invertebrates are described below. A summary of recommended conservation actions for all plant and animal conservation targets can be found in Chapter 12 (*Charting the Course: Implementing the CLN*).

1. Protect and restore healthy riparian, wetland, and vernal pool habitats, and create new pond and vernal pool habitats where appropriate.
2. Maintain, manage, and restore pond networks, especially those associated with streams. Elimination of bullfrogs and fish will enhance habitat for California Red-legged Frog and California Tiger Salamander. Regulatory streamlining will allow for more rapid and less costly pond maintenance and restoration.
3. Determine the status of water rights as they relate to the maintenance of dams for stock ponds to ensure adequate water supply and in-stream flows for streams.
4. Conduct comprehensive surveys for Foothill Yellow-legged Frog to better quantify the species' distribution and provide a basis for metapopulation dynamics and viability.
5. Map the occurrence of chytrid fungus, and estimate its current and potential impact on local amphibians. Minimize spread of the disease by implementing best management practices, such as washing field equipment and boots when conducting pond surveys (see *Additional Resources*).
6. Maintain grazing regimes that support habitat for amphibians, reptiles, and grassland butterfly species. Avoid build-up of thatch and biomass, which degrade grasslands and reduce ground squirrel populations, which provide burrows for amphibians and prey for snakes.
7. Bolster metapopulations by reintroducing rare and even common butterfly species into habitats where they have gone locally extinct.
8. Manage habitat for overwintering Monarch Butterfly to maintain proper microclimate conditions for this target species.
9. Control invasive weeds that crowd out native plants and alter vegetation composition and hydrology in native habitats.
10. Enhance native bee populations in agricultural landscapes by maintaining small patches of native vegetation within the agricultural areas and establishing diverse hedgerows of flowering native plants (Kremen pers. comm. January 2010). The Xerces Society provides numerous resources for native bee conservation in California. (See *Additional Resources*.)



Alameda County Conservation Partnership staff





## Data Gaps

Additional metapopulation studies of California Red-legged Frog, California Tiger Salamander, and other pond-dwelling species are needed to guide landscape-scale pond management, restoration, and creation, and to provide estimates of metapopulation viability.

Biological surveys are needed for the more obscure taxa. The long list of invertebrates in CNDDDB, in particular, is poorly surveyed.

These and other data gaps are discussed further in Chapter 13 (*Research Needs, Measuring Success, and Conservation Lands Network 2.0*).

## Additional Resources

Bibliography for California Red-legged Frog management - [www.elkhornsloughctp.org/uploads/1237561708CombinedMgt26Feb09.pdf](http://www.elkhornsloughctp.org/uploads/1237561708CombinedMgt26Feb09.pdf)

Chytrid fungus - [www.amphibianark.org/the-crisis/chytrid-fungus](http://www.amphibianark.org/the-crisis/chytrid-fungus)

Chytrid fungus best management practices - [www.jcu.edu.au/school/phtm/PHTM/frogs/papers/chytrid-report.pdf](http://www.jcu.edu.au/school/phtm/PHTM/frogs/papers/chytrid-report.pdf)

Lange's Metalmark Butterfly Action Plan, US Fish and Wildlife Service - [ecos.fws.gov/docs/action\\_plans/doc3177.pdf](http://ecos.fws.gov/docs/action_plans/doc3177.pdf)

Pond management - [www.agwaterstewards.org/txp/Resource-Center-Articles/19/farm-ponds-for-irrigation](http://www.agwaterstewards.org/txp/Resource-Center-Articles/19/farm-ponds-for-irrigation)

Recovery Plan for Vernal Pool Ecosystems of California and Southern Oregon - [ecos.fws.gov/docs/recovery\\_plan/060614.pdf](http://ecos.fws.gov/docs/recovery_plan/060614.pdf)

Wildlife-friendly ponds - [www.acrcd.org/ForRuralLandownersWildlifeFriendlyPondsProgram.aspx](http://www.acrcd.org/ForRuralLandownersWildlifeFriendlyPondsProgram.aspx)

Xerces Society resources for native bee conservation in California - [www.xerces.org/pollinators-california-region/](http://www.xerces.org/pollinators-california-region/)

2005 Santa Rosa Plain Conservation Strategy, US Fish and Wildlife Service - [www.fws.gov/sacramento/es/santa\\_rosa\\_conservation.html](http://www.fws.gov/sacramento/es/santa_rosa_conservation.html)

2002 Recovery Plan for the California Red-legged Frog, US Fish and Wildlife Service - [ecos.fws.gov/docs/recovery\\_plan/020528.pdf](http://ecos.fws.gov/docs/recovery_plan/020528.pdf)

1985 Recovery Plan for the San Francisco Garter Snake, US Fish and Wildlife Service - [ecos.fws.gov/docs/recovery\\_plan/850911.pdf](http://ecos.fws.gov/docs/recovery_plan/850911.pdf)

1998 Recovery Plan for the California Freshwater Shrimp, US Fish and Wildlife Service - [ecos.fws.gov/docs/recovery\\_plan/980731a.pdf](http://ecos.fws.gov/docs/recovery_plan/980731a.pdf)

1998 Recovery Plan for Serpentine Soil Species of the San Francisco Bay Area, US Fish and Wildlife Service - [ecos.fws.gov/docs/recovery\\_plans/1998/980930c.pdf](http://ecos.fws.gov/docs/recovery_plans/1998/980930c.pdf)

### General Viability Articles for California Red-legged Frog

Davidson C, Shaffer HB and Jennings MR. 2001. "Declines of the California red-legged frog: climate, UV-B, habitat, and pesticides hypotheses." *Ecological Applications* 11:464-479.

Jennings MR. 1988. "Natural history and decline of native ranids in California." Pp. 61-72 In: *Proceedings of the conference on California Herpetology*. Delisle HF, Brown PR, Kaufman B, and McGurty BM, editors. Southwestern Herpetologists Society Special Publication No.4.

**Figure 8.10 ■ Amphibian, Reptile, and Invertebrate Conservation Targets.** A more detailed table is available in Appendix E.

Common Name	Scientific Name	Legal Status*
<b>Amphibians</b>		
California Tiger Salamander	<i>Ambystoma californiense</i>	FT, CA SSC
Northwestern Salamander	<i>Amybstoma gracile</i>	--
Black Salamander	<i>Aneides flavipunctatus flavipunctatus</i>	--
Arboreal Salamander	<i>Aneides lugubris</i>	--
Gabilan Mountains Slender Salamander	<i>Batrachoseps gavilanensis</i>	--
California Toad	<i>Bufo boreas halophilus</i>	--
California Giant Salamander	<i>Dicamptodon ensatus</i>	--
Yellow-eyed Salamander	<i>Ensatina eschscholtzi xanthoptica</i>	--
Foothill Yellow-legged Frog	<i>Rana boylei</i>	CA SSC
California Red-legged Frog	<i>Rana draytonii</i>	FT, CA SSC
Western Spadefoot	<i>Spea hammondi</i>	--
Rough Skinned Newt	<i>Taricha granulosa</i>	--
Red-bellied Newt	<i>Taricha rivularis</i>	--
Coast Range Newt	<i>Taricha torosa torosa</i>	CA SSC
<b>Reptiles</b>		
Western/Northwestern Pond Turtle	<i>Actinemys marmorata</i>	CA SSC, BLM S, USFS S, FSC
Silvery Legless Lizard	<i>Anniella pulchra pulchra</i>	FSC, CA SSC
Glossy Snake	<i>Arizona elegans occidentalis</i>	--
Western Whiptail	<i>Aspidoscelis tigris</i>	--
Rubber Boa	<i>Charina bottae</i>	--
Northern Pacific Rattlesnake	<i>Crotalus oreganus oreganus</i>	--
Nightsnake	<i>Hypsiglena ochrorhyncha</i>	--
California Nightsnake	<i>Hypsiglena ochrorhyncha nuchalata</i>	--
California Mountain Kingsnake	<i>Lampropeltis zonata</i>	CA SSC, USFS S
Coachwhip	<i>Masticophis flagellum</i>	--
Alameda Whipsnake	<i>Masticophis lateralis euryxanthus</i>	FT, CT
California Horned Lizard	<i>Phrynosoma blainvilli</i>	CA SSC
Coast Horned Lizard	<i>Phrynosoma coronatum</i>	CA SSC
Gilbert's Skink	<i>Plestiodon gilberti cancellosus</i>	--
Long-nosed Snake	<i>Rhinocheilus lecontei</i>	--
Northern Sagebrush Lizard	<i>Sceloporus graciosus graciosus</i>	BLM S
Western Black-headed Snake	<i>Tantilla planiceps</i>	--
Western Terrestrial Garter Snake	<i>Thamnophis elegans</i>	--
Giant Garter Snake	<i>Thamnophis gigas</i>	FT, CT
Common Garter Snake	<i>Thamnophis sirtalis</i>	--
San Francisco Garter Snake	<i>Thamnophis sirtalis tetrataenia</i>	FE, CE
Side-blotched Lizard	<i>Uta stansburiana</i>	--
<b>Invertebrates</b>		
<b>Arachnids</b>		
California Tarantula	<i>Aphonopelma</i> sp.	--
Incredible Harvestman	<i>Banksula incredula</i>	--
Marin Blind Harvestman	<i>Calicina diminua</i>	--
Edgewood Blind Harvestman	<i>Calicina minor</i>	--

Common Name	Scientific Name	Legal Status*
Edgewood Park Microblind Harvestman	<i>Microcina edgewoodensis</i>	--
Hom's Microblind Harvestman	<i>Microcina homi</i>	--
Jung's Microblind Harvestman	<i>Microcina jungi</i>	--
Lee's Microblind Harvestman	<i>Microcina leei</i>	--
Lum's Microblind Harvestman	<i>Microcina lumi</i>	--
Tiburón Microblind Harvestman	<i>Microcina tiburona</i>	--
Ubick's Gnaphosid Spider	<i>Talanites ubicki</i>	--
<b>Crustaceans</b>		
Midvalley Fairy Shrimp	<i>Brachinecta mesovallensis</i>	--
Longhorn Fairy Shrimp	<i>Branchinecta longiantenna</i>	FE
Vernal Pool Fairy Shrimp	<i>Branchinecta lynchi</i>	FT
Tomales Isopod	<i>Caecidotea tomalensis</i>	--
Isopod	<i>Calasellus californicus</i>	--
Vernal Pool Tadpole Shrimp	<i>Lepidurus packardi</i>	FE
California Fairy Shrimp	<i>Linderiella occidentalis</i>	--
California Freshwater Shrimp	<i>Syncaris pacifica</i>	FE, CE
<b>Insects – Butterflies</b>		
Oplers Long-horned Moth	<i>Adella oplerella</i>	--
Lange's Metalmark Butterfly	<i>Apodemia mormo langei</i>	FE
--	<i>Apodemia mormo</i> subspecies	--
Western Meadow Fritillary	<i>Boloria epithore epithore</i>	CA SSC
Johnson's Hairstreak	<i>Callophrys johnsoni</i>	--
San Bruno Elfin Butterfly	<i>Callophrys mossii bayensis</i>	FE
Marin Elfin Butterfly	<i>Callophrys mossii marinensis</i>	--
Muir's Hairstreak	<i>Callophrys muiri</i>	--
Green Hairstreak	<i>Callophrys rubi</i>	--
Sonoma Arctic Skipper	<i>Carterocephalus palaemon magnus</i>	--
California Dog-face Butterfly	<i>Colias eurydice Boisduval</i>	--
Monarch Butterfly	<i>Danaus plexippus</i>	--
Smith's Blue Butterfly	<i>Euphilotes enoptes smithii</i>	FE
Bay Checkerspot Butterfly	<i>Euphydryas editha bayensis</i>	FT
Edith's Checkerspot and others	<i>Euphydryas editha luesterae</i> and other subspecies	--
Mission Blue Butterfly	<i>Icaricia icarioides missionensis</i>	FE
Pt. Reyes Blue Butterfly	<i>Icaricia icarioides paraperes</i>	F SC
Great Arctic	<i>Oeneis nevadensis</i>	--
Indra Swallowtail	<i>Papilio indra</i>	--
Myrtle's Silverspot Butterfly	<i>Speteria zerene myrtleae</i>	FE
Unsilvered Silverspot Butterfly	<i>Speyeria adiastrae adiastrae</i>	CA SSC
Behren's Silverspot Butterfly	<i>Speyeria zerene behrensii</i>	FE
Callippe Silverspot Butterfly	<i>Speyeris callippe callippe</i>	FE
<b>Other Insects</b>		
ant species	<i>Formicidae</i>	--
Vernal Pool Andrenid Bee.	<i>Andrena blennospermatis</i>	--
Antioch Dunes Anthicid Beetle	<i>Anthicus antiochensis</i>	FSC
Sacramento Anthicid Beetle	<i>Anthicus sacramento</i>	FSC
Sacramento Valley Tiger Beetle	<i>Cicindela hirticollis abrupta</i>	--

Common Name	Scientific Name	Legal Status*
<b>Other Insects</b> , continued		
Sandy Beach Tiger Beetle	<i>Cicindela hirticollis gravida</i>	FC
Globose Dune Beetle	<i>Coelus globosus</i>	FC
San Joaquin Dune Beetle	<i>Coelus gracilis</i>	FC
Valley Elderberry Longhorn Beetle	<i>Desmocerus californicus dimorphus</i>	FT
Giuliani's Dubiraphian Riffle Beetle	<i>Dubiraphia giulianii</i>	FSC
Stage's Dufourine Bee	<i>Dufourea stagei</i>	--
Hairy Water Flea	<i>Dumontia oregonensis</i>	FSC
Antioch Efferian Robberfly	<i>Efferia antiochi</i>	FSC
Delta Green Ground Beetle	<i>Elaphrus viridis</i>	FT
Redheaded Sphecid Wasp	<i>Eucerceris ruficeps</i>	--
Ricksecker's Water Scavenger Beetle	<i>Hydrochara rickseckeri</i>	--
Leech's Skyline Diving Beetle	<i>Hydroporus leechi</i>	FSC
Curved-foot Hygrotus Diving Beetle	<i>Hygrotus curvipes</i>	FSC
Middlekauff's Shield-back Katydid	<i>Idiostatus middlekauffi</i>	FSC
San Francisco Forktail Damselfly	<i>Ischnura gemina</i>	--
Bumblebee Scarab Beetle	<i>Lichnanthe ursina</i>	--
Molestan Blister Beetle	<i>Lytta molesta</i>	FSC
Hurd's metapogon robberfly	<i>Metapogon hurdi</i>	FSC
Antioch multilid wasp	<i>Myrmosula pacifica</i>	FSC
San Francisco Lacewing	<i>Nothochrysa californica</i>	FSC
Antioch Andrenid Bee	<i>Perdita scitula antiochensis</i>	FSC
Antioch Sphecid Wasp	<i>Philanthus nasalis</i>	FSC
Wilbur Springs Shorebug	<i>Saldula usingeri</i>	--
Antioch Dunes Halcetid Bee	<i>Sphecodogastra antiochensis</i>	--
dragonfly (full name?)	<i>Tanypeteryx haggini</i>	--
(a) Leaf-cutter Bee	<i>Trachusa gummifera</i>	--
Metallic Wood-boring Beetle	<i>Trachykele hartmani</i>	--
Serpentine Cypress Wood-boring Beetle	<i>Trachykele hartmani</i>	--
Serpentine Cypress Long-horned Beetle	<i>Vandykea tuberculata</i>	--
misc.	honeybees threatened by colony collapse disorder	--
Western Bumble Bee	<i>Bombus occidentalis</i>	--
Ground beetles	<i>Carabidae family</i>	--
Mayflies and Caddisflies	<i>Ephemeroptera and Trichoptera orders</i>	--
<b>Mollusks</b>		
Peninsula Coast Range Shoulderband Snail	<i>Helminthoglypta nickliniana awania</i>	FSC
Bridges' Coast Range Shoulderband Snail	<i>Helminthoglypta nickliniana bridgesi</i>	FSC
Mimic Tryonia (California Brackishwater Snail)	<i>Tryonia imitator</i>	FSC
Robust Walker	<i>Pomatiopsis binneyi</i>	--
Marin hesperian	<i>Vespericola marinensis</i>	BLM S, USFS S

Common Name	Scientific Name	Legal Status*
<b>REMOVED from list</b>		
Arctic Skipper	<i>Carterocephalus palaemon</i>	
Racer	<i>Coluber constrictor</i>	
Ringneck Snake	<i>Diadophis punctatus</i>	
Northern Alligator Lizard	<i>Elgaria coerulea</i>	
Southern Alligator Lizard	<i>Elgaria multicarinata</i>	
Western Skink	<i>Eumeces skiltonianus skiltonianus</i>	
Common King Snake	<i>Lampropeltis getula</i>	
Gopher Snake	<i>Pituophis catenifer</i>	
Western Fence Lizard	<i>Sceloporus occidentalis</i>	

### Legal Status Descriptions

BLM S - BLM Sensitive

CA C - California Candidate

CA FP - California Fully Protected

CA SSC - California Species of Special Concern

CE - California Endangered

CT - California Threatened

FC - Federal Candidate

FE - Federal Endangered

FT - Federal Threatened

FSC - Federal Species of Concern

USFS S - US Forest Service Sensitive



Alameda County Conservation Partnership staff



## CHAPTER

# 9

# Conservation Target Viability



Bob Gunderson

## Introduction

No conservation planning process is complete without consideration of the processes vital to species viability. Will the targeted species and ecosystems in the Conservation Lands Network (CLN) still be healthy – or even exist – decades into the future? Ecosystems, communities, and populations are dynamic, and the viability of conservation targets depends on a myriad of intertwined and interacting factors. Invasive plants, non-native animals, climate change, fire, air pollution, disease, and succession are among the many factors that define the current era of rapid environmental change, and each greatly affects species viability. Understanding these factors is an essential part of conservation planning and management. Where and when is grazing appropriate, necessary, or inappropriate? When should natural succession be arrested to maintain open habitats? How can resiliency to climate change be built into the CLN? How do we best prioritize and manage invasive plants and non-native animals? These conservation challenges require careful consideration, so that stewardship and management needs can be addressed across the various scales of the CLN.

The large, intact, interconnected landscapes of the Conservation Lands Network help sustain functioning ecosystems and are configured to minimize threats presented by roads and human activities. The Conservation Suitability layer, comprised of population density (USGS), distance to roads (USGS), and parcelization (Upland Habitat Goals), directed Marxan to select areas for conservation that are away from roads, have lower human populations, and larger parcel sizes. In addition, the CLN captures redundancy and resilience by setting goals for each target species in every landscape unit within that species'



Lech Naumovich Photography

range. This geographic stratification captures genetic variability and provides multiple representations of the targets, bolstering resilience in the event of major habitat loss, rapid climate change, or other disturbances.

Still, specific viability factors were not directly incorporated into the design of the CLN. The sheer complexity of interactions among the factors, confounded by incomplete spatial data, makes their inclusion in the Marxan selection process difficult. In some cases, such as the watershed integrity analysis (Chapter 5), a subset of viability factors was included for quantitative and qualitative assessments. But many viability factors are specific to particular vegetation types or target species, and require local, site-specific management responses that balance the needs of different species. For example, control of non-native plants by prescribed fire or mowing can be effective, but if poorly timed may disturb nesting birds.

This chapter presents a brief assessment of development risk to intact habitat, followed by summaries of nine important viability factors – the Viability Summaries. Some factors, like invasive non-native plants, are well-recognized problems; others, such as nitrogen deposition, are not yet widely appreciated. Each Viability Summary describes the process, distribution, ecological effects, management and policy recommendations, and references for more information. The summaries are not meant to be comprehensive treatments of these very complex subjects, but to provide an overview of the scale and intricacies of some important land stewardship issues.

Connectivity, a key viability factor, buffers many target species from the impacts of genetic, demographic, and environmental variability. The Conservation Lands Network emphasizes connectivity within and between landscape units, and to lands beyond the study area boundary. Because connectivity has been discussed in detail in Chapter 6 (*Fine Filter: Mammals*) and is the subject of *Critical Linkages: The Bay Area and Beyond* ([www.scwildlands.org/projects/bayarea.aspx](http://www.scwildlands.org/projects/bayarea.aspx)), it is not included as a separate Viability Summary.

### Viability Summaries

1. Climate Change and Bay Area Microclimates
2. Atmospheric Nitrogen Deposition
3. Fire
4. Ecological Succession
5. Flood and Drought
6. Landslides and Erosion
7. Invasive Plants
8. Non-native Animals
9. Pathogens and Disease





## Development Risk Assessment

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Development in all forms is a significant cause of habitat fragmentation. Roads are paved, buildings are constructed with parking areas, fences are put up, pesticides are applied, and water is diverted from streams. This section looks at several indicators that can be used to evaluate the risk of development to the Conservation Lands Network.

### Lands at Risk

Greenbelt Alliance, a Bay Area nonprofit land conservation and planning advocacy organization, conducts a periodic analysis of development risk indicators (e.g., approved or pending development proposals, zoning and general plan designations, and parcelization, among others) to evaluate the threat of development. In their most recent release, the 2006 edition of *At Risk: The Bay Area Greenbelt* declared 125,500 acres at risk of urban and suburban development by 2016, and 276,200 acres at risk by 2036 (Figure 1.3). Much of the proposed development is clustered around major urban areas and thus has only minimal overlap with the Conservation Lands Network. However, the areas where the CLN and Lands At Risk intersect should be considered priorities for conservation actions if biological surveys reveal significant biological values.

Conversely, the low-risk areas called out by the At Risk map generally coincide with the CLN, highlighting opportunities for conservation via fee or easement acquisition from willing sellers, stewardship incentives for forest and rangeland owners, or land use policies.

Greenbelt Alliance will be updating the At Risk study by 2012, offering a new opportunity to set conservation priorities based on current risk assessments. More information about the study is available at [www.greenbelt.org](http://www.greenbelt.org).

### Rural Residential Development and Parcelization

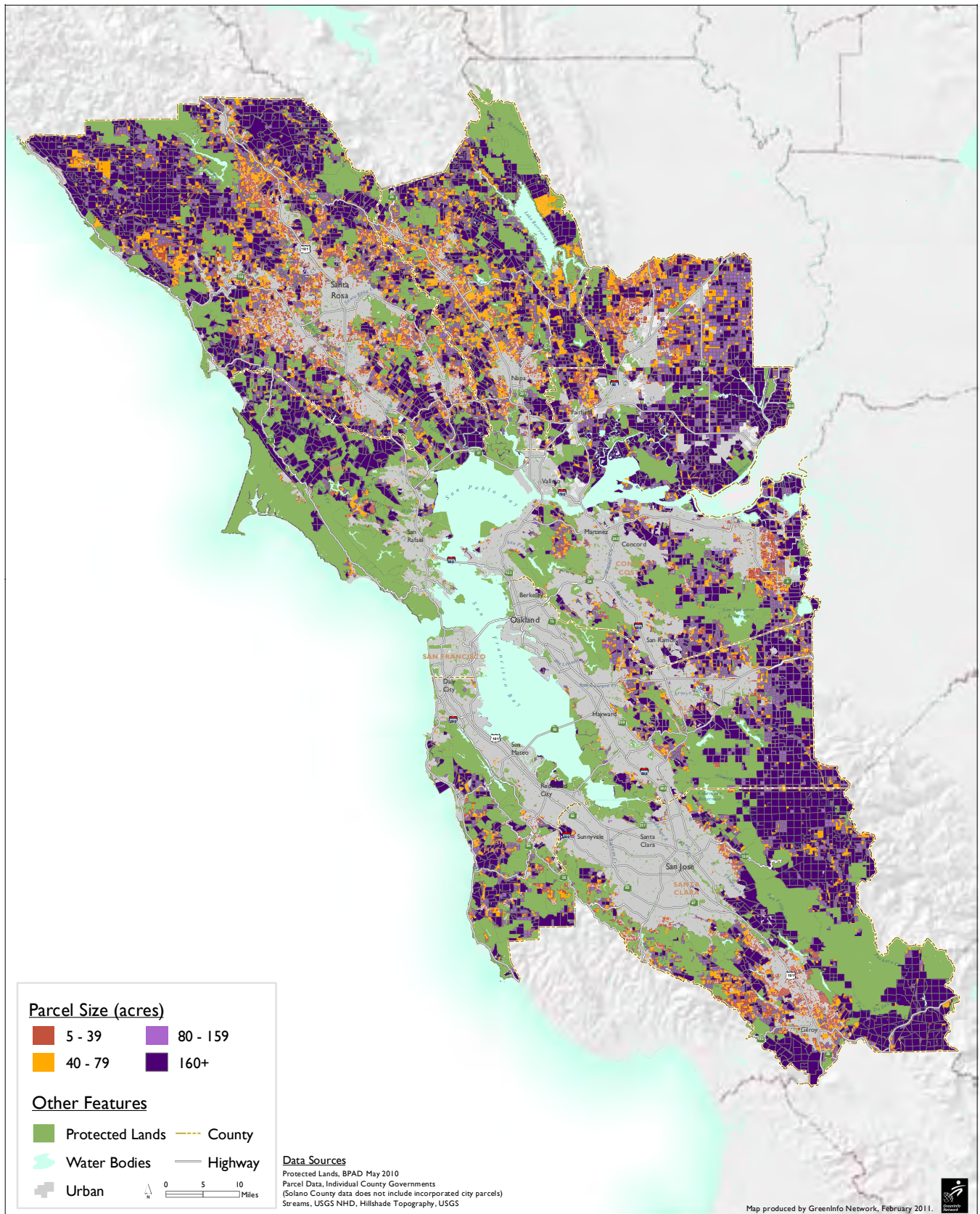
Greenbelt Alliance's At Risk study and map (Figure 1.3) included parcels of five acres or less and did not conduct a more detailed assessment of the threats posed by rural residential development. Rural residential development, also called rural sprawl, frequently results in fragmented habitat, fences that restrict wildlife movement, habitat conversion, road development, increased sediment and pollutant runoff into streams, and other impacts to biodiversity (Forman 1995, Merenlender *et al.* 2009). Estimating the threat of rural sprawl is complex and should consider local land use and short- and long-term socioeconomic factors.

The number of small parcels is one indicator of possible habitat fragmentation representing the extent of existing and potential future rural residential development. The Project Team created Figure 9.1 using county parcel data to identify areas of potential fragmentation based on parcel size. Larger parcels (160 acres or more, shown in purple) are generally well outside of urban and suburban areas. The smaller parcels (5 to 39 acres, reddish-brown) tend to cluster near the suburban fringes, but there are several exceptions of note in northwestern, central, and western Sonoma County, and the Tassajara Hills.

Figure 9.1 is only a rough guide to areas that may be impacted by rural residential development. Conservation practitioners may find that upon closer inspection, numerous small adjacent parcels are still in one ownership with few or no home sites. Limiting rural residential development through land use policies and educating those already living in rural areas are opportunities to meet the goals of the Conservation Lands Network.

Assessing development threat is a complex, evolving process that will be further addressed in future updates of the CLN. Maps of build-out scenarios based on current zoning, infrastructure, and land-use regulations – as well as urban growth projection models (Theobald *et al.* 2009) and informed expert local opinion such as that from Greenbelt Alliance – will offer more insight into the degree and distribution of threats.

**Figure 9.1 ■ Parcel Sizes in the San Francisco Bay Area.** Parcelization, or the numbers of parcels in a given area, is an indicator of habitat fragmentation. Areas with many small parcels indicate a higher risk of rural residential development, and habitat loss. A high-resolution, zoomable version of this map is available at [www.BayAreaLands.org](http://www.BayAreaLands.org).

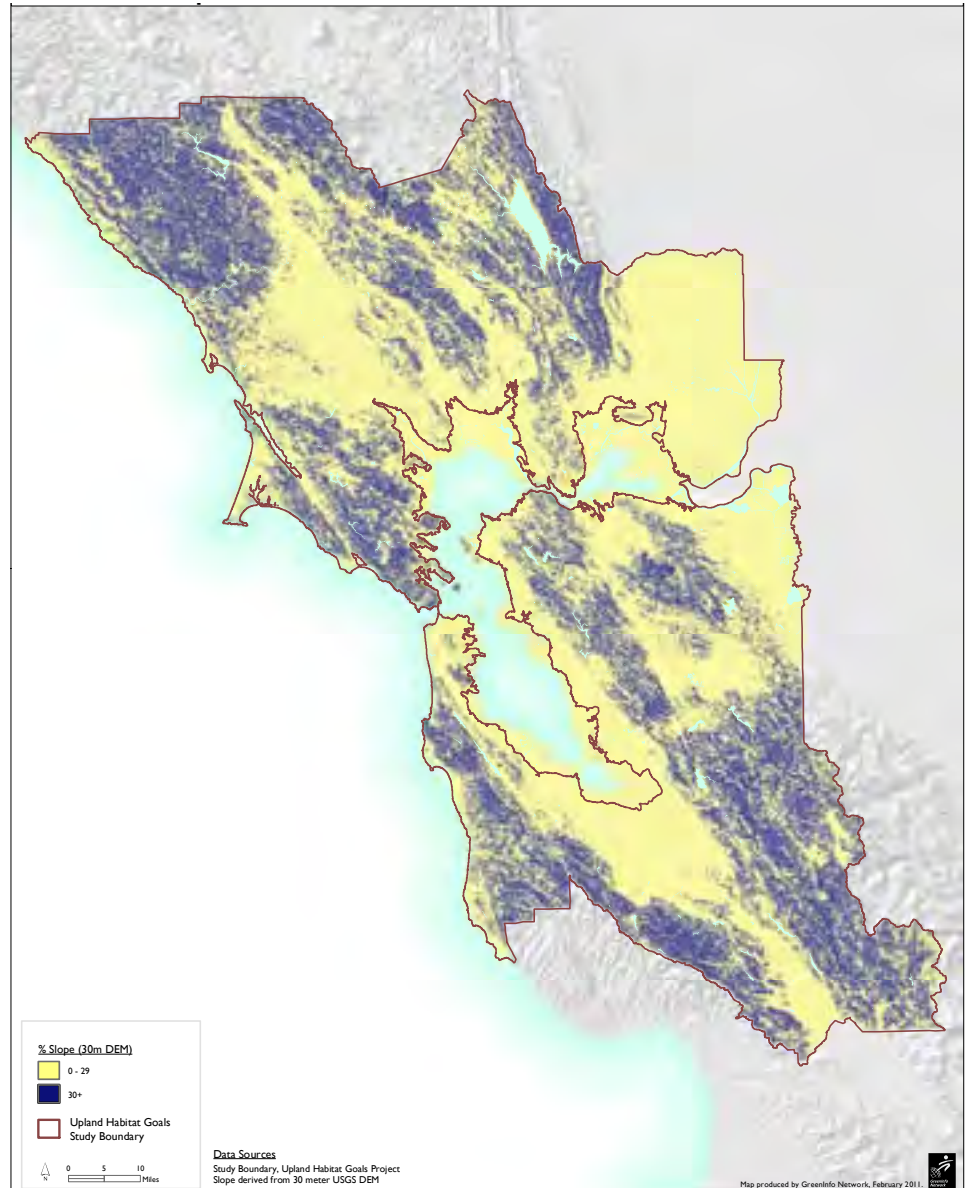


## Slope as a Development Risk Assessment Tool

Steep land, particularly in the remote outer reaches of the Bay Area, offers de facto protection from many types of development – at least for the near term. Remote areas with greater than 30% slopes are often geologically unstable (Wentworth *et al.* 1997) and pose major difficulties for intensive development. These difficulties are reflected in county and city slope ordinances for residential and agricultural developments. The slope map in Figure 9.2 shows percent slope across the region. The flat valley floors have been the most impacted by urban and agricultural development. The foothill areas lying between the developed valleys and the steep, remote areas tend to be the most at risk, and could be conservation priorities in some areas.

The Conservation Lands Network includes many of the steeper, less developable areas because they typically have higher ecological integrity due to fewer roads and lower population densities.

**Figure 9.2 ■ Percent Slope in the San Francisco Bay Area.** Remote areas with slopes steeper than 30% are often geologically unstable and difficult to develop, and therefore face a low threat of development. Data calculated from a 30m digital elevation model (USGS National Elevation Dataset).



# Viability Summary 1

## Climate Change and Bay Area Microclimates

### Process

Earth is entering a period of rapid warming and regional changes in precipitation, driven by human emissions of greenhouse gases, land cover changes, and complex interactions among environmental elements. By 2100, the annual mean temperature in California is predicted to increase by 3- 10° F (Cayan *et al.* 2005), with less certain changes in regional precipitation and seasonal temperatures. Climate change will force species to move as they track shifting climates, causing similar shifts for interdependent species including predators and prey, plants and pollinators, and diseases and hosts. These projected changes pose a profound challenge to the viability of conservation targets in the Conservation Lands Network.

Climate change projections indicate broad-scale warming trends, but precipitation projections vary widely, and fog is poorly represented in all the models (Cayan *et al.* 2005). One scenario is a northward shift in storm tracks and climate zones, meaning that the Bay Area could eventually experience the drier climate of today's Central Coast or Los Angeles Basin. Other scenarios impose higher precipitation. In general, the increase in summer temperatures will increase summer drought stress, even if more rain falls in the winter months. The fog gradient may be enhanced by warmer inland temperatures, but the effect is also dependent on ocean currents and is a major uncertainty. In the Bay Area, substantial sea level rise is nearly certain (Cayan *et al.* 2005).

Climate varies through time and across the landscape, and that variability is the key to understanding how projected climate change will affect current ecosystems. Spatial variability in climate occurs at different levels, including macroclimate, mesoclimate, topoclimate, and microclimate (Geiger *et al.* 2003). Macroclimate is the broad pattern of atmospheric circulation across 100mi+ scales of latitude and longitude, such as the north-south rainfall gradient along the Pacific Coast. Mesoclimates are variations at the 1mi to 100mi scale, reflecting penetration of marine air and effects of local mountain ranges. Topoclimates (<1mi) represent the effects of aspect, slope, relative elevation, and surrounding terrain on solar exposure, wind, and cold air drainage at night. The finest-scale variability, microclimate, represents change in areas less than 100ft, and is determined by vegetation cover and fine-scale surface features.

How resilient is the Conservation Lands Network in the face of macroclimate change? Species distributions and ecosystem processes are driven by variable weather, latitude, elevation, coastal fog, and complex terrain at all levels of spatial variability. These



interactions produce the rich, fine-scale mosaic of vegetation types across the Bay Area, as described in Chapter 4, *Coarse Filter: Vegetation*. The rich spatial diversity of the Bay Area climates and ecosystems can help buffer effects of macroclimate change; some species may have to move only a short distance to adjust their ranges (Murphy and Weiss 1992). An assessment of CLN climate resiliency is described below (see the section on Spatial Distribution). Climate change and biodiversity research is advancing rapidly, and the approach presented here is but a pilot for deeper analyses of the complex climatic landscape. In 2010, a research group of more than 25 scientists, headed by Dr. David Ackerly of UC Berkeley, was formed to pursue an approach based on the principles described above and implemented below, and is currently developing products that will be incorporated into the Conservation Lands Network.

## Distribution

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### Past Climate Changes

To put future climate projections in context, it is important to consider how the Bay Area climate has changed in the past. The region warmed at the end of the Ice Age 10,000 years ago, and experienced severe droughts and wet periods over intervening millennia (Minnich 2007). Extreme drought in the Medieval Warm Period (1100 - 1300) (Stine 1994) was followed by cool wet periods of the Little Ice Age (1450 - 1850).

Over the last century, Bay Area climate has continued to change as a result of both greenhouse gases and local land use changes, such as conversion to irrigated agriculture and urbanization (Christy *et al.* 2006). Regional trends in monthly weather data from 1895 to the present (WestMap 2009; see *Additional Resources*) were used to develop the following summary of climate over the past century in the San Francisco Bay Hydrologic Unit (CalWater 2.2.1), which includes most of the nine Bay Area counties:

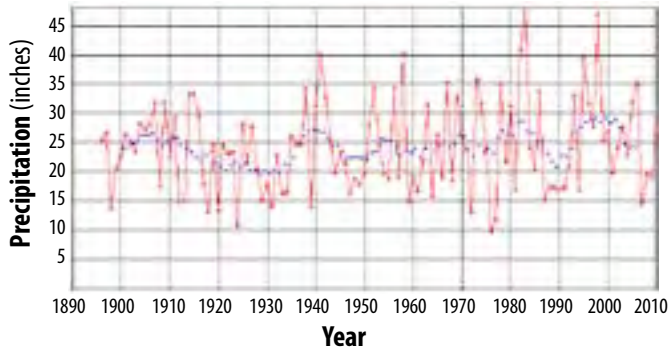
1. Annual precipitation (July - June) ranged from 10 - 48in, with no trend, but variability has increased since the mid-1970s drought (Figure 9.3A).
2. Average temperature (a 10-year running average) rose from 56° F in 1910 - 1920 to 59° F in 1990 - 2000 (Figure 9.3B). Swings in mean annual temperature were 2 - 3° F within decadal periods.
3. Average maximum temperature rose rapidly from 66.5° F in the period 1910 - 1920, to 69° F in 1930 - 1940, followed by a slow rise to 70° F by 1980 - 1990, and little change thereafter (Figure 9.3C).
4. Average minimum temperature increased irregularly from 45° F for the period from 1910 - 1920, to 47° F in 1960 - 1970, followed by a rise to 48.5° F between 1990 - 2000 (Figure 9.3D).
5. In addition, summer fog frequency has decreased over the past century (Johnstone and Dawson 2010).

Future climate projections, from a number of models and emissions scenarios (Cayan *et al.* 2005), indicate the following changes:

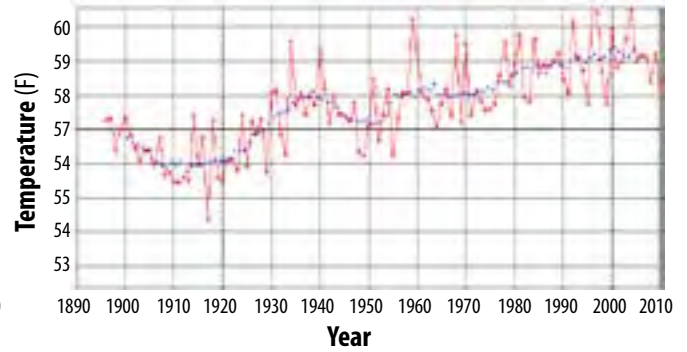
1. Average temperatures will increase 3 - 10° F by 2100. The amount of projected warming is primarily a function of the greenhouse gas emission scenarios used.
2. Increases in minimum temperatures may be greater than increases in maximum temperatures, but both will increase.
3. Precipitation trends are uncertain - some scenarios/models produce drying trends, some show no change, and yet others indicate wetter conditions.
4. Fog is poorly represented in the models, but there will always be a strong coastal-to-inland temperature gradient.
5. Regardless of the precipitation trend, there will be increased evaporative demand during warmer summer dry seasons, leading to a generally more arid landscape.

**Figure 9.3 ■ WestMap Estimates of Historical Climate in the San Francisco Hydrologic Unit (CalWater 2.2.1).** Blue dots are 10-year running means for each year.

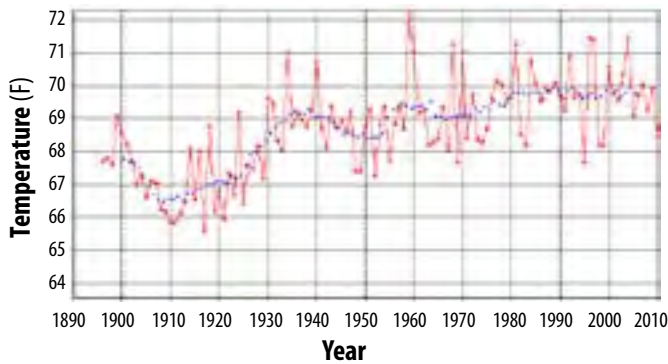
9.3A. Precipitation



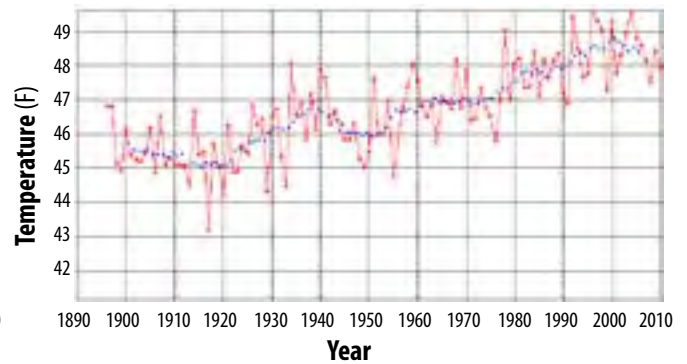
9.3B. Mean Annual Temperature



9.3C. Mean Annual Maximum Temperature



9.3D. Mean Annual Minimum Temperature



## Spatial Distribution

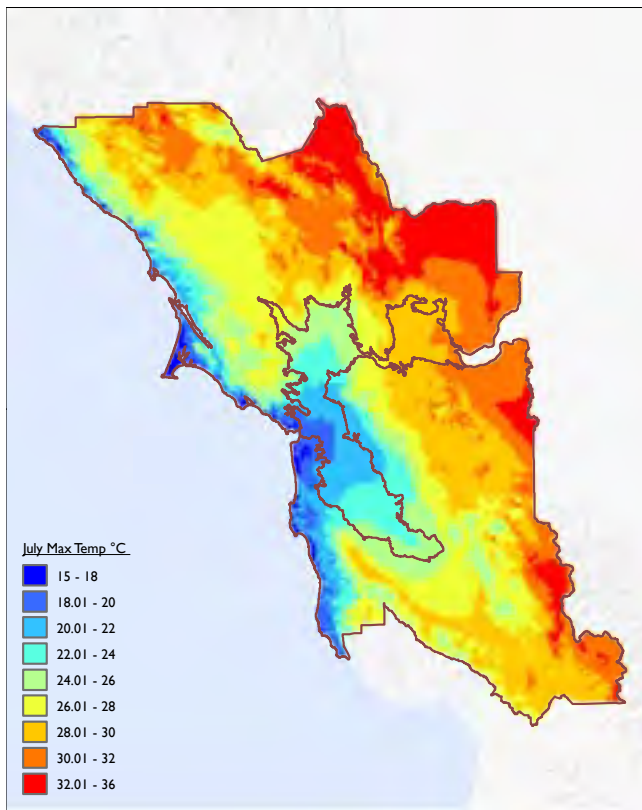
To assess climate resiliency of the CLN, the spatial variability in two key climate factors (July maximum temperature and annual precipitation) was mapped at the mesoclimate scale (800m), and the available range of temperature and precipitation within landscape units was quantified. Those ranges are a first metric of resiliency at the scale of the landscape unit; they indicate how much climate space species have locally to adjust their distribution within landscape units.

Under macroclimatic change, mesoclimatic and topoclimatic patterns remain relatively stable, and provide similar amounts of local spatial variability within a different average climate (Geiger *et al.* 2003). The present variability in mesoclimate and topoclimate indicates the amount of climate space available within a given area, and is a metric of resiliency against macroclimate change. Importantly, mesoclimates and topoclimates buffer against climate changes in any direction – warmer, cooler, drier, or wetter.

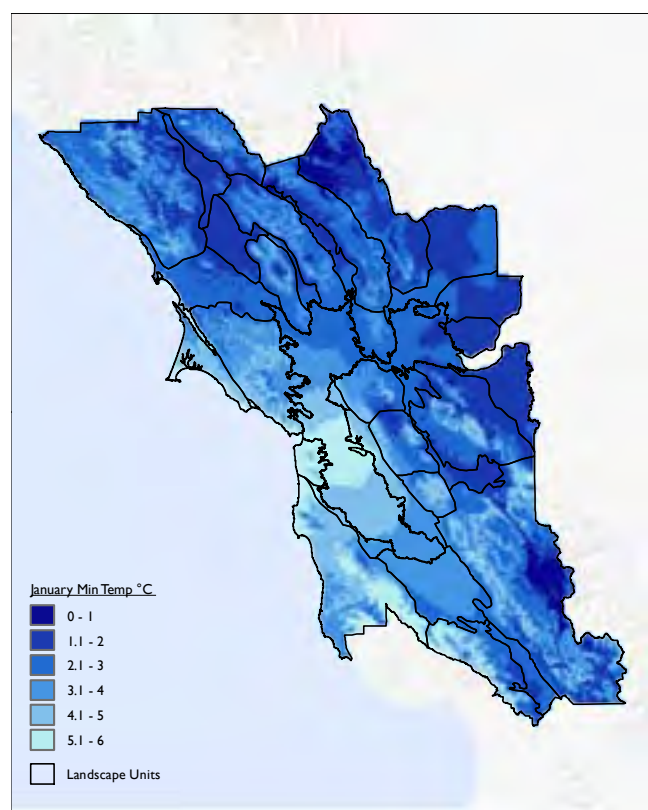
Quantified data on current spatial distributions of mesoclimates in the Bay Area are available as 800m grids (PRISM 2009). July maximum temperature (Figure 9.4A) shows the primary mesoclimatic gradient in the region, with cool temperatures (60 - 65° F) at the coast and where marine air penetrates through low spots, and warmer temperatures (90 - 100° F) inland. January minimum temperatures show cold air inversions in large valleys that create differences between warmer peaks/slopes and cooler valley floors of 4 - 6° F (Figure 9.4B). Annual precipitation (Figure 9.4C) ranges from 13 to 80in or more, and exhibits a north-south gradient, wet windward slopes, and peaks with drier inland rain shadows.

**Figure 9.4 ■ Mesoclimate Analysis from PRISM – 1971-2000 Averages.**

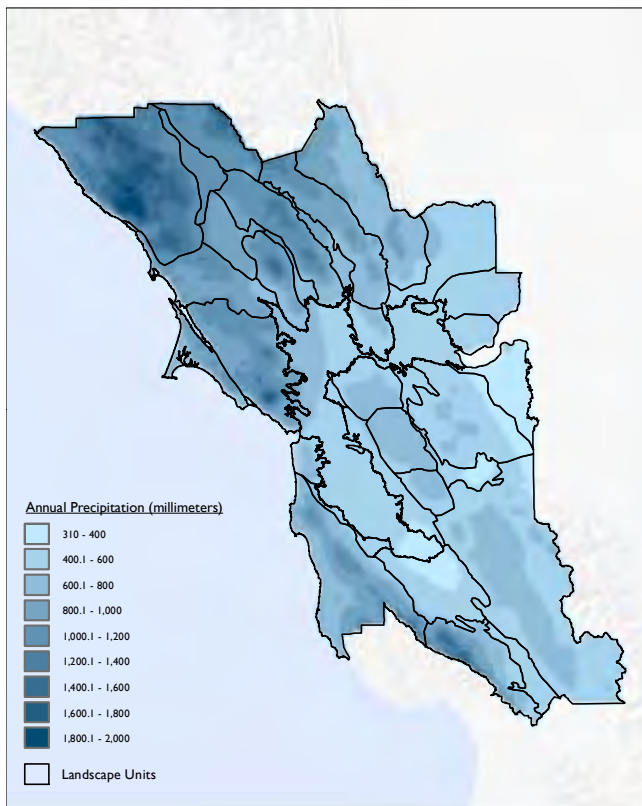
9.4A July Maximum Temperatures



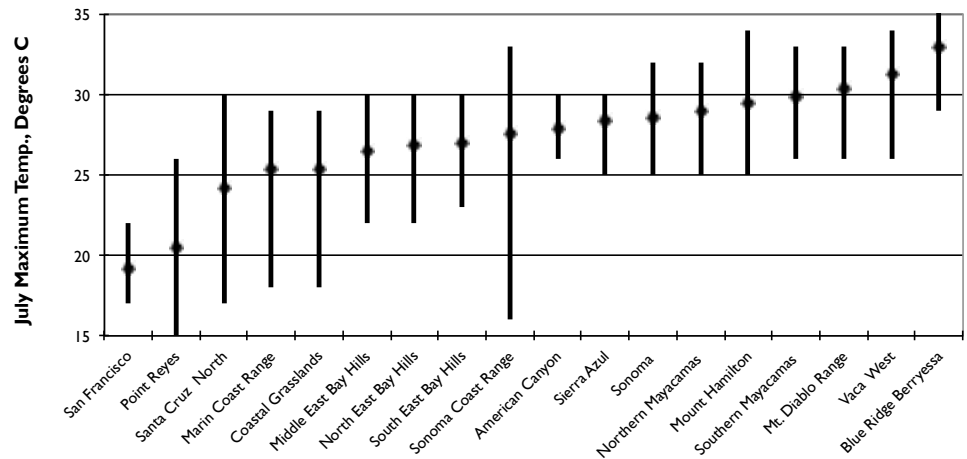
9.4B January Minimum Temperatures



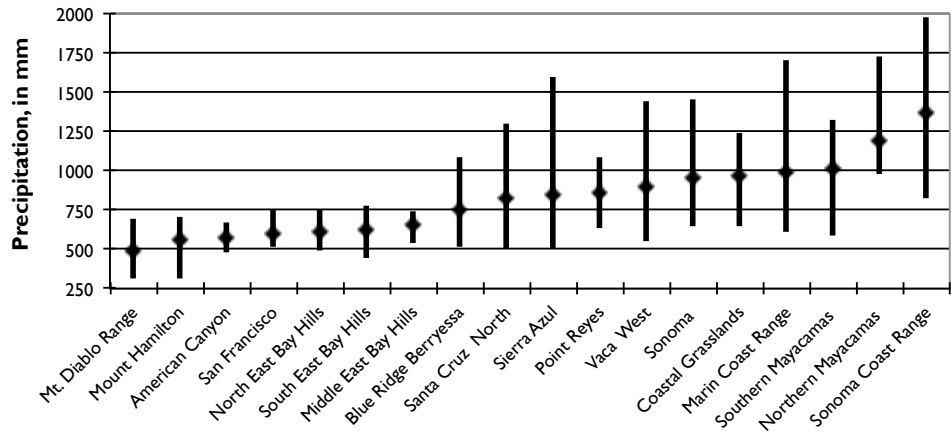
9.4C. Annual Precipitation



9.4D. Average and Range of July Maximum Temperatures for Selected Landscape Units. The table is ordered from lowest to highest temperatures.



9.4E. Range of Average Annual Precipitation within Landscape Units. The table is ordered from lowest to highest precipitation amounts.



The spatial ranges of July maximum temperatures and annual precipitation by landscape unit (Figure 9.4D and 9.4E) demonstrate large mesoclimatic variability. Because these analyses are most relevant for large, contiguous landscapes, valley landscape units were not included. Many landscape units have temperature ranges larger than projected temperature increases (3 - 10° F, Cayan *et al.* 2005). The coolest landscape unit in July is San Francisco (66° F), with a small spatial temperature range of 10° F. The Point Reyes Landscape Unit, only a few degrees warmer on average than the San Francisco Landscape Unit, has a substantially greater range (20° F). The Sonoma Coast Range Landscape Unit has the broadest temperature range (30° F); in general, the coastal landscape units have the greatest temperature ranges. Inland landscape units have smaller July maximum temperature ranges; for example, Blue Ridge Berryessa Landscape Unit has a range of 13° F.

The driest landscape units (<25in average annual precipitation) are inland, and have small absolute spatial ranges (6 - 7in). The Sonoma Coast Range is on average the wettest (50in) and has the greatest spatial range of precipitation, 32 - 78in (46in).

At the topoclimate scale, south-facing slopes can be 5 - 15° F warmer than north-facing slopes during the day. On cold, calm nights, ridgetops and slopes may be 10 - 15° F warmer than valley bottoms (Geiger *et al.* 2003). Topoclimatic effects can effectively increase the local spatial range of both high and low temperature, providing additional buffer from climate change in areas with topographic diversity.



## Ecological Impacts and Threats

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The ecological impacts of rapid climate change are predicted to be large and pervasive. The structure and composition of vegetation depends on a balance between precipitation and evaporation over the growing season, as well as differing sensitivity to freezing. For the Bay Area, most climate models predict a more intense dry season with higher temperatures and reduced summer stream flow. These changes will cause a rebalancing of site water availability and vegetation cover. Fire threat and intensity will increase, driving shifts in vegetation. Rising minimum temperatures will reduce freeze risk, but the reduction in winter chilling will affect dormancy for many plants.

Phenology (the timing of biological events such as germination, flowering, and leaf drop for plants, growth and maturity for animals) is moisture- and temperature-dependent, and thus will be directly affected by climate change. Phenological changes can disrupt relationships between plants, herbivores, and pollinators, creating more favorable conditions for insect pests and disease. Mesoclimatic and topoclimatic variability spread phenological events across space (spring flowering dates, for example, can be four to five weeks apart on opposing north and south-facing slopes), which buffers climate change impacts at least in the short term.

A statewide study (Loarie *et al.* 2008) suggests a major redistribution of plant species across California will occur under a range of climate scenarios. The ability of a species to adjust depends on the rate of decline of its current habitat, and on the species' ability to expand into newly suitable areas. Arid species may expand their range in areas where small outlying stands are currently found. Conversely, small outlying stands of mesic species may be particularly vulnerable because of the predicted loss of cool, moist habitats. Species will move at different rates, vegetation associations will change, and disturbance regimes will change – perhaps giving an edge to invasive species. Ecological interactions among species will be disrupted, with cascading effects. For example, migratory birds may return north only to find that the insects and plants upon which they depend are either too early or too late to provide the food sources needed during the breeding season (Root and Schneider 2006). In addition, warming and precipitation changes can add to and interact with factors such as nitrogen deposition and increased carbon dioxide concentrations (Henry *et al.* 2006, Zavaleta *et al.* 2003).

Current projections of sea level rise by 2100 are on the order of 4 - 5ft, which will inundate many areas of the current shoreline. Sea level rise will also erode coastal cliffs, and shift baylands further inland in areas where development does not prevent such movement.

## Network Design and Management Responses

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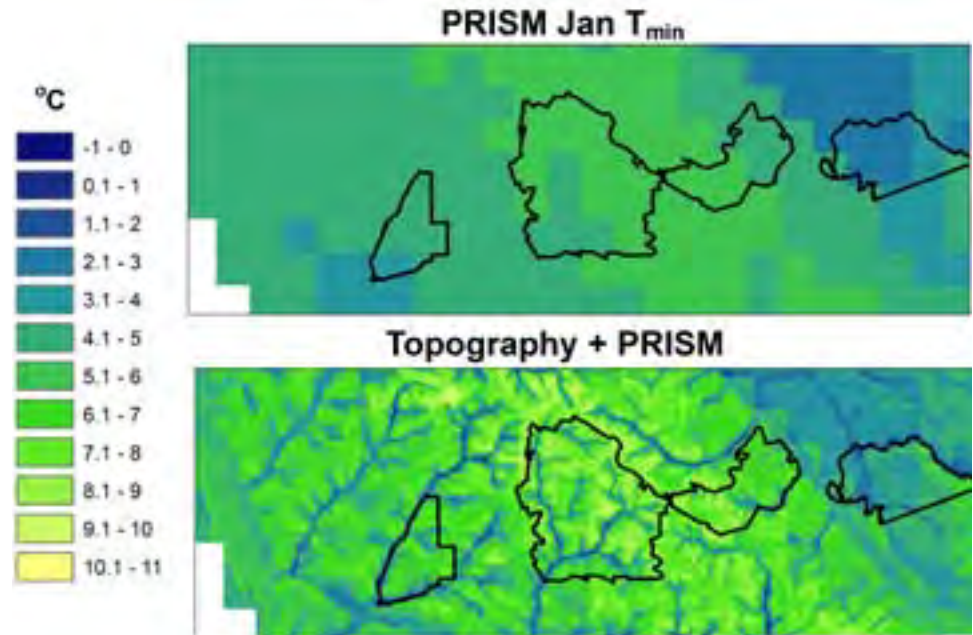
The rich climatic complexity at multiple scales in the Bay Area is largely captured in the CLN, and should provide ample opportunities for many species to track climate change on local and regional scales and maintain populations within landscape units. The coarse filter strategy of assigning vegetation Rarity Ranks and high conservation goals for each landscape unit captures full mesoclimatic gradients, as the rarer vegetation types often reflect local meso- and topoclimatic extremes. For example, in the Southern Mayacamas and Sonoma Mountain Landscape Units, small patches of redwood forest (which have high conservation goals) represent the cool, moist end of the climate gradient in the study area; conversely, small patches of Chamise Chaparral and Blue Oak Woodland within the Sonoma Coast Range Landscape Unit represent the warm, dry end of the climate gradient. Continuity across mesoclimatic and topoclimatic gradients is a natural consequence of large connected reserves. The 100ha scale of the Marxan analysis includes local topoclimatic diversity. At a local level, fine-scale analysis of mesoclimatic and topoclimatic diversity (similar to those shown in Figures 9.4 and 9.5) should become a standard assessment of a potential conservation acquisition or easement, to ensure that a range of temperatures is represented.



Lech Naumovich Photography

**Figure 9.5 ■ A Sample Topoclimatic Analysis.** This example shows a coastal-inland segment of the Santa Cruz Mountains, with four protected areas outlined. The upper map shows minimum January temperatures in °C (T<sub>min</sub>) at the 800m mesoclimatic scale (PRISM). Note that at this scale, each protected area has a range of only 1 - 2° C (2 - 4° F).

The lower map shows finer-scale (30m) topoclimatic patterns driven by cold-air drainage from ridges into canyon bottoms. The range within each protected area is much higher at 7 - 10° C (13 - 18° F), indicating higher climatic resiliency than is apparent at the 800m PRISM scale (Ackerly *et al.* 2010).



The network design also places a high priority on open land adjacent to baylands, to allow for landward movement of wetlands in the event of sea level rise. Most direct baylands-uplands connections are in the North Bay and Suisun Marsh, and are included in the Baylands Boundary Area for Further Consideration (Chapter 10). Here, as these areas are inundated, valuable coastal terraces, dunes, marshes, and stream mouths will erode and be forced inland.

Clearly, stewardship and management responses to climate change will become ever more important for long-term viability. Effective monitoring programs for climate-driven vegetation change are necessary to determine rates of change and develop appropriate management responses. Monitoring the spread of warm outliers and the decline or stagnation of cool outliers may provide early warning of widespread shifts. Change may be abrupt, and extreme events such drought, intense fire, insect outbreaks, and disease can drive the decline of existing vegetation. The single most important management response is to control invasive species during vegetation transitions.

For species that reach their climatic limits and become trapped, assisted migration may be the only option if climate has changed beyond local mesoclimatic and topoclimatic variability. Assisted migration is fraught with ecological and philosophical issues and should be viewed with caution and used selectively (McLachan *et al.* 2007). Successful relocations require deep knowledge of the ecology of species and the suitability of introduction sites.

## Policy and Institutional Responses

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Conservation institutions are starting to address the implications of climate change, and there are many incipient efforts from international to local levels. In California, incorporating climate change considerations into biodiversity planning is being promoted by the California Coastal Conservancy, Bay Conservation and Development Commission, and other government agencies. Nongovernmental organizations such as The Nature Conservancy and private foundations are funding assessments, but the disparate scientific approaches to the problems have yet to be synthesized.

The Ackerly Group effort is bringing together the scientific community to develop numerous climate change impact tools, including full climate space analyses, quantitative consideration of vegetation transition, and shifting hydrology. These results will build on the concepts here and are expected to become available by 2012.

While a discussion of policies to reduce greenhouse gas emissions is beyond the scale of Upland Habitat Goals Project, it is important to note that there is much uncertainty in predicting the magnitude of climate change. Additional global warming, on the order of 0.6° C, is certain based on historical emissions; the future trajectory beyond about year 2035 utterly depends on emissions levels. Without emissions reduction or mitigation, temperatures will continue to climb after 2100 and will push many systems well beyond any local buffering capacity.

## Monitoring

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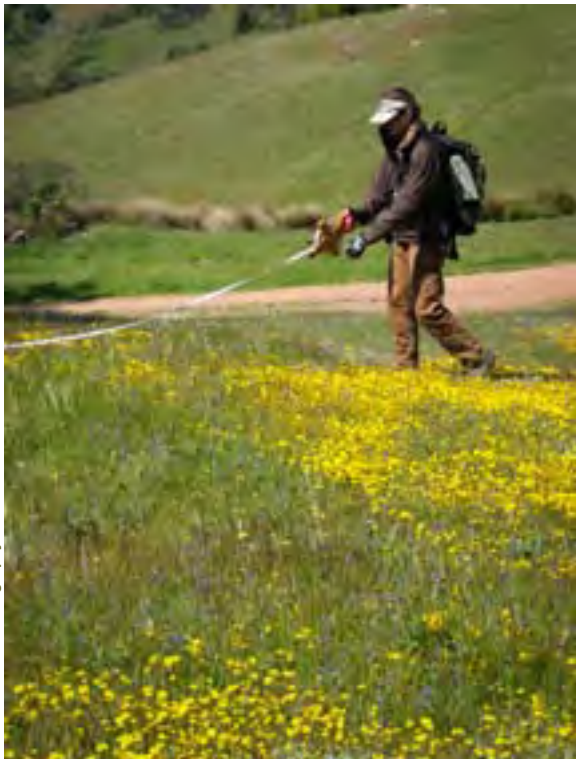
Effective climate change monitoring requires long-term collection and analysis of weather data. The Bay Area is rich with climate stations and stream gauges. Rapidly advancing technology will allow dense sensor networks to monitor fine-scale topoclimatic and microclimatic variation if there is funding to install such technology.

Monitoring biotic responses is also critical; these include changes in populations, species composition, and vegetation type. With these data, modeling exercises can be used to develop alternative hypotheses on the pace and direction of change. High-quality baseline data and repeated sampling are necessary to monitor changes (Elzinga *et al.* 1998).

Some ecosystems respond rapidly over the short term (*e.g.*, annual grasslands); others are much slower to change and may take decades, or even centuries to respond (*e.g.*, redwood forest).

Phenological monitoring is also a key element in monitoring climate change. The National Phenology Network ([www.usanpn.org](http://www.usanpn.org)) and the California Phenology Project ([www.usanpn.org/cpp](http://www.usanpn.org/cpp)) are developing programs that will coordinate data collected by citizens and professionals to monitor phenology of native species.

Newly-established programs addressing climate change impacts on biodiversity include the California Landscape Conservation Cooperative, the Bay Area Ecosystem Climate Change Consortium, and the North Bay Climate Adaptation Initiative.



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## Conclusions, Management Recommendations, and Research Needed

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1. Rapid climate change will likely rearrange habitats across the entire Bay Area and at multiple spatial scales. Although predictions vary, the most likely scenario is a substantial shift toward aridity in most areas. Changes in coastal fog patterns, however, remain uncertain.
2. Changes will be reflected in species' phenology, distribution, interactions, and assemblages. Changing disturbance regimes, especially fire and drought-related mortality, will be major drivers of shifts in vegetation.
3. The mesoclimatic and topoclimatic variability of the Bay Area will provide some buffering against climate change, and these factors are largely captured by the vegetation coarse filter in the Conservation Lands Network. The resilience of the CLN within each landscape unit is a function of the local variation in key climate factors, and can be mapped to predict the amount of local buffering available.
4. Monitoring of the physical climate, hydrology, and biotic responses are necessary to identify climate-driven range shifts. Better fine-scale networks of weather stations, fine-scale climate maps, hydrological modeling and measurement, and carefully designed monitoring of vegetation (especially at range limits) are among many activities that will clarify the impacts of climate change.
5. Numerous initiatives at national, state, and local levels are addressing climate change impacts, and the field is advancing rapidly.

## Additional Resources on Climate Change

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### Climate and weather

PRISM, 2009 - [www.prism.oregonstate.edu](http://www.prism.oregonstate.edu)

WestMap, 2009 - [www.cefa.dri.edu/Westmap/Westmap\\_home.php](http://www.cefa.dri.edu/Westmap/Westmap_home.php)

### Climate projections and monitoring

California Phenology Project - [www.usanpn.org/cpp](http://www.usanpn.org/cpp)

National Phenology Network - [www.usanpn.org](http://www.usanpn.org)

Cayan D, Luers AL, Hanemann M, Franco G, Croes B. 2005. Scenarios of Climate Change in California: An Overview. California Climate Change Center CEC-500-2005-186-SF.

### Biotic responses to climate change

California Landscape Conservation Cooperative - [www.californialcc.org](http://www.californialcc.org)

North Bay Climate Adaptation Initiative - [www.nbcai.com](http://www.nbcai.com)

Bay Area Ecosystems Climate Change Consortium - [www.baeccc.org](http://www.baeccc.org)

Henry HAL, Chiariello NR, Vitousek PM, Mooney HA, Field CB. 2006. "Interactive effects of fire, elevated carbon dioxide, nitrogen deposition, and precipitation on a California annual grassland." *Ecosystems* 9(7): 1066-1075.

Johnstone JA, Dawson TE. 2010. "Climatic context and ecological implications of summer fog decline in the coast redwood region." *Proceedings of the National Academy of Sciences*. 107(10): 4533-4538.

Loarie SR, Carter B, Knight CA, Hayhoe KA, Ackerly DD. 2008. "Climate change and the future of California's endemic flora." *PLoS ONE* 3(6):e2502.

Murphy DD, Weiss SB. 1992. "The effects of climate change on biological diversity in western North America: species losses and mechanisms." In Peters RL, Lovejoy TJ, editors. *Global Warming and Biological Diversity*. New Haven, CT: Yale University Press.

# Viability Summary 2

## Atmospheric Nitrogen Deposition

### Process

Exhaust from automobiles, trucks, and agricultural equipment, along with emissions from agricultural fields and animal operations, contain reactive nitrogen gases (nitrogen oxides and ammonia) that contribute to air pollution. The reactive nitrogen is blown downwind and deposited on the landscape, where it acts as a slow-release fertilizer.

Because most terrestrial ecosystems are nitrogen-limited, nitrogen deposition causes a profound and unprecedented biogeochemical disruption. Dry deposition, which in coastal California predominates over wet deposition (by rain, snow, and fog), is a process by which nitrogen-based pollutants are directly absorbed by plant leaves or adsorbed onto surfaces and eventually washed into the soil where it is taken up by roots and microbes. Where air pollution is elevated, increased nitrogen availability drives growth of non-native annual grasses and other weeds, which then crowd out native species (especially forbs), change fire cycles that drive broad-scale vegetation type conversion, and threaten many of the rarest ecosystems and taxa.

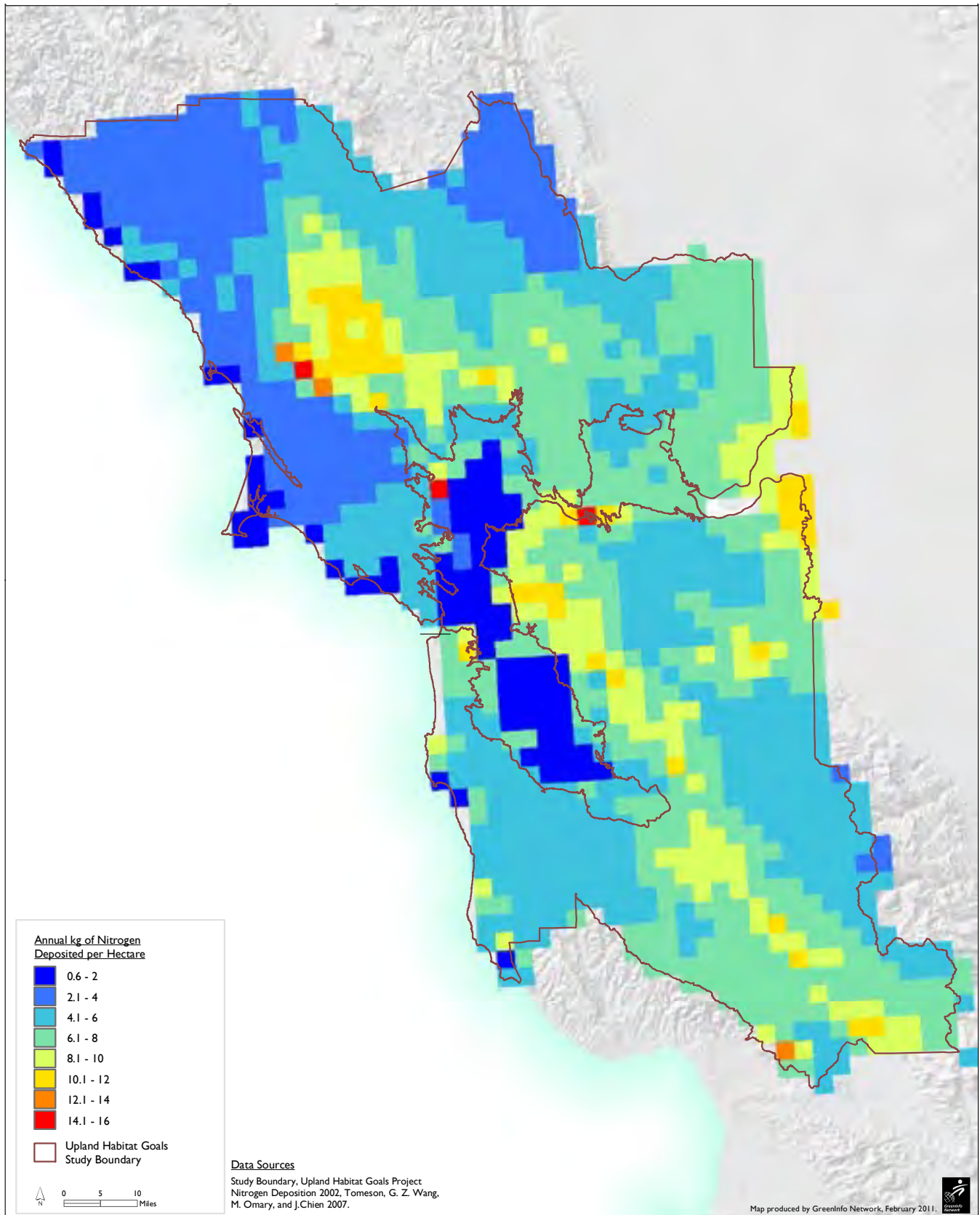
### Distribution

Using output from the Community Multiscale Air Quality (CMAQ) model (Figure 9.6), a state-of-the-art atmospheric physics and chemistry model, a map showing predicted nitrogen (N) deposition at a 4x4km scale was developed. The model predicts N-deposition loads in the Bay Area of up to 15kg-N/ha/year, primarily as dry deposition.



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**Figure 9.6 ■ Predicted Levels of Annual Nitrogen Deposition (CMAQ).** Major nitrogen deposition hotspots occur in southern Sonoma and Napa Counties, southern Santa Clara County, the East Bay Hills, and the Livermore Valley.



The patterns reflect urban and agricultural sources of nitrogen oxides and ammonia, prevailing meteorology, terrain, and complex atmospheric chemistry. Major hotspots include southern Sonoma and Napa Counties, the Santa Rosa Plain, southern Santa Clara County, the East Bay Hills, and Livermore Valley, with smaller hotspots scattered elsewhere. More localized hotspots are not represented on the map, but are found adjacent to heavily-used roads and concentrated animal agriculture.

## Ecological Impacts and Threats

In the Bay Area, serpentine grasslands, vernal pools, and other nutrient-poor ecosystems are highly vulnerable to N-deposition, which drives the invasion of non-native annual grasses and possibly other types of weeds. Increased grass growth in all grassland vegetation types, woodland understories, and open shrublands can lead to thatch accumulation, which suppresses new growth resulting in the loss of native species productivity and diversity. Higher fuel loads also increase fire severity and frequency.

Closed-canopy systems appear less sensitive to nitrogen deposition, but all ecosystems are affected to some degree. Long-term exposure to nitrogen deposition can lead to nitrogen saturation and subsequent leaching of nitrate into streams and groundwater, increased trace gas emissions, and nutrient imbalances contributing to long-term vegetation decline. Using current literature (Fenn *et al.* 2003, Fenn *et al.* 2010) and local expert opinion, the vegetation types were classified according to their sensitivity to nitrogen deposition (Figure 9.7). Far more research is needed to assess the impacts of nitrogen deposition on specific ecosystems.

Critical loads for nitrogen are being defined for some California ecosystems (Fenn *et al.* 2010). A critical load of any pollutant is defined by Nilsson and Grennfelt 1988 as:

*A quantitative estimate of an exposure to one or more pollutants below which significant harmful effects on specified sensitive elements of the environment do not occur according to present knowledge.*

**Figure 9.7 ■ Relative Sensitivity of Upland Habitat Goals Vegetation Types to Nitrogen Deposition.**

Highly sensitive	Moderately sensitive	Less sensitive
Barren / Rock	Coastal Brackish / Salt Marsh	Bishop Pine Forest
Black Oak Forest / Woodland	Coastal Scrub	California Bay Forest
Blue Oak / Foothill Pine Woodland	Coulter Pine Forest	Canyon Live Oak Forest
Blue Oak Forest / Woodland	Juniper Woodland and Scrub / Cismontane Juniper Woodland	Central Coast Riparian Forests
Coast Live Oak Forest / Woodland	Knobcone Pine Forest	Chamise Chaparral
Coastal Terrace Prairie	McNab Cypress	Douglas-Fir Forest
Cool Grasslands	Permanent Freshwater Marsh	Grand Fir
Dune	Sargent Cypress Forest / Woodland	Mixed Chaparral
Hot Grasslands	Serpentine Conifer	Mixed Conifer / Pine
Interior Live Oak Forest / Woodland	Serpentine Hardwoods	Mixed Montane Chaparral
Moderate Grasslands	Serpentine Knobcone	Montane Hardwoods
Native Grassland	Serpentine Leather – Oak Chaparral	Monterey Cypress Forest
Oregon Oak Woodland	Serpentine Riparian	Monterey Pine Forest
Semi-Desert Scrub / Desert Scrub	Serpentine Scrub	Ponderosa Pine Forest
Serpentine Barren	Wet Meadows	Pygmy Cypress Forest
Serpentine Grassland		Redwood Forest
Valley Oak Forest / Woodland		Sycamore Alluvial Woodland
Vernal Pools		Tanoak Forest
Warm Grasslands		

For example, the critical load for serpentine grassland and other nutrient-poor grasslands is approximately 6kg-N/ha/year, and for canopy lichens found in numerous forest types, the critical load is even lower at 3kg-N/ha/year. These thresholds can be used as an initial screening for potential impacts from nitrogen deposition.

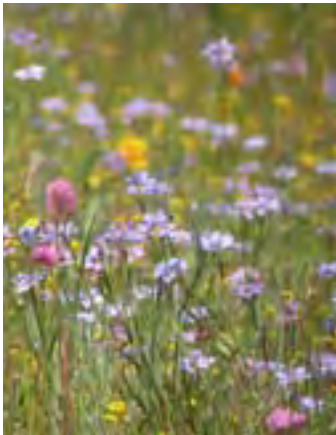
The exposure levels of rare, threatened, and endangered plants to N-deposition were calculated utilizing an overlay of CNDDDB records onto the CMAQ map. An analysis of 173 CNDDDB taxa, ordered by increasing exposure to N-deposition, reveals that the majority of taxa (109 out of 173) have mean exposure levels of more than 5kg-N/ha/year. Many of these taxa are in sensitive habitats such as serpentine grasslands, annual grasslands (which include many native species), and vernal pools; many are small-statured annuals that are vulnerable to overgrowth by annual grass. In addition, increased grass growth around vernal pools leads to shortened hydroperiods, putting animal species such as California Tiger Salamander at risk. While this initial analysis makes clear that the problem is widespread and serious and that a number of taxa may require management to mitigate these effects, it is also clear that much more research is needed to define the risks posed to individual taxa. For details of this analysis, see [www.BayAreaLands.org/gis/tables.php](http://www.BayAreaLands.org/gis/tables.php).

Other air pollutants also can affect ecosystems. Ozone, in particular, can suppress primary productivity and weaken trees, and effects are widespread in Southern California and the Sierra Nevada (Bytnerowicz *et al.* 2003). In the Bay Area, ozone levels are relatively modest (by California standards). Little is known about ozone impacts on vegetation in the Bay Area. Ponderosa pine is an ozone-sensitive species, and the isolated stands in the Mt. Hamilton Range downwind of Silicon Valley may be impacted to some degree, but more research is needed.

## Network Design and Management Responses

Sensitive vegetation types with numerous rare species, such as serpentine grasslands and vernal pools, have high conservation goals in all landscape units, so are well represented across the nitrogen deposition exposure gradient in the Conservation Lands Network. More common but still sensitive vegetation types are also well represented across the range, meaning that clean air areas are captured to the degree possible, given the widespread air pollution in the Bay Area.

For lands included in the CLN, diligent stewardship is essential. Management prescriptions must be site-specific, long-term, and based on solid science and monitoring. For large areas, the best control of invasive annual grasses is well-managed moderate cattle grazing. Cattle selectively eat the nitrogen-rich annual grasses and provide openings for native wildflower species (Figure 9.8). Fire can have positive effects over the short-term (1 - 2 years) and is most effective in late spring before grass seed drops. Mid- to late spring mowing and other mechanical treatments can be applied over small areas.



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**Figure 9.8 ■ Effects of Grazing on Nitrogen-Enhanced Grasslands.** In this serpentine grassland, N-deposition is approximately 15 - 20kg-N/ha/year. On the left side of the fence, there was no grazing and non-native grasses dominate; on the grazed grassland to the right of the fence, native forbs dominate.



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## Policy and Institutional Responses

The ultimate solution to this environmental threat requires regulation to effect large reductions in emissions of nitrogen oxides and ammonia. At a national level, federal agencies are defining critical loads as a first step in future air quality regulations, but adoption will be – at best – several years in the future. Even if policies to control nitrogen emissions are enacted, resulting reductions will take years, even decades, and habitat management will still be required.

In Santa Clara County, mitigation for nitrogen impacts of three power plant projects on serpentine grasslands began in 1999, and was extended to impacts of highway improvement (Mayall 2008). At present, 800ac of serpentine grassland have been set aside as mitigation, with management endowments for monitoring, grazing management, and weed control. The Santa Clara Valley Habitat Conservation Plan, which grew out of these individual projects, provides a model for addressing regional-scale impacts of N-deposition.

The ranching community plays a huge role in maintaining grasslands and woodlands, specifically through reducing annual grass accumulation and weed management. Weed Management Areas, local collaborative groups run through county agriculture departments, play an important role across the region in addressing weed invasions. Funding mechanisms for weed management via mitigation fees for increased N-deposition from road projects and other developments have been suggested (Weiss 2006).

## Monitoring

At many sites around the region, the Bay Area Air Quality Management District monitors air quality, including nitrogen oxides (NO<sub>x</sub> and particulate nitrate and ammonium) (CARB 2009). Ammonia (NH<sub>3</sub>) is not regularly monitored, but there is evidence that ammonia emissions from vehicles are declining (Kean *et al.* 2009). Nitrogen oxides trends have been downward, reflecting decades of pollution control efforts at the state and national levels (CARB 2009).

The effects of nitrogen deposition on ecosystems are not regularly monitored except in serpentine grasslands in Santa Clara County, where grassland composition plots across different management regimes are sampled annually for a series of mitigation projects. Monitoring the effects of nitrogen deposition is complex, because the impacts are so dependent on management and establishment of baseline or clean-air controls for comparison is difficult.

## Conclusions, Management Recommendations, and Research Needed

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1. Nitrogen deposition is a major threat to biodiversity across much of the Bay Area. The major effect of nitrogen deposition is increased growth of non-native annual grasses and other nutrient-demanding weeds that outcompete native species.
2. More detailed study of the effects of nitrogen deposition on individual taxa and ecosystems is needed.
3. Nitrogen deposition levels will drive stewardship needs for many ecosystems and species.
4. Well-managed grazing is the most effective means for controlling non-native annual grasses over large areas. Smaller areas can be treated by prescribed fire and mowing.
5. Policies and institutions are being developed locally, and provide models for mitigation and management.

## Additional Resources on Atmospheric Nitrogen Deposition

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California Air Resources Board (CARB). 2009. The California Almanac of Emissions and Air Quality. [www.arb.ca.gov/aqd/almanac/almanac09/almanac09.htm](http://www.arb.ca.gov/aqd/almanac/almanac09/almanac09.htm)

Conservation Lands Network Explorer – The Biodiversity Portfolio Report created by CLN Explorer for a user-designated area or property provides data on nitrogen deposition levels.

*Santa Clara County Habitat Conservation Plan* – [www.scv-habitatplan.org](http://www.scv-habitatplan.org)

Tonnesen GZ, Wang MO, Chien CJ. 2007. *Assessment of Nitrogen Deposition: Modeling and Habitat Assessment*. California Energy Commission, PIER Energy-Related Environmental Research. CEC-500-2005-032.

Weiss SB. 2006. *Impacts of Nitrogen Deposition on California Ecosystems and Biodiversity*. California Energy Commission, PIER Energy-Related Environmental Research. CEC-500-2005-165.

Weiss SB. 1999. “Cars, Cows, and Checkerspot Butterflies: Nitrogen Deposition and Management of Nutrient-Poor Grasslands for a Threatened Species.” *Conservation Biology* 13(6): 1476–1486.

# Viability Summary 3

## Fire

### Process

Fire is a natural and essential process that maintains the structure, function, and diversity of many California ecosystems, but in some ecosystems, it can be very destructive. The long, dry summers of the Bay Area's Mediterranean climate create flammable landscapes in which wildland fires are inevitable. In addition, increased annual grasses from nitrogen deposition build up fine fuel loads, significantly increasing fire extent and intensity in more arid areas (Fenn *et al.* 2003). As climate change increases the intensity of our dry seasons, fire is anticipated to become an even more transformative process. Increased fire frequency will likely bring more conversion of forests and woodlands to shrublands (Barbour *et al.* 2007, Sawyer *et al.* 2009).

Wildland fire management is complex, expensive, and dangerous. The stewardship challenge is balancing ecological benefits with public safety and expense to find the proper place for fire as a management tool in the Conservation Lands Network.

### Distribution

Because lightning is relatively rare in the Bay Area, the natural fire interval is measured in decades or centuries. The vast majority of fires are caused – either intentionally or unintentionally – by people.

Indigenous people used fire extensively to manage food resources, and imposed a high-frequency, low-intensity fire regime over a significant portion of the landscape (Anderson 2005). Extreme conditions may have allowed these to develop into large intense fires. Post-European fire regimes have been dominated by accidental fires, with numerous fires in the late 19th century from logging. In the past century, rapid fire suppression has reduced the extent of fires, but has led to fuel accumulation and some ecosystem degradation.

Of the 409 contemporary fires recorded by CAL FIRE (the California Department of Forestry and Fire Protection), only eight were caused by lightning. The vast majority of fires were from unknown (but human) causes; identifiable causes are primarily accidents and arson (Figure 9.9).



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**Figure 9.9 ■ Ignition Sources for Bay Area Fires Between 1950 and 2005 (CAL FIRE).**

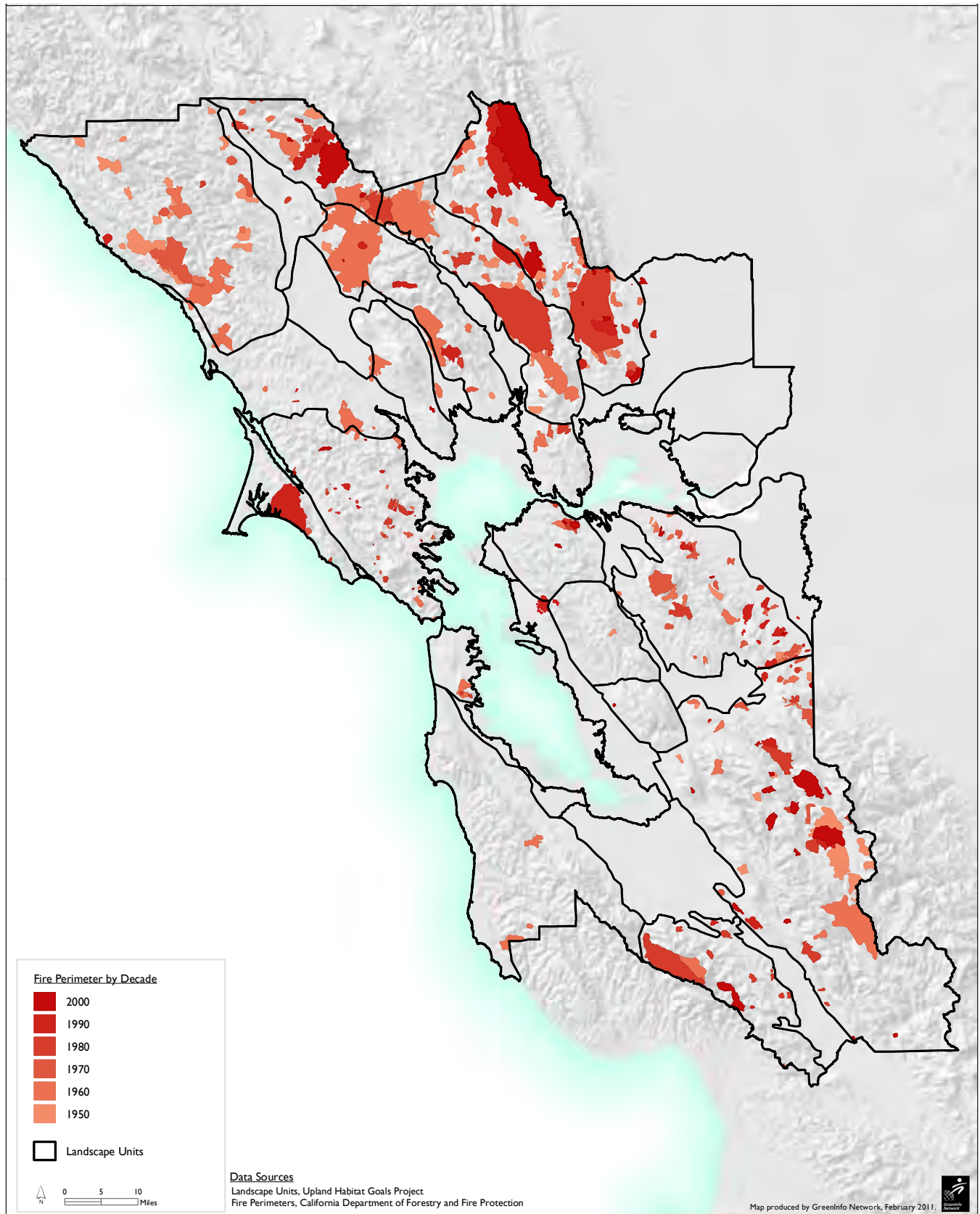
Cause	Occurrences
Unknown / unidentified	318
Equipment	28
Arson	19
Powerline	13
Lightning	8
Miscellaneous	8
Vehicle	6
Debris	4
Playing with fire	3
Campfire	1
Smoking	1
Aircraft	0
Escaped prescribed burn	0
Firefighter training	0
Illegal immigrant campfire	0
Non-firefighter training	0

In the Bay Area, the total acreage burned (fire perimeter) from 1950 to 2009 encompasses approximately 650,000ac (Figure 9.10).



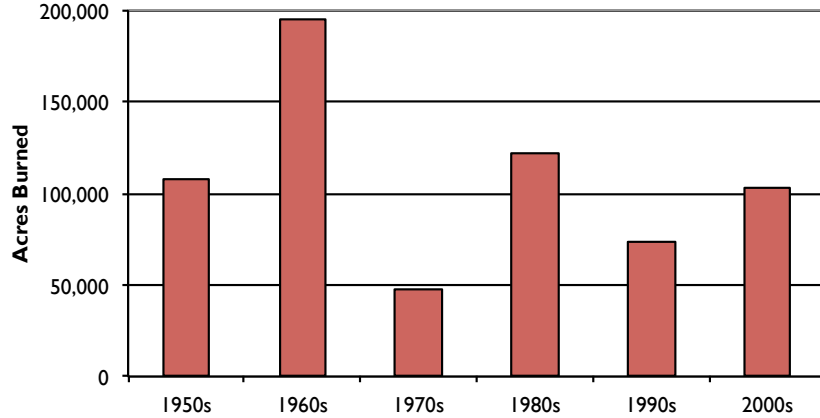
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**Figure 9.10 ■ Fire Perimeters from All Causes between 1950 - 2009 (CAL FIRE).** Approximately 650,000 acres were burned during this 59-year period.

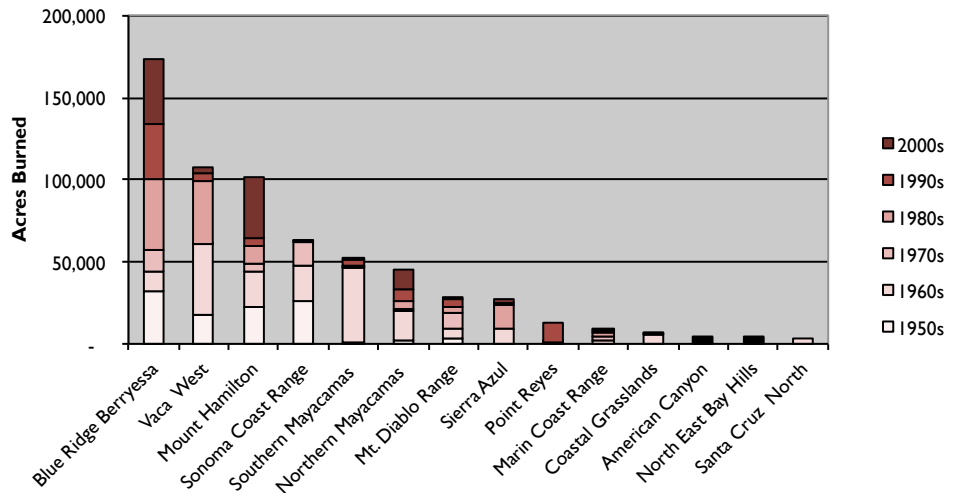


The total area burned by decade ranges from 200,000ac in the 1960s to 50,000ac in the 1970s, but as Figure 9.11 illustrates, there is no obvious trend. During this period, more than half of the acreage burned was in three eastern landscape units: Blue Ridge Berryessa (173,000ac), Vaca West (104,000ac), and Mount Hamilton (100,000ac) (Figure 9.12).

**Figure 9.11 ■ Total Acres Burned by Decade in the Bay Area from All Causes.**

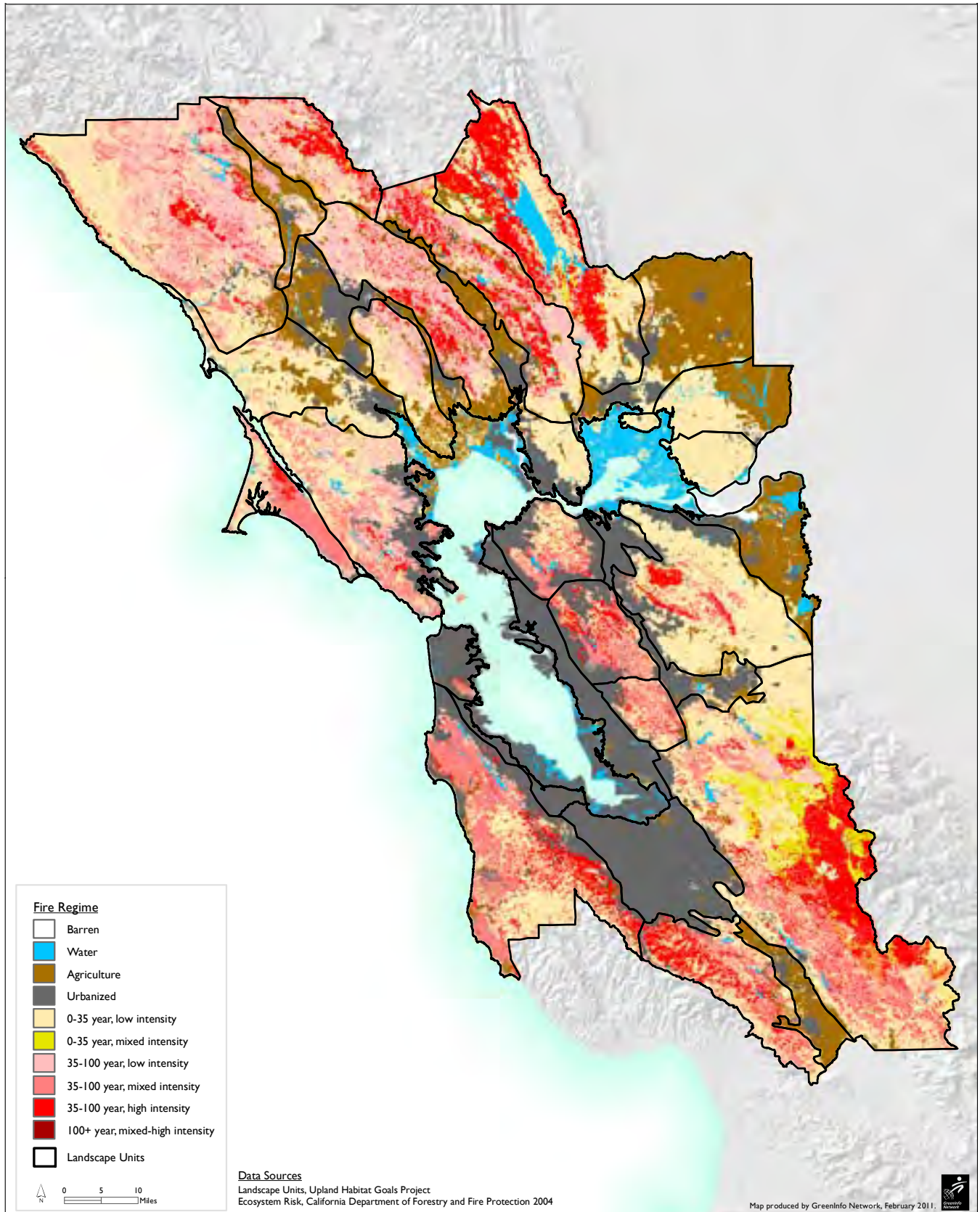


**Figure 9.12 ■ Acreage Burned by Decade by Landscape Unit.** Three of the eastern landscape units – Blue Ridge Berryessa, Vaca West, and Mount Hamilton – had the highest acreages burned.



Geographic trends can also be seen on the CAL FIRE map of fire regimes (Figure 9.13), which shows fire return intervals and intensity classes (low, mixed, and high). The 35 - 100yr high-intensity areas are the extensive stands of chaparral in the interior mountain ranges and on the eastern slopes of the Santa Cruz Mountains, as well as closed-cone forests of Bishop pine (Point Reyes and Sonoma Coast Range Landscape Units) and Sargent and McNab Cypress found in interior serpentine areas. Most of the forests and woodlands in the coastal mountains are in the 35 - 100yr low- and mixed-intensity categories. Most grasslands are in the 0 - 35yr low-intensity regime.

**Figure 9.13 ■ CAL FIRE Fire Regimes.** Fire regimes – fire return intervals and intensity – throughout the state were calculated by CAL FIRE. The extensive stands of chaparral in the interior mountain ranges and on the eastern slopes of the Santa Cruz Mountains, closed-cone forests of Bishop pine (Point Reyes and Sonoma Coast Range Landscape Units) and interior serpentine species of Sargent and McNab Cypress are characterized by the highest fire intensity.



## Ecological Impacts and Threats

Fire consumes above-ground biomass and can kill individuals of many species outright. High-frequency fires can eliminate shrubs and trees, converting habitats to non-native grasslands. High-intensity fires can sterilize soils and lead to hydrophobic soil surfaces that lead to debris flows, landslides, and stream sedimentation.

Conversely, some vegetation types thrive – even require – fire. Many fire-adapted species stump-sprout (e.g., chamise and some manzanitas), and others seed profusely (e.g. knobcone pine, Bishop pine, and many *Ceanothus* species), and may even require fire for seed germination. A whole set of “fire-following” annual forbs (see Table 13.5 in Keely and Davis 2007) occur in abundance only immediately after a chaparral fire.

On the other hand, in many vegetation types, a lack of fire can lead to ecosystem conversion. Without fire, cool and moderate grasslands can be rapidly converted to stands of coyote brush after one or two wet winters, and Douglas-fir can invade grasslands on the immediate coast. The lack of understory burns in oak woodlands, oak forests, and montane hardwoods leads to invasion of Douglas-fir, which can eventually dominate the forest.

Ecosystem risks from altered fire regimes are mapped by CAL FIRE (Figure 9.14). Ecosystem risk is defined as a deviation from historical fire regimes, where the new regime has significant ecological impacts, such as altered successional pathways, reductions in disturbance frequency, and excessive fuel build-up. The high-risk areas (red) are primarily in the coastal mountains, but also scattered in some interior ranges, and include forest and woodland types that have been affected by lack of fire and may be undergoing structural changes and eventual vegetation type conversion. Low-risk areas (green) include redwood forests, grasslands, and open oak woodlands and shrublands.

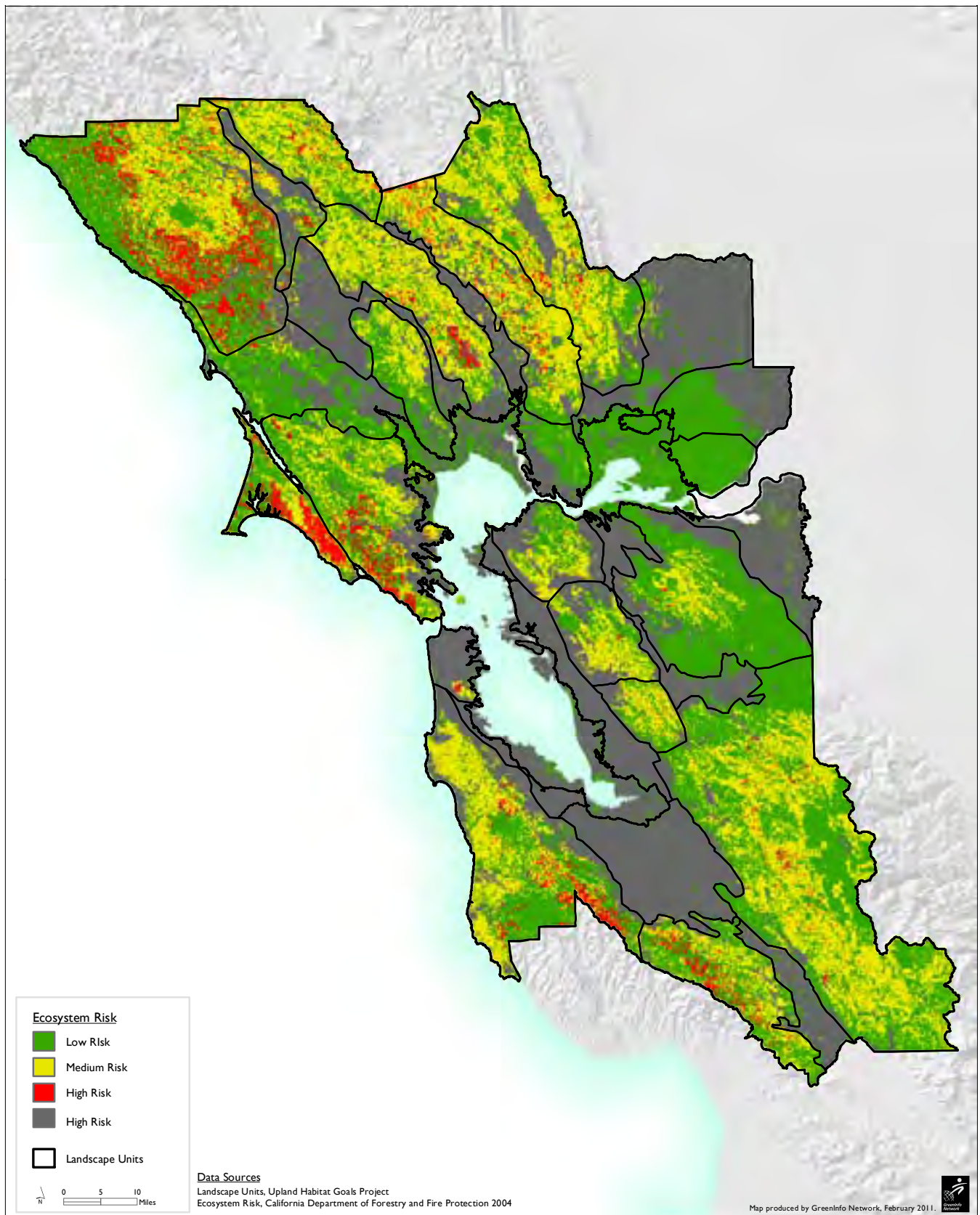
The ecological importance of fire varies by vegetation type (Figure 9.15). The ecological effects in vegetation types with numerous fire-adapted species (including chaparral and closed-cone conifer types) are high because lack of fire can lead to lack of reproduction and vegetation type change. Moderate and Cool Grasslands are also considered to have high ecological effects from the lack of fire, because fire may be required to arrest brush and tree invasions. In most other Bay Area vegetation types, fire has a medium effect; it is not required for reproduction and can pose a threat to some biotic elements, but effects are varied and need to be considered on a case-by-case basis. Detailed responses of various vegetation types to fire can be found in Barbour *et al.* 2007 and Sawyer *et al.* 2009.



Bob Gunderson / www.flickr.com/photos/bobgunderson



**Figure 9.14 ■ Ecosystem Risk from Altered Fire Regimes (CAL FIRE).** CAL FIRE defines ecosystem risk as a deviation from historical fire regimes, where the new regime has significant ecological impacts.



**Figure 9.15 ■ Ecological Effects of Fire for Different Vegetation Types.** Vegetation types that require fire for reproduction or to slow succession are considered to have high ecological effects when fire is suppressed.

<b>High Ecological Effect</b> Fire is essential for maintenance of vegetation	<b>Medium Ecological Effect</b> Fire is important to structure of vegetation	<b>Low Ecological Effect</b> Fire is not a factor
Bishop Pine Forest	Black Oak Forest / Woodland	Barren / Rock
Chamise Chaparral	Blue Oak / Foothill Pine Woodland	Coastal Salt / Brackish
Coastal Scrub	Blue Oak Forest / Woodland	Dune
Cool Grasslands	California Bay Forest	Permanent Freshwater Marsh
Knobcone Pine Forest	Canyon Live Oak Forest	Serpentine Barren
McNab Cypress	Central Coast Riparian Forests	Wet Meadows
Mixed Chaparral	Coast Live Oak Forest / Woodland	
Mixed Montane Chaparral	Coastal Terrace Prairie	
Moderate Grasslands	Coulter Pine Forest	
Monterey Pine Forest	Douglas-Fir Forest	
Sargent Cypress	Grand Fir	
Serpentine Knobcone	Hot Grasslands	
	Interior Live Oak Forest / Woodland	
	Juniper Woodland and Scrub	
	Mixed Conifer / Pine	
	Montane Hardwoods	
	Monterey Cypress Forest	
	Native Grassland	
	Oregon Oak Woodland	
	Ponderosa Pine Forest	
	Pygmy Cypress	
	Redwood Forest	
	Semi-Desert Scrub / Desert Scrub	
	Serpentine Conifer	
	Serpentine Grassland	
	Serpentine Hardwoods	
	Serpentine Leather / Oak Chaparral	
	Serpentine Riparian	
	Serpentine Scrub	
	Sycamore Alluvial Woodland	
	Tanoak Forest	
	Valley Oak Forest / Woodland	
	Warm Grasslands	

## Network Design and Management Responses

The Conservation Lands Network includes areas adjacent to and intermingled with suburban and exurban development, as well as large contiguous tracts in remote areas. The approach to fire management in a given area depends on the ecosystem type, as well as on adjacent land uses and human occupancy.

Residential development in heavily vegetated areas has created dangerous urban-wildland interfaces where rapid fire suppression is necessary to protect human life and property. Most of these areas are encompassed by the Urban and Rural Residential land cover types, and are explicitly excluded from the CLN, except for localized targets such as riparian zones and some fine filter targets. Maintenance of defensible space around structures and removal of underbrush can be done in ways that support functional wildlife habitat. Well-designed fuel breaks near populated areas are an important component of fire management, but must be implemented in a way that minimizes invasive weeds and erosion. However, under extreme circumstances, even fuel breaks will not be sufficient; wind-blown embers from the 1991 Oakland Hills fire jumped eight lanes of Highway 24.

In the extensive backcountry of the larger mountain ranges, large natural and accidental wildfires will occur, and fire management options range from rapid suppression to management for resource benefits. In 2007, a large accidental fire (approximately 50,000ac) in Henry Coe State Park produced a mosaic of differing burn intensities and many desirable ecosystem effects. A variety of different burn ages in rugged terrain provides varied fuel/moisture combinations that can reduce fire spread under normal weather conditions. Under extreme conditions, dry winds will drive fires regardless of fuel conditions and most fire-fighting efforts.

Fire is also a powerful management tool that can be used for weed control and other purposes; this requires an understanding of the ecological effects of fire. These effects are in large part determined by the season in which the fire occurs. For example, wet season prescribed burns can short-circuit post-fire succession by steaming seedbanks and reducing recruitment. Alternatively, high-intensity fires during the peak of the dry season can sterilize the soil as well as threaten lives and property. For this reason, prescribed fires are generally restricted to early summer or early autumn.



Stuart B. Weiss



Appropriately-timed prescribed fires in grasslands are important for weed control, thatch reduction, and control of brush invasion. In these ecosystems, late spring and early summer burns will catch most grass seeds on plants before they have shattered and fallen to the ground; shrub seedlings are also most vulnerable at this time. Burn timing is especially important for yellow starthistle, which is vulnerable in early summer; late summer and autumn burns actually increase densities of this widespread weed and its relatives (Bossard *et al.* 2000).

Well-conceived prescribed fire programs are an important component of long-term land stewardship, but systematic use of fire as a management tool is difficult. In many jurisdictions, air quality, safety concerns, and institutional issues limit the regular use of prescribed fires. In relatively safe vegetation types, prescribed burns coordinated across jurisdictions could be a useful stewardship tool. Large tracts of contiguous conserved lands away from development provide opportunities for prescribed fire.

## Policy and Institutional Responses

Fire suppression will always be necessary to protect lives and property in populated areas. Appropriate fire-fighting methods can minimize long-term damage; bulldozer scars, in particular, should be avoided in sensitive habitats and steep terrain. Best management practices (BMPs) for post-fire rehabilitation should include guidelines for erosion control that encourages native plants, instead of ryegrass and other non-native cover crops. Robichaud *et al.* 2000 offers a review of post-fire BMPs.

Good examples of fire management planning can be found on the East Bay Regional Park District and the National Park Service websites (see links under *Additional Resources*). Both agencies focus on the urban-wildland interface with numerous projects designed to reduce fire risk.

## Monitoring

Ecological monitoring of post-fire vegetation and wildlife recovery is essential for understanding the positive and negative impacts of both accidental and prescribed fire. Monitoring of erosion risk is particularly important for downstream aquatic systems. Monitoring plans should have high scientific standards for sampling design and data collection (Robichaud *et al.* 2000). The National Park Service Fire Monitoring Handbook (USDI National Park Service 2003) describes protocols that can serve as a benchmark for standardized data collection and multi-level monitoring, including procedures and recommended frequencies for monitoring and analysis.

## Conclusions, Management Recommendations, and Research Needed

1. Fire is an integral part of our landscape, but is also a threat to life and property. Today, most fires in the Bay Area are caused by humans (according to CAL FIRE).
2. Many vegetation types are dependent on appropriate fire regimes.
3. Fire frequency and intensity are likely to increase with climate change.
4. The appropriate balance between fire suppression and ecological needs should be determined on a site-by-site basis.
5. Prescribed fire is an important management tool, especially for weed control in grasslands; proper institutional and policy structures are needed for regular use.
6. Rigorous monitoring of post-fire effects is important for stewardship programs and adaptive management.
7. Future research should focus on understanding changes in fire regimes under

climate change, impacts of firebreaks and other treatments on biodiversity in the urban-wildland interface, consequences of wet season burns on scrub communities, consequences of loss of low-intensity burns in woodland and forest understories, and reducing institutional barriers to implementation of prescribed fire.

## **Additional Resources on Fire**

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East Bay Regional Park District Fire Management Planning –  
[www.ebparks.org/about/fire/mgmt](http://www.ebparks.org/about/fire/mgmt)

National Park Service Fire Management Planning –  
[www.nps.gov/goga/parkmgmt/firemanagement.htm](http://www.nps.gov/goga/parkmgmt/firemanagement.htm)

*US National Park Service Fire Monitoring Handbook* – [www.nps.gov/fire](http://www.nps.gov/fire)

# Viability Summary 4

## Ecological Succession

### Process

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Ecological succession is the long-term process in which plant species replace others in a vegetative community over time, changing both vegetation composition and structure. Vegetation types are dynamic; competition and disturbance cause continual changes in vegetation types and dominant species. The pace of succession can be rapid – open grassland can become a solid stand of coyote brush within five years; live oak seedlings can create dense thickets within 15 - 20 years. The full dynamic range of ecological succession plays out over decades and even centuries.

New species – and thus succession – can be introduced via interfaces between different vegetation types. Other introductions can result from dispersal that allows plant species to become established far from seed sources thanks to transportation by animals (e.g. oaks) or wind (e.g. coyote brush). Climate change, nitrogen deposition, weed invasions, disease, and other site conditions can all alter natural successional pathways.

Some successional series produce simplified vegetation structure; for example, the steady loss of oaks in woodlands over time leads to conversion to annual grassland. More typically, however, ecological succession is accompanied by higher biomass and greater complexity, exemplified by the grassland-shrubland-woodland-forest transition. The dominant climax species – present in the final stages of succession – and maximum biomass at a site is ultimately determined by water balance and soil fertility.

### Distribution

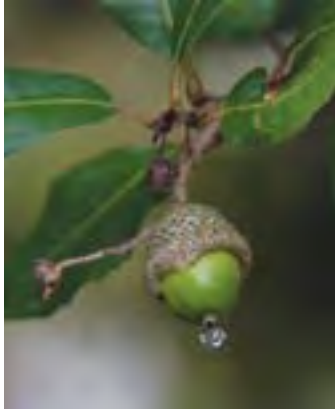
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Natural and anthropogenic disturbances have shaped the Bay Area landscape and distribution of vegetation for thousands of years. Extensive burning and localized digging by California Native Americans (Anderson 2005) was followed by timber harvesting, fires, grazing, land clearing, plowing, and urbanization after the arrival of Europeans. These activities have left a mosaic of different-aged stands of vegetation interspersed with permanently disturbed urban and agricultural land.

Extensive reviews for succession in many vegetation types can be found in Barbour *et al.* 2007 and Sawyer *et al.* 2009. Some key successional dynamics of concern to the Conservation Lands Network include:

1. In the absence of grazing and/or fire, open grasslands convert to shrublands, especially dense coyote brush. This process occurs throughout the coastal belt (including the Berkeley Hills) and has led to the loss of rich coastal prairies represented by Cool and Moderate Grasslands. Coyote brush can die back in some areas, allowing the return of open grassland, but most of the succession is unidirectional.
2. Open grasslands convert to conifer forest, especially Douglas-fir and pines. This process is most frequent in the coastal zone, but can occur in grasslands near Douglas-fir stands in inland locations.
3. Shrublands convert to woodland and forest as trees overtop the shrubs. For example, manzanita stands on Mt. Tamalpais are gradually converting to Douglas-fir forest.
4. Oak woodland and montane hardwoods are invaded by Douglas-fir, and is occurring in many coastal areas. In Sonoma County, Pepperwood Preserve and Annadel State Park are both experiencing a conversion to Douglas-fir forests.
5. Open oak woodlands become denser and convert to closed canopy woodlands, resulting in the loss of understory grassland.

Stephen Rosenthal



6. Many oak woodlands and montane hardwood forest will eventually be dominated by bay laurel as a natural process of succession. Sudden Oak Death can accelerate this transition because bay trees harbor the pathogen that kills live oaks and tanoaks.
7. The senescence of mature oaks and the lack of recruitment leads to the conversion of oak woodlands to open grassland.

## Ecological Impacts and Threats

Succession is neither good nor bad; its ecological impact depends on context and the resources at risk. Succession eventually leads to local losses and even severe reductions of some species, and can affect the composition of entire landscapes. For example, succession of coastal grasslands into native shrubs and trees is a natural process, but if the grassland supports endangered species or a particularly rich native flora, it may compromise biodiversity conservation goals.

In the Bay Area, where many rare species are grassland obligates, the loss of open grassland habitats and associated species can have significant impacts on biodiversity. Native brush succession on San Bruno Mountain, for example, has emerged as a major threat

to the rich coastal grasslands and associated endangered species (TRA Environmental Sciences 2007).

The invasion of oak woodlands by Douglas-fir creates dense thickets of Douglas-fir that crowd the forest floor, eventually over-topping the oaks, leading to losses of oaks and understory shrubs and herbs. After several decades of dense canopy closure, natural mortality thins out the Douglas-fir trees, letting more light reach the forest floor and creating a complex multi-story forest.

The biomass accumulation that typically accompanies ecological succession can lead to increased fire risks – a serious problem at the urban-wildland interface where shrub cover can increase potential fire intensity and spread rates.



Stuart B. Weiss

## Network Design and Management Responses

Many successional changes are inevitable, and it is not possible or desirable to manage succession across the entire Conservation Lands Network. Selected stewardship actions are necessary to maintain biodiversity in a dynamic landscape.

Successional vegetation transitions require careful consideration in conservation planning. In the design phase, the Upland Habitat Goals Project strategy of capturing large areas of extant vegetation provides some buffer against short-term change.

On existing or potential conservation lands, local land managers should inventory key resources likely to be affected by succession. The basic questions to ask include:

1. Is there on-the-ground evidence of incipient or ongoing succession?
2. What might this landscape look like in 10, 20, or 30+ years if these trends continue with no intervention?

3. Can rates of succession be inferred from historical data such as aerial photographs and surveys such as the Wieslander maps?
4. Can feasible management actions help achieve conservation goals?

Managing succession requires clear local goals for maintenance of vegetation types, combined with adequate resources to implement management actions such as grazing, mechanical removal, chemical application, or prescribed burning. Management actions need to be carefully planned and documented in an adaptive management process, so that effectiveness can be evaluated and appropriate adjustments made through time.

Early treatment of invasive species (native and non-native) is essential to maintain open early successional habitats. Once certain shrubs (e.g., coyote brush) become established in grasslands, they may prove difficult to remove because of resprouting. In the case of Douglas-fir invasion of oak woodlands, treatment of trees is best done in the sapling or pole stage – the larger the trees to be removed, the more expensive and disruptive the management treatments. For more information on non-native invasives, see the Invasive Plants Viability Summary.

Oak recruitment need occur only intermittently to sustain populations, and individual trees can live for a century or more. In some cases, small established oaks may get browsed down each year; protection from browsing will allow them to grow to a larger, less-vulnerable size. Loss of oaks can be mitigated by planting, as well as by management to encourage local recruitment.

## Policy and Institutional Responses

Recognition of the dynamic nature of vegetation is central to developing policies for succession management. On many conservation lands, a hands-off approach is the default policy because of assumptions about what is natural and a lack of stewardship resources. In extensive wildlands, doing nothing may be appropriate. In some areas, natural fires may provide the successional mosaic desired for biodiversity. However, over time, such hands-off approaches may lead to undesirable outcomes, especially where locally-rare



Lech Naumovich Photography



conservation targets are at risk or where fire is not an option. In smaller habitats or urban settings, policies that support management practices such as grazing, mowing, or planting can be essential for biodiversity conservation.

Education of both the land management community and the general public can improve support for hands-on management of natural lands; in addition, funding for ongoing stewardship is critical. Policies regarding the use of fire and other treatments for succession management can be unwieldy and delay, stop, or increase costs of management. Streamlining the environmental review process and developing programmatic Environmental Impact Reports can reduce these barriers.

## Monitoring

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Monitoring succession is an essential part of a management program. Field observations can provide early detection of the establishment of transition species as seedlings and young plants. Ground-based and aerial photo monitoring and satellite remote sensing are invaluable for documenting long-term changes. In small habitat areas of reference sites, repeat sampling of permanent plots can track fine-scale successional dynamics, but in broader landscapes, extensive surveys are necessary. Post-treatment monitoring is a critical part of adaptive management plans (Elzinga *et al.* 1998).

## Conclusions, Management Recommendations, and Research Needed

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The dynamics of vegetation succession pose ongoing management issues across the Conservation Lands Network. Some key conclusions and recommendations to keep in mind are:

1. The landscape at present is a mosaic of different successional stages that reflect historic and prehistoric disturbance regimes.
2. Succession will continue in the absence of disturbance, and may result in desirable or undesirable changes to vegetation and impacts on species.
3. Explicit decisions about succession are usually necessary to meet resource management goals.
4. Anticipation of undesirable changes and rapid response to incipient successional dynamics are always easier than trying to reverse succession once it is well along.
5. Compilation of vegetation type conversions since the 1930s through detailed analysis of the Wieslander vegetation maps could provide some baselines on rates of change.
6. Succession is affected by many of the other viability factors. The interactions among these factors should be evaluated and elucidated.
7. Climate change, in particular, will alter succession because aridity will increase and directly limit many species. Increased fire frequency and intensity will accelerate type conversions. add another sentence: Better locally calibrated climate/fire/succession models will enhance the understanding of the potential rates of conversion under climate change scenarios.

## Additional Resources on Ecological Succession

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Barbour M, Keeler-Wolf T, Schoenherr A, editors. 2007. *Terrestrial Vegetation of California*. University of California Press, Berkeley, CA.

Sawyer JO, Keeler-Wolf T, Evans J. 2009. *Manual of California Vegetation*. Second Edition. Sacramento: California Native Plant Society. 1312pp.

University of California Oak Woodland Management – [ucanr.org/sites/oak\\_range](http://ucanr.org/sites/oak_range)

# Viability Summary 5

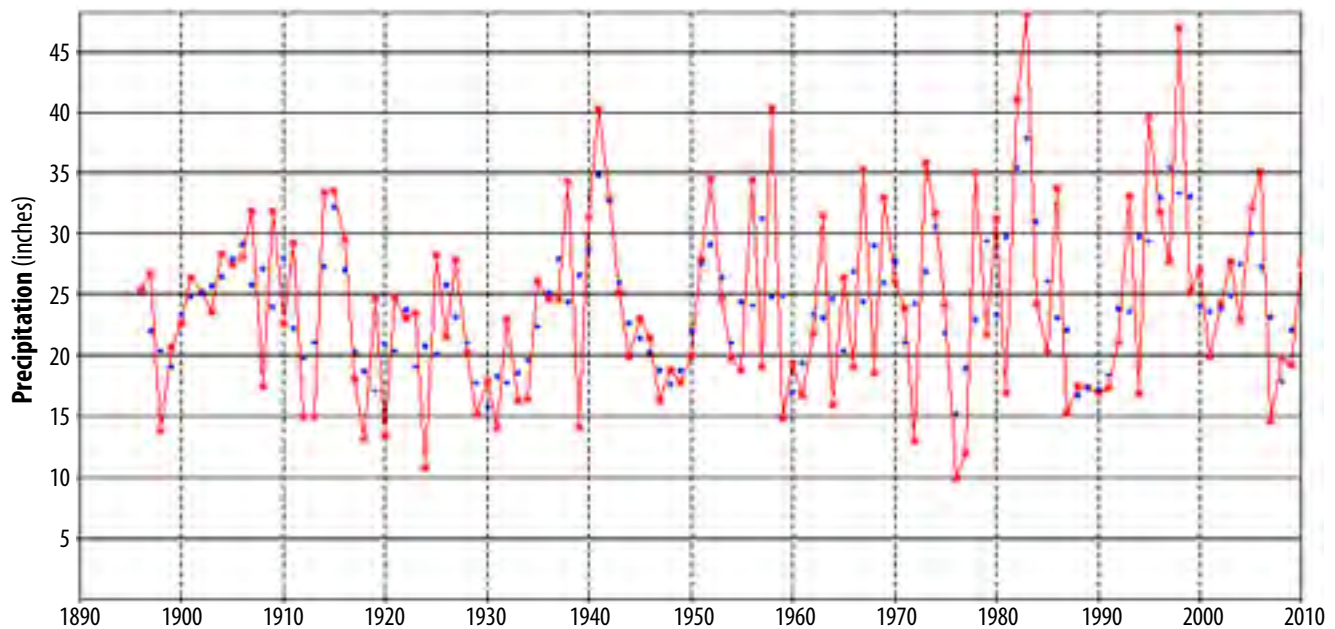
## Flood and Drought

### Process

Extremes of flood and drought are natural features of the Bay Area's Mediterranean climate, with its cool rainy winters and warm dry summers. The North Pacific High, a dome of high atmospheric pressure, moves north in the summer and south in the winter and controls California's storm track. Every year has a summer drought lasting about six months, causing streams to naturally draw down, creating disconnected pools, and partially or fully drying wetlands. The accumulated water stress profoundly shapes local ecosystems, largely determining which plant species can grow.

Extreme interannual variation in rainfall is the rule in the Bay Area. More than a century of rainfall records for the San Francisco Bay Hydrologic Unit (Figure 9.16) show extreme wet years (> 45in precipitation in 1982 - 83 and 1997 - 98, both strong El Niño years) and extreme dry years (10in precipitation in 1924 - 25 and 1975 - 76). The three-year running average (blue dots) helps identify multi-year periods of droughts or heavy precipitation.

**Figure 9.16 ■ Annual Precipitation (July - June) for the San Francisco Bay Hydrologic Unit, 1895 - 2010** (WestMap). The blue dots show three-year running averages for annual precipitation. Data are extracted from 4km interpolated monthly climate surfaces (PRISM), and delivered by WESTMAP (see Appendix B, *Data and Methods*, Chapter 3 and *Additional Resources* at the end of this section).



Extreme rainfall occurs when atmospheric rivers of subtropical moisture stream into California from around Hawaii, bringing heavy rains to the Pacific Coast – a phenomenon known as the Pineapple Express. This subtropical jet stream brings in storm after storm, saturating soils that result in landslides and huge amounts of sediment and runoff into rivers and streams. Stream banks are overtopped and adjacent flatlands are flooded. Where development has been allowed in flood plains, such flooding can cause property damage, environmental destruction, and even loss of life.

At the other extreme, the North Pacific High hardly moves south in the winter, deflecting storms away from the state. A single dry year does not constitute a true drought; successive years of below-average rainfall lead to accumulated water deficits that define drought

periods. When this occurs, surface runoff and groundwater recharge are insufficient to maintain water supplies. Ponds and reservoirs remain empty, streams dry out, the normal dry season is exacerbated, and vegetation experiences much higher water stress.

## Distribution

Most Bay Area flood events are driven by large-scale storms, and as a result occur throughout the region. While the Russian and Napa Rivers are particularly susceptible to floods because of their large mountainous basins, any stream is capable of flooding. Major flood control projects and dams have reduced the extent of flooding in most populated areas.

Floods are rated according to their return interval; a 100-year flood has a 1% chance of occurring in a given year; a 10-year flood has a 10% chance. For example, at Oak Knoll on the Napa River, the 10-year flood is 25 - 30,000 cubic feet per second (cfs), the 50-year flood (experienced in February 1986) is approximately 37,000cfs, and the 100-year flood is estimated at 48,500cfs (Wadsworth 2006). The 100-year flood is the general standard for flood protection, and for sizing bridges, culverts, and other infrastructure.

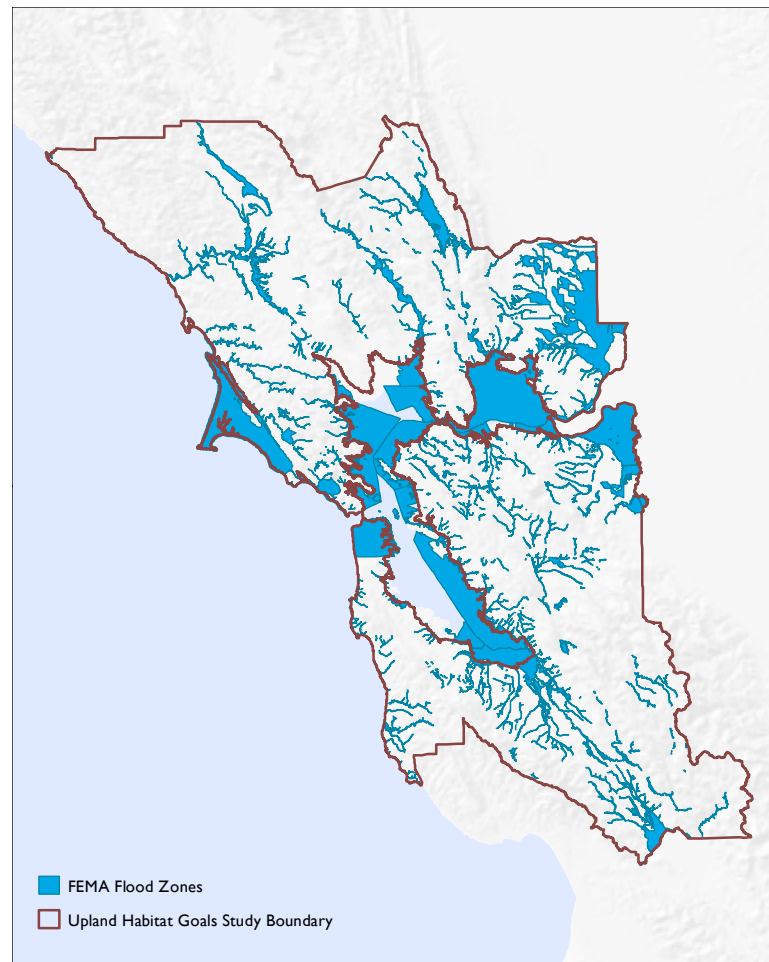
Some recent notable floods include December 1955, January 1982, January 1995, March 1995, January 1997, February 1998, and December 2005. The most extreme historical flood occurred in January 1862, when San Francisco received 24in of rainfall (Brewer 1866, 2003). Most lowlands in the state were underwater for at least short periods of time, and parts of the Central Valley and some local valleys (Santa Clara, lower Napa) were flooded for weeks – even months. The United States Geological Survey (Porter *et al.* 2011) has developed a simulation of the 1862 event, using modern meteorological methods, in a project called ARkStorm (see *Additional Resources*). With this scenario, the project examines the landslides and flooding that resulted from such a storm, which was considered a 500-year or 1,000-year flood.

Droughts of varying magnitude are common in the Bay Area (Figure 9.17). Notable recent droughts include that of 1975 - 76 to 1976 - 77 (the two driest years since 1895). These years produced virtually no runoff, and soils never fully charged with water; water emergencies and severe rationing were declared around the region. Fortunately, this drought was followed by a very wet year in 1977 - 78, which recharged the water table and filled reservoirs. A decade later, a six-year drought, lasting 1986 - 87 through 1991 - 92, led again to water emergencies and rationing. Most recently, the three successive dry years from 2006 - 07 through 2008 - 09 led to some water rationing.



Katie Pilat

**Figure 9.17 ■ San Francisco Bay Area FEMA Floodplain Map.**



## Ecological Impacts and Threats

An overview of the ecological impacts and threats of floods is presented below.

1. One of the most profound ecological effects of floods is the human response to reduce their impacts. Flood control measures, especially concrete channelization of creeks on urbanized valley floors, eliminate riparian habitat and create barriers to fish migration. Massive modifications of floodplains and wetlands have converted many streams into little more than flood control channels with little or no riparian zones. Riparian vegetation is further degraded when local property owners and flood control districts armor banks to prevent erosion.
2. In more natural channels, floods drive channel geomorphology and create complex structures that enhance fish habitat, such as meanders, deeper pools, and large woody debris.
3. Where they are allowed, overbank flows fill wetlands, recharge groundwater, deposit silt, and provide water for riparian vegetation away from the banks of streams.
4. Floods reduce salinity in San Francisco Bay, and can provide opportunities for freshwater fish species to colonize lower reaches of creeks where salinity levels are generally too high.
5. Large floods can disrupt riparian restoration projects before stream banks are stabilized.
6. Streams with simple channel structure do not have winter high flow refugia, and fish, frogs, and turtles get blown out by high flood flows.
7. Flooding disperses invasive species downstream in riparian zones, and can create fresh sites for invasion.

An overview of the ecological impacts and threats of droughts is presented below.

1. Drought can deplete the water in wetlands, ponds, and streams, reducing habitat, local ranges, and numbers of many organisms, including anadromous and resident fish, frogs, and salamanders.
2. When water supply is low (relative to demand), overdrafts of surface and groundwater can deplete critical in-stream flows, exacerbating the effects of drought.
3. Shortened growing seasons and low vegetation productivity reduce food availability for terrestrial animals. For example, Bay Checkerspot Butterfly suffered extreme population declines and some local extinctions in the 1975 - 77 drought, and large declines during the 1986 - 1992 drought (Ehrlich and Hanski 2004).
4. Extreme drought can weaken and kill established vegetation, which can lead to vegetation type conversions.
5. Desiccated vegetation and longer dry seasons increase fire risks.

The native biota and ecosystems of the Bay Area are well adapted to extremes of flood and drought, and can thrive where the landscape and hydrologic systems are relatively intact. In fragmented and degraded systems, these negative effects can push species over the edge locally, and recovery or recolonization may be slow or impossible.

## Network Design and Management Responses

The Conservation Lands Network includes large areas of relatively undisturbed watersheds, which support hydrologic functions that ameliorate both flooding and drought. It also includes all riparian corridors and the largest tracts of riparian forests that represent wide floodplains. The project's approach to riparian buffers – make them as wide as possible – is one way to leave room for floodwaters and re-establish riparian vegetation. Restoration of riparian zones is a high priority for conservation, and will also help buffer ecosystems and human development from the effects of flooding.

The large number of ponds in the CLN increases the chances that there is a mix of sizes and hydrologic responses so some ponds will persist even in severe drought.

Other management responses and issues specifically related to streams and riparian habitat are covered in Chapter 5.



## Policy and Institutional Responses

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Flood control has a well-developed policy and institutional infrastructure. Many jurisdictions prohibit or severely limit development in flood plains. Recent flood control projects have been much more environmentally sensitive than previous ones; the Napa and Guadalupe Rivers provide good examples.

Water agencies typically respond to drought by increased diversions and groundwater withdrawal, water importation, and voluntary water conservation. Mandatory water rationing was widespread in the severe droughts of 1975 - 77 and 1986 - 92. Securing a legal guarantee of in-stream water flows during droughts is critical for the survival of fish and riparian-dependent species.

## Monitoring

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Streamflow is measured by numerous flood control agencies and the United States Geological Survey (USGS). Stream gauges provide fundamental baseline data on aquatic habitat, water supply, and flood risk.

Pre- and post-flood and drought monitoring of ecosystem structure and function, and distribution and abundance of species is critical to understanding biotic responses to extreme events. As with many monitoring programs, this requires long-term consistent data collection since the exact timing of extreme events cannot be predicted. Climate change makes monitoring streamflow and floods ever more important, as it will likely increase the frequency and intensity of floods and droughts.

## Conclusions, Management Recommendations, and Research Needed

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1. Swings in precipitation, and the accompanying floods and drought, are inevitable and natural in the Bay Area.
2. Most Bay Area species and ecosystems are tolerant of at least some drought, but intense droughts can stress them beyond limits, especially in fragmented and degraded areas.
3. Protection and restoration of streams and floodplains ameliorates flood risks to humans and allows more natural processes that enhance biodiversity.
4. Further research into flood and drought frequencies at multiple scales and their effects on biodiversity, especially with regard to climate change, will inform design of restoration projects and develop better management options.

## Additional Resources on Flood and Drought

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Brewer WH. 1866, 2003. *Up and Down California in 1860 - 1864: The Journal of William H. Brewer*. Fourth Edition. Edited by Francis P. Farquhar. Berkeley CA: University of California Press.

Guadalupe River Flood Control - [www.grpg.org/FloodControl.shtml](http://www.grpg.org/FloodControl.shtml)

Napa County Flood Control and Water Conservation District - [www.countyofnapa.org/FloodDistrict](http://www.countyofnapa.org/FloodDistrict)

USGS National Watershed Information System, Streamflow Data - [waterdata.usgs.gov/ca/nwis/sw](http://waterdata.usgs.gov/ca/nwis/sw)

USGS ARKstorm scenario - [pubs.usgs.gov/of/2010/1312](http://pubs.usgs.gov/of/2010/1312)

WestMap (climate information and mapping) - [www.cefa.dri.edu/Westmap/Westmap\\_home.php](http://www.cefa.dri.edu/Westmap/Westmap_home.php)

# Viability Summary 6

## Landslides and Erosion

### Process

Landslides and erosion create fresh geologic surfaces; deep, loose soils; and natural wetlands and ponds. They can also generate sediment that profoundly impacts streams. Heavy rains, fires, and earthquakes cause shallow landslides and high erosion rates in the mountains, which have steep, fault-riddled topography, weak rocks, and erosion-prone soils. Fires followed by heavy rains can lead to large-scale debris flows in steep, unstable terrain.

While many geologic formations, especially marine mudstones and siltstones, naturally produce copious amounts of fine sediments, erosion is exacerbated by human disturbance. Unpaved roads, logging, mining, agriculture, poor engineering of culverts and bridges, and inappropriate development can greatly increase erosion rates by removing vegetation, exposing bare soil to precipitation, and concentrating runoff. Disturbances in distant parts of a watershed release and redistribute sediments downstream where they are eventually deposited in reservoirs, San Francisco Bay, and the ocean. Altered sediment loads, flood control structures, stream channelization, and loss of wetlands have produced extensive downcutting of valley floor stream channels, which simplifies riparian structure.

Erosion and watershed integrity issues are discussed in more depth in Chapter 5, *Fine Filter: Riparian Habitat and Fish*.

### Distribution

Landslides are common throughout the Bay Area, particularly in steeper upland landscapes. Landslides may be slow tectonic movements, deep slides on mountainsides, earthquake-driven slide complexes, shallow slides following heavy rainfall, small slides on unstable roadcuts, or gradual hillside soil creep. Coastal bluffs are particularly susceptible to landslides, and continued shoreline retreat is inevitable with sea level rise.

Throughout the Bay Area, anthropogenic disturbance – particularly unpaved roads, timber harvesting, residential development, and poorly managed grazing – lead to erosion. Going back to the Gold Rush, a legacy of poor land management, especially clearcut logging and poorly designed and maintained unpaved roads, still contributes to sediment.

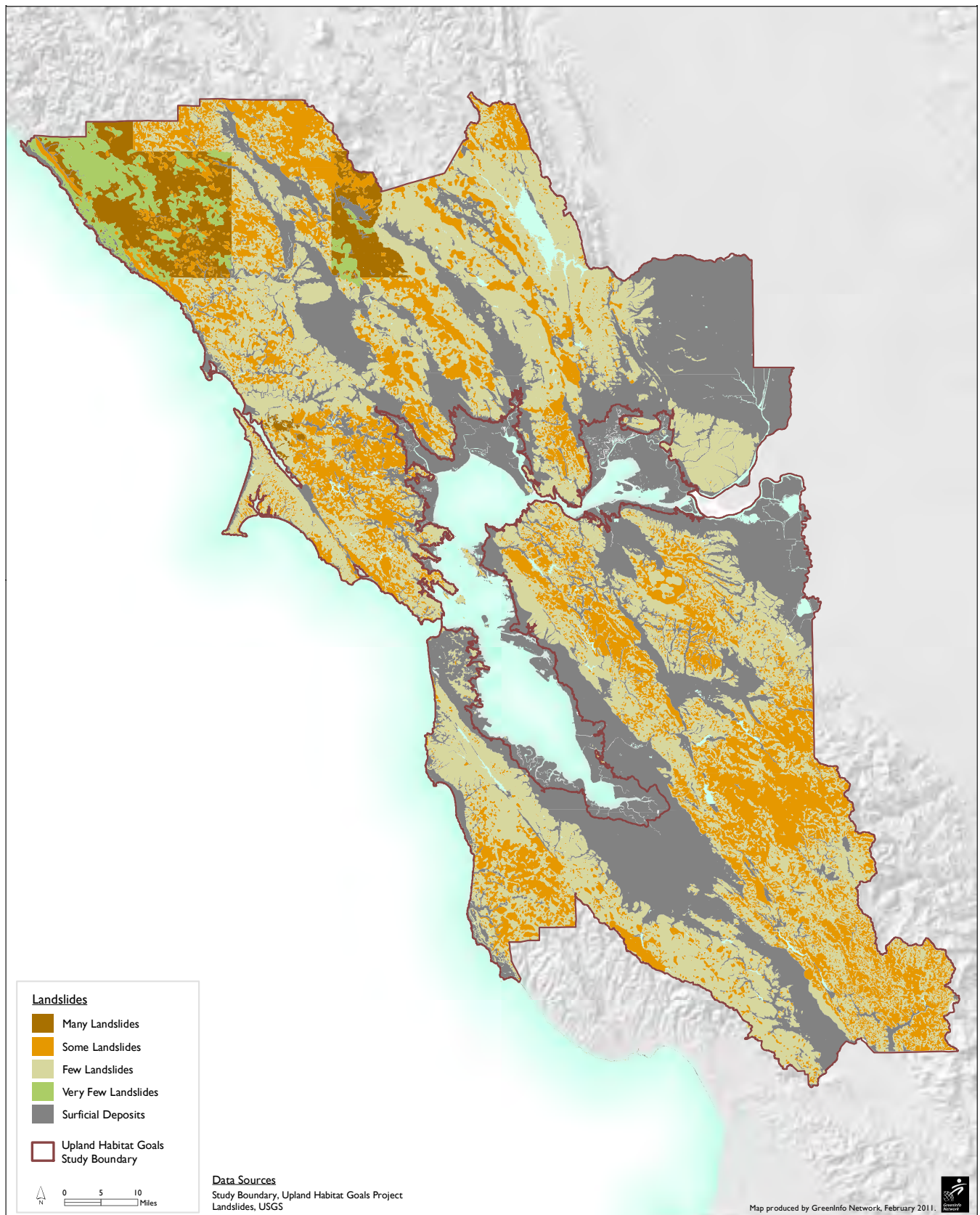
Landslides are far more common in years of high precipitation. According to data from the USGS, significant landslides occurred in 1906 (following the earthquake), 1955, 1964, 1982, 1983, 1986, 1995, and 1998 – all years with heavy rainfall and flooding.

The USGS has mapped general landslide categories across the region (Figure 9.18). Extensive areas in the mountains include significant numbers of landslides. Note that landslides are present throughout the landscape, especially the steeper parts of the Mt. Hamilton Range, where the majority of the landscape is landslides. The Association of Bay Area Governments (ABAG) provides finer-scale online maps of landslides (see link in *Additional Resources*); a sample ABAG map for Santa Clara County is shown in Figure 9.19.



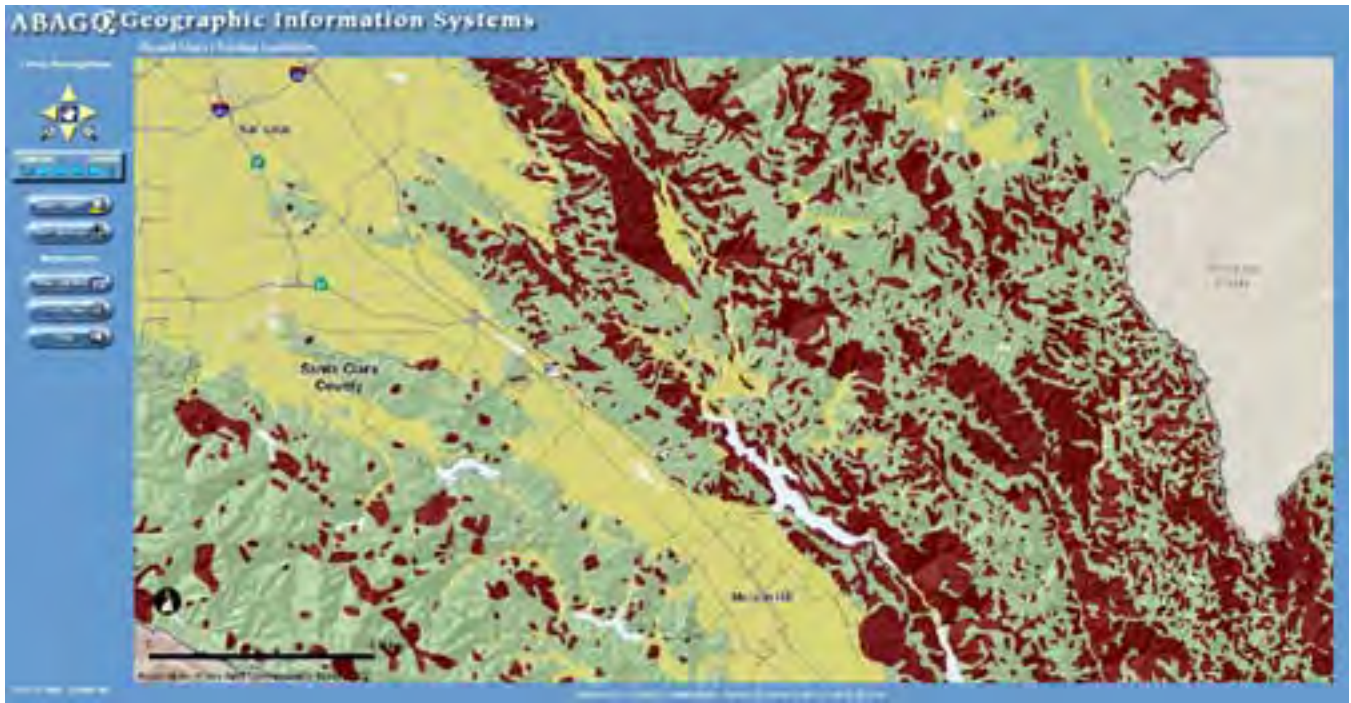
Katie Pilat

**Figure 9.18 ■ Landslide Frequency across the Bay Area (USGS 1997).**



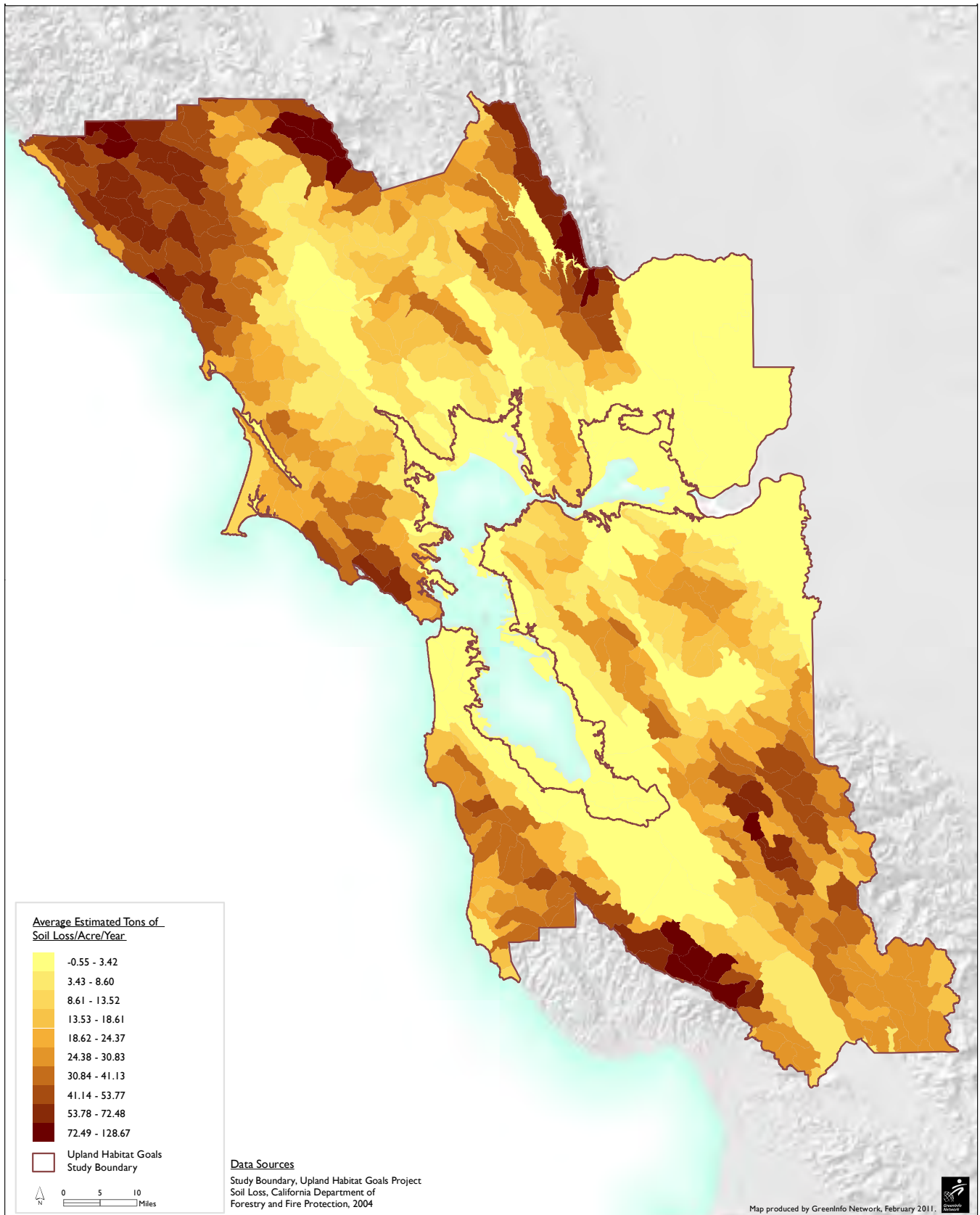


**Figure 9.19 ■ Sample ABAG Landslide Map.** Landslides are shown in brown. Map from [quake.abag.ca.gov/landslides](http://quake.abag.ca.gov/landslides).



Slope is the dominant factor contributing to erosion, but soil type, rainfall potential, and other factors also play a role. Figure 9.20 maps the average post-fire erosion potential, as estimated by CAL FIRE, for the CalWater 2.2.1 Planning Watersheds. Post-fire erosion potential was one of the factors considered in the Watershed Integrity Analysis completed for the Riparian/Fish Focus Team and discussed in Chapter 5.

**Figure 9.20 ■ Erosion Potential Following Fire (CAL FIRE).** CAL FIRE estimates of annual soil loss anticipated after a fire are plotted by CalWater 2.2.1 Planning Watersheds.



## Ecological Impacts and Threats

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Naturally-occurring landslides can be beneficial – creating features such as fresh rock escarpments, rubble piles, deep pockets of soil, small wetlands, and ponds. Such disturbances influence the distribution of vegetation types at a fine scale, including habitats of many rare species. For example, cliffs are particularly valuable habitats for bats and birds of prey, while springs, small wetlands, and permanent ponds provide locally-unique habitats that are breeding and dispersal sites for amphibians. Natural ponds in the Bay Area are rare, and are generally the result of landslides in soils with high clay content.

Many ecological effects of landslides are negative. Landslides can release excess fine sediments into streams, creating major water quality impacts to listed species such as steelhead and coho salmon. The list of sediment-impaired streams includes many of the Bay Area’s important river and creek systems including the Gualala, Russian, Napa, Sonoma, and San Francisquito.

**Figure 9.21 ■ Landslide-created Pond.** Landslides can create localized beneficial disturbances, such as this natural pond at Koopman Ranch in Sunol.



Stuart B. Weiss

Reduced sediment transport in streams can also be a problem. Dams significantly alter stream geomorphology downstream by eliminating naturally occurring coarse sediments, leading to stream channel incision, channel simplification, and loss of spawning and rearing habitat for anadromous fish. Downcut stream channels are particularly problematic in North Bay river systems – Napa River, Sonoma Creek, and the Russian River – all of which support some of the best remaining fish habitat in the Bay Area.

## Network Design and Management Responses

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The design of the Conservation Lands Network, with large contiguous protected lands, allows large areas for natural erosion and sedimentation processes to occur. The topography of some landslide-prone lands provides additional protection from human interference in these processes because these remote and rugged areas face little threat of development. In less remote landslide-prone areas, land use regulations often restrict development because of the geologic hazard posed to people and property.



Erosion control is central to watershed management; maintaining water quality in the face of upstream development will always be a challenge for riparian management. Remote, steep watersheds that form the headwaters of many streams are included in the Conservation Lands Network, and the Riparian/Fish Focus Team emphasized conservation of these areas through fee or easement purchase, land use policies, and voluntary landowner incentives that support stewardship of headwaters. The Riparian/Fish Focus Team also underscored the need for comprehensive, multi-stakeholder watershed planning because of the critical need for coordinated watershed management. For example, upstream areas should be conserved before downstream areas are restored. Restoration of eroded watersheds is enormously

complex; even the partial restoration of incised channels, such as in the Napa River, will require decades to complete.

While a background sediment load will always remain, erosion can be managed, in part, through best management practices in grazing, forestry, and development. Management can address the design, maintenance, removal, and restoration of unpaved roads and trails. Sedimentation and water retention basins can be designed as seasonal wetlands. On grazed lands, maintaining appropriate levels of residual dry matter (dead plant material) and controlling livestock distribution can greatly diminish erosion potential.

The Natural Resources Conservation Service (NRCS), local Resource Conservation Districts, US Fish and Wildlife Service Partners for Wildlife, and CAL FIRE Forestry Stewardship Program provide financial and technical assistance to help landowners effectively manage natural resources to reduce the likelihood of landslides and erosion while creating wildlife habitat. More information on these programs can be found at [www.nrcs.usda.gov](#).

Erosion inevitably leads to sediment accumulation in reservoirs and diminishes their usefulness. The era of dam removal has arrived, as exemplified by the proposed removal of Searsville Dam on San Francisquito Creek and York Creek Dam near St. Helena. Dam removal poses vexing problems for planners and requires many decades of planning and implementation.

## Policy and Institutional Responses

Policies, institutions, and processes dealing with erosion issues at the federal, state, and local levels are well established; unfortunately, policies are not always fully enforced. The federal Clean Water Act of 1972 provides a regulatory framework to address sedimentation and is administered through the State and Regional Water Quality Control Boards, Environmental Protection Agency, and the US Army Corps of Engineers.

The amount of sediment that will impair a stream is measured by its Total Maximum Daily Load (TMDL); this measurement can be used in both management and policy. The Napa River TMDL, for example, used a science-based process to address erosion issues in a

complex wildland-vineyard-residential watershed that supports the highest fish biodiversity in the Bay Area (see Chapter 5 and *Additional Resources*).

CAL FIRE and the State Board of Forestry and Fire Protection oversee many timber harvest regulations designed to reduce sedimentation and other impacts to riparian areas. In addition, many city and county land use policies restrict development on steep hillsides and in other slide-prone areas, in part, to reduce sedimentation in nearby streams. For example, Napa County has many special requirements for development on slopes between 20 and 30%, with a 30% maximum slope restriction for vineyards. Hillside vineyards are also required to implement erosion plans that specify appropriate cover crops, proper drainage, and vineyard design.

## Monitoring

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Landslides are mapped and monitored by local agencies as well as by the US Geological Survey (USGS). The National Weather Service delivers landslide alerts. The Association of Bay Area Governments (ABAG) provides online maps of landslides at a relatively fine scale. Land managers can use all of these to monitor landslides and erosion on lands of interest as well as on lands upstream.

Water quality monitoring, integral to the Clean Water Act, can help measure the effects of landslides and erosion. Sediment loads and water quality are monitored by various agencies for many purposes, including regulatory compliance with TMDLs and flood control capacity. San Francisco Estuary Institute runs a Regional Monitoring Program that includes sediment and contaminants (see link in *Additional Resources*).

## Conclusions, Management Recommendations, and Research Needed

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1. The Bay Area is a naturally high-erosion landscape where landslides are a dominant feature across many of the steep uplands.
2. Erosion rates have increased because of human activities. According to the Napa River Sediment TMDL, unpaved roads are the single biggest anthropogenic source of sediment across the region. Erosion potential, agricultural lands, forestry, and residential development are major components of watershed integrity.
3. Erosion causes excess fine sediments in streams, a major water quality issue for fish and aquatic habitat. Numerous Bay Area streams are listed as “sediment-impaired” under the Clean Water Act.
4. The Conservation Lands Network provides some protection for upper watersheds. Long-term, comprehensive watershed management and riparian restoration are necessary to protect riparian resources from excess sedimentation caused by landslides and erosion.
5. A regulatory framework is well established at national, state, and local levels, but enforcement of regulations and coordination among regulating agencies is critical to ensure consistent enforcement.
6. Incorporate the USGS landslide maps into the watershed integrity analysis described in Chapter 5 (*Fine Filter: Riparian Habitat and Fish*).

## **Additional Resources on Landslides and Erosion**

Summary Distribution of Slides and Earth Flows in the San Francisco Bay Region (USGS - [pubs.usgs.gov/of/1997/of97-745/sfbr-sef-dbdesc.pdf](https://pubs.usgs.gov/of/1997/of97-745/sfbr-sef-dbdesc.pdf))

Association of Bay Area Governments Landslides - [quake.abag.ca.gov/landslides](https://quake.abag.ca.gov/landslides)

### **Watershed Planning**

San Francisco Bay Regional Water Quality Control Board - [www.swrcb.ca.gov/rwqcb2/water\\_issues/programs](https://www.swrcb.ca.gov/rwqcb2/water_issues/programs)

San Francisco Estuary Institute Regional Monitoring Program - [www.sfei.org/rmp](https://www.sfei.org/rmp)

US EPA Handbook for Developing Watershed Plans to Restore and Protect Our Waters, March 2008 (EPA reference number EPA 841-B-08-002) - [www.epa.gov/owow/nps/watershed\\_handbook](https://www.epa.gov/owow/nps/watershed_handbook)

Alameda County Watershed Forum - [www.alamedacountywatersheds.org](https://www.alamedacountywatersheds.org)

The California Watershed Network - [www.watershednetwork.org](https://www.watershednetwork.org)

The Watershed Portal, California Department of Conservation - [www.conservation.ca.gov/dlrp/watershedportal/Pages/Index.aspx](https://www.conservation.ca.gov/dlrp/watershedportal/Pages/Index.aspx)

Clearinghouse for Dam Removal Information - [www.lib.berkeley.edu/WRCA/CDRI/index.html](https://www.lib.berkeley.edu/WRCA/CDRI/index.html)

### **Stewardship Incentives and Technical Assistance for Landowners**

Natural Resources Conservation Service - [www.ca.nrcs.usda.gov/programs](https://www.ca.nrcs.usda.gov/programs)

US Fish and Wildlife Service Partners for Wildlife - [www.fws.gov/cno/partners](https://www.fws.gov/cno/partners)

Forest Stewardship Program and California Forest Improvement Program - [www.ceres.ca.gov/foreststeward/index.html](https://www.ceres.ca.gov/foreststeward/index.html)

### **Forestry and Grazing Best Management Practices**

USDA Forest Service, Water Quality Management for National Forest System Lands in California - [www.fs.fed.us/r5/publications/water\\_resources/waterquality](https://www.fs.fed.us/r5/publications/water_resources/waterquality)

Forest Stewardship Council Forest Management Standards - [www.fscus.org/standards\\_criteria/forest\\_management.php](https://www.fscus.org/standards_criteria/forest_management.php)

UC Agriculture and Natural Resources, California Rangelands - [californiarangeland.ucdavis.edu](https://californiarangeland.ucdavis.edu)

Grazing Handbook: A Guide for Resource Managers in Coastal California, Soyotome Resource Conservation District - [www.sotoyomercd.org/GrazingHandbook.pdf](https://www.sotoyomercd.org/GrazingHandbook.pdf)

### **Total Maximum Daily Loads or TMDLs**

Central Coast Regional Water Quality Control Board - [www.waterboards.ca.gov/centralcoast/water\\_issues/programs/tmdl/303d\\_and\\_tmdl\\_projects.shtml](https://www.waterboards.ca.gov/centralcoast/water_issues/programs/tmdl/303d_and_tmdl_projects.shtml)

San Francisco Bay Regional Water Quality Control Board - [www.swrcb.ca.gov/rwqcb2/water\\_issues/programs/TMDLs](https://www.swrcb.ca.gov/rwqcb2/water_issues/programs/TMDLs)

North Coast Regional Water Quality Control Board - [www.swrcb.ca.gov/northcoast/water\\_issues/programs/tmdls](https://www.swrcb.ca.gov/northcoast/water_issues/programs/tmdls)

# Viability Summary 7

## Invasive Plants



Katie Pilat

### Process

Invasive weeds pose one of the largest immediate threats to biodiversity in the Bay Area (Bossard *et al.* 2000). According to the 2006 California Invasive Plant Inventory, California has more than 4,200 native plant species, while 1,800 introduced non-native plant species now grow in the wild. Of these 1,800 non-native species, approximately 200 are considered invasive weeds – species that can spread rapidly, displacing native plants, disrupting ecosystem processes, reducing or eliminating native biodiversity, and causing large economic losses. Giant reed (*Arundo donax*), for example, has invaded numerous riparian zones, clogging stream channels, increasing flood risk, and outcompeting native riparian vegetation. The Eurasian annual grass medusahead (*Taeniatherum caput-medusae*) can dominate rangelands and greatly reduce forage quality. New potential invasives are discovered on a regular basis. Many wildland weeds are also agricultural weeds.

Weed invasions start as small founding populations called spreading foci. Seeds are dispersed by wind, animals, humans, water, and gravity, which expand existing populations and create more spreading foci. Spreading foci are the key driver of rapid weed invasions, with important consequences for control and management. Given the right conditions, inconspicuous new weeds can become locally dominant in just a few years.

### Distribution

Invasive weeds are found in every vegetation type and ecosystem. California grasslands, in particular, have been radically transformed by invasive annual grasses and forbs. Lists of recognized invasive weeds and broad-scale weed distributions are maintained by several institutions listed at the end of this summary.

The distribution and abundance of invasive plants are affected by numerous activities and processes that cause disturbance. Development, agriculture, logging, roads, fire, grazing, wild pigs, erosion, landslides, and other disturbances expose bare soil, presenting opportunities for weed establishment. Roads and trails serve as efficient dispersal corridors. Weed invasions in grasslands are enhanced by nitrogen deposition, especially in nutrient-poor soils such as serpentine (Weiss 2006, Fenn *et al.* 2010). Climate change may alter disturbance regimes and make a given habitat more hospitable to new weeds.

Some invasive plants, including many annual grasses, can become established in the absence of disturbance. For example, within just several years, false purple brome (*Brachypodium distachyon*) came to dominate otherwise undisturbed grasslands at Edgewood Natural Preserve in San Mateo County.

### Ecological Impacts and Threats

Invasive weeds are a pervasive problem for native biodiversity. A full review of problem weeds and their effects and threats is beyond the scope of this summary, but a few observations are worth noting:

1. Grasslands of all types in California are generally dominated by invasive plants, and are particularly vulnerable to new invasives. Many non-native annual grasses and forbs are effectively naturalized and have become the basis of many ecosystems. Yellow starthistle (*Centaurea solstitialis*), artichoke thistle (*Cynara cardunculus*), other thistles, medusahead (*Taeniatherum caput-medusae*), and barb goatgrass (*Aegilops triuncialis*) are among the worst grassland weeds; they outcompete the few remaining natives and degrade rangeland quality. Non-native perennial grasses such as pampas grass (*Cortaderia*



*selloana*) are becoming established in many coastal grasslands and are particularly difficult to control.

2. Invasive shrubs, especially nitrogen-fixing brooms and gorse, can form dense stands in grasslands and shrublands as well as in the understories of open forests. Long-lived seedbanks and soil enrichment can lead to enduring legacies. Broom and gorse also present major fire hazards. Examples of broom and gorse invasions can be found in the Marin Municipal Water District, on San Bruno Mountain in San Mateo County, and near Bodega Bay in coastal Sonoma County. Broom invasions continue along many highways; for example, the Highway 280 corridor in San Mateo County is riddled with small populations of broom spreading into adjacent conserved lands.
3. Giant reed (*Arundo donax*) has invaded riparian areas and wetlands throughout the Bay Area, eliminating native riparian habitat and increasing flood risk from obstructed channels. The Russian River in the Alexander Valley has significant stands of giant reed in the river channel and surrounding riparian habitat.
4. Potentially invasive species sometimes provide key habitats for special native species. For example, eucalyptus forests along the coast can spread rapidly if not contained, and are generally considered to be a nuisance. However, a few specific stands support overwintering Monarch Butterflies and require management within specified footprints to maintain appropriate habitat for the butterfly.

## Network Design and Management Responses

The inclusion of large, remote, and relatively undisturbed wildlands in the Conservation Lands Network does not prevent the invasion of many non-native plants. Invasive weeds are now part of our landscape, and regional eradication for the vast majority of them is not a viable option.

All conservation lands require active management of invasive plants, focused on preventing, containing, and controlling infestations to minimize impacts on native biodiversity. In grasslands, local eradication is typically not feasible; the management goal is reduction of weed cover and increase in native cover and diversity. Invasive plants can and must be managed on local scales to maintain native biodiversity.

Weed management can be broken down into the strategic, tactical, and operational levels within an adaptive management framework.

**The strategic level** involves identifying management priorities and employing one or more of these strategic responses:

1. **Prevention.** Keeping invasive weeds out of a region may involve inspections and quarantines, as well as working with wholesalers and nurseries to prevent the sales of known invasive weeds.
2. **Identification and prioritization.** Understanding potentially problematic species is necessary to prioritize actions according to their impacts on native biodiversity.
3. **Early detection and rapid response.** It is always easier to treat small infestations than large ones. Detecting and treating incipient weed invasions requires systematic planning and many trained eyes on the ground.
4. **Mapping.** Knowing the local distribution and abundance of key weeds across property boundaries will help predict and manage invasions. Core areas of the invasive, and especially spreading foci, should be thoroughly mapped using GPS coordinates.
5. **Control high-priority spreading foci.** Small infestations far from core infestations should receive immediate treatment followed by monitoring and additional treatment as necessary.
6. **Containment.** A containment plan should define and prioritize zones where the spread of invasives will be stopped. Sensitive habitats with rare species are obvious places for containment. Most current weed management programs should be focused on containment.



7. **Core area treatment.** Once containment is achieved, treatment of large core infestations can be considered. Treating core areas requires a commitment to ongoing treatments, or any successes will be short-lived.
8. **Restoration with native species.** Following the removal of invasives, native species may not return on their own. Without active restoration, weed treatments can cycle between invasives with little benefit for natives. However, passive restoration can work well in low-density weed infestations.
9. **Adaptive management framework.** Weed management programs should be executed with a set of goals, actions, monitoring, and reassessment. Tracking actual costs and effectiveness of treatments is central to adaptive management.
10. **Long-term funding.** Weed management is an ongoing task, but consistent efforts over many years produce good results. Ground gained can be lost very quickly if funding fails before the work is complete; dedicated long-term funding is essential.

The **tactical level** of management is defined by the actions taken to kill invasive weeds, including hand-pulling, mowing, flaming, cutting, digging, applying herbicides, burning, grazing, and utilizing biocontrol. Each invasive weed species has a combination of effective treatments that must be applied at the proper time of year to be successful. Multiple treatments extending over years and even decades are necessary for local control and – where possible – eradication. The restoration of native species is essential following removal to avoid trading one invasive for another. Weed control tactics should be tested with rigorous replicated experiments to find the most effective and feasible solution for a given site.

The **operational level** of weed management is the deployment of the proper personnel, equipment, and methods necessary to meet strategic and tactical goals. Large-scale operations involving mechanical equipment and herbicide spraying will require professional crews. Volunteer groups can be effectively deployed for specific tasks, especially hand clean-up after initial treatments, as well as for subsequent restoration with native plants. The operational level may be the most difficult to execute due to limited resources and institutional barriers. Jurisdictional, liability, regulatory, and property issues can all confound operations. Operational capacity is a fundamental limitation for effective weed management, especially when treatment windows are short.

## Policy and Institutional Responses

A number of public and private organizations offer resources, guidelines, or funding for the management of invasive plants. References and web addresses are listed in *Additional Resources*.

National, state, and local laws address various aspects of invasive weeds and can be found at the California Invasive Plant Council (Cal-IPC) website. The California Department of Food and Agriculture has a Noxious Weed Information Project that maintains a list of invasive plants and summarizes relevant laws, including import and transport restrictions, and laws providing authority to treat invasive plants on private lands.

Funding is a fundamental limiting factor in invasive weed management; needs greatly outweigh available resources. Directed appropriations at the state and federal levels fluctuate wildly with government budgets. Endowments for long-term stewardship that include weed management are far more effective than short-term funding. Regulatory agencies are now requiring long-term management endowments for mitigation lands.

Weed Management Areas (WMAs) are county-scale organizations that provide grants from the California Department of Food and Agriculture (CDFA) and offer local forums for managers across institutional boundaries. The CDFA grants are typically matched 3:1 or more with other resources, including in-kind contributions.

The Bay Area Early Detection Network (BAEDN) was formed in 2006 as a collaborative partnership to coordinate and implement Early Detection and Rapid Response across the nine Bay Area counties. BAEDN is developing new mapping tools via CALFLORA.



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Resource Conservation Districts can provide technical assistance and financial support through state grants and various programs funded through the Natural Resources Conservation Service.

Stewardship staff members at land agencies and land trusts have primary responsibility for weed management on their lands and can provide volunteer opportunities focused on weed management. A good example of long-term volunteer commitment with considerable success over nearly two decades is Friends of Edgewood Natural Preserve.

Non-governmental organizations such as The Nature Conservancy have invasive weed programs; others, such as the California Native Plant Society, advocate at various levels of government for policies and regulation of sales of invasive species.

Ranchers suffer direct impacts from rangeland weeds and play key roles in weed management. Appropriate grazing regimes can effectively reduce non-native annual grass cover, control yellow star-thistle, and encourage native bunchgrasses and wildflowers. The California Rangeland Conservation Coalition is a cooperative organization that advocates and provides information and resources for rangeland conservation and weed management.

## Monitoring

An adaptive management framework for invasive plants requires monitoring and mapping. Better mapping tools and new information technologies are being deployed by Cal-IPC, Bay Area Early Detection Network, CALFLORA, and other groups. Monitoring treatment effectiveness and costs is essential for rational deployment of limited resources.

## Conclusions, Management Recommendations, and Research Needed

Invasive weeds are the largest immediate threat to biodiversity on protected and unprotected lands. They also cause large direct and indirect economic damages. For example, unpalatable annual grasses (medusahead and goatgrass) reduce forage quality in rangelands, and giant reed clogs stream channels and increases flood risk (Bossard *et al.* 2000).

1. Invasive plant species affect all ecosystems across the Bay Area landscape. Weeds often flourish where disturbance is greater, but can also become established without disturbance.
2. Weeds invade rapidly when conditions are favorable, especially following disturbance. Invasions often follow corridors such as roads and trails. The greatest rate of spread is characterized by spreading foci as opposed to advancing solid fronts.
3. Specific threats to native biodiversity from weeds are well documented. Grasslands in particular are at great risk.
4. Weed management is a long-term process. Plans must consider tactical, strategic, and operational levels within an adaptive management framework. Simply killing large numbers of weeds may not provide biodiversity benefits, and prioritization is essential.
5. Many organizations provide expertise and resources for invasive weed management. Coordination among agencies and land owners is essential.
6. Adaptive management plans, including monitoring and mapping, are essential for maximizing the effectiveness of invasive plant control treatments.

## Additional Resources on Invasive Plants

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Bay Area Early Detection Network - [www.baedn.org](http://www.baedn.org)

CALFLORA - [www.calflora.org](http://www.calflora.org)

California Association of Resource Conservation Districts - [www.carcd.org](http://www.carcd.org)

California Department of Food and Agriculture, Encycloweediea - Identification, Biology, and Management of Plants Defined as Noxious Weeds - [www.cdffa.ca.gov/phpps/ipc/encycloweedia/encycloweedia\\_hp.htm](http://www.cdffa.ca.gov/phpps/ipc/encycloweedia/encycloweedia_hp.htm)

California Department of Food and Agriculture, Weed Management Areas - [www.cdffa.ca.gov/phpps/ipc/weedmgtareas/wma\\_index\\_hp.htm](http://www.cdffa.ca.gov/phpps/ipc/weedmgtareas/wma_index_hp.htm)

California Invasive Plant Council - [www.cal-ipc.org](http://www.cal-ipc.org)

California Native Plant Society - advocates for policies and laws at various levels of government - [www.cnps.org/cnps/grownative/weeds.php](http://www.cnps.org/cnps/grownative/weeds.php)

California Rangeland Conservation Coalition - [www.carangeland.org](http://www.carangeland.org)

California Weed Science Society - [www.cwss.org](http://www.cwss.org)

California Weed Science Society 2002. *Principles of Weed Control in California*, 3rd edition. Fresno CA: Thompson Publ.

DiTomaso JM and Healy EA. 2006. *Weeds of California and Other Western States*. Univ. California, DANR. Publ. #3488, 1808 pp.

DiTomaso JM and Healy EA. 2003. *Aquatic and Riparian Weeds of the West*. Univ. California, DANR. Publ. #3421, 442 pp.

Friends of Edgewood Natural Preserve - [www.friendsofedgewood.org](http://www.friendsofedgewood.org)

Natural Resources Conservation Service - [www.nrcs.usda.gov](http://www.nrcs.usda.gov)

The Nature Conservancy - [www.nature.org/initiatives/invasivespecies](http://www.nature.org/initiatives/invasivespecies)

UC Integrated Pest Management Program - information on weed identification and management - [www.ipm.ucdavis.edu/PMG/menu.weeds.html](http://www.ipm.ucdavis.edu/PMG/menu.weeds.html)

Weed Science Society of America - the main scientific society covering both agricultural and wildland weeds - [www.wssa.net](http://www.wssa.net)



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# Viability Summary 8

## Non-native Animals

### Process

Many animal species have been introduced to California and are now established in the Bay Area. These species can disrupt native plant and animal plant communities. For example, eastern grey squirrels compete with native squirrels for food and habitat, starlings monopolize nesting cavities, red fox prey upon native species (including endangered Clapper Rails), Argentine Ants displace native ants, and wild pigs root through and overturn meadows and grasslands. Once established, populations of non-native animals can explode in size and disperse to new areas, making them virtually impossible to eradicate.

### Distribution

Introduced animals are found throughout the Bay Area, in myriad ecosystems. Some (e.g., feral cats) are more highly associated with human settlement; others (e.g., wild pigs and turkeys) are well established in wildlands, and also sometimes enter suburban neighborhoods.

### Ecological Impacts and Threats

Many introduced animal species affect native biodiversity; it is not possible to discuss them all here. Among the many non-native animals found in the Bay Area, the most relevant to viability are presented below.

1. Wild pig (*Sus scrofa*) is a major threat to native vegetation. These animals can literally excavate entire grassy meadows and disturb understories in shrublands, woodlands, forests and riparian zones. This disturbance directly harms native plant communities and opens the door for weed invasions. Wild pigs also consume huge amounts of acorns, which are a primary food source for an array of native animals.
2. Red fox (*Vulpes vulpes*), brought to the Bay Area by the fur trade, is a voracious mid-sized predator that can deplete populations of many ground-nesting birds – most notably California Clapper Rail (*Rallus longirostris*). Red fox can also outcompete the smaller native grey fox.
3. Bullfrog (*Rana catesbeiana*) is a major threat to the pond-dwelling California Red-legged Frog and California Tiger Salamander, both as a predator and as a competitor.
4. Fish species such as bass, sunfish, mosquito fish, and other game fish have been introduced into streams, ponds, and lakes across the region. These non-native species prey upon and outcompete native fishes and amphibians.
5. Starling (*Sturnus vulgaris*) can monopolize nesting cavities, suppressing populations of native cavity nesters such as bluebirds.
6. Wild turkey (*Meleagris gallopavo*) populations have greatly increased in recent years, and these birds consume huge quantities of acorns and other foods essential to native species.
7. Feral cats (*Felis catus*) prey upon birds and small mammals, and can spread diseases such as feline leukemia, which has been devastating to the native spotted skunk. Feral cats are more closely associated with human settlements than are other non-native animals.
8. Non-native insect pests can devastate forests and individual species. Gypsy Moth (*Lymantria dispar*) and other generalist insect herbivores are a constant threat to native



Stuart B. Weiss

vegetation. Agricultural pests such as Light Brown Apple Moth (*Epiphyas postvittana*) and Glassy Winged Sharpshooter (*Homalodisca coagulata*) may lead to control measures that have impacts on native species. The invasive Argentine Ant (*Linepithema humile*) outcompetes native ants (bad for both the native ants and ant-feeding specialists such as Coast Horned Lizard) and can decimate native invertebrates that have co-evolved with native ants. Insects that are introduced to provide biocontrol of pest species may later begin to prey on desirable native species.

## Network Design and Management Responses

The design of the Conservation Lands Network with large tracts of wildlands buffers the impacts of introduced species that are associated with human populations, such as feral cats. But many other non-native animals, such as feral pigs, occupy wildland areas, are wide-ranging, and cannot be managed by network design alone.

Management is essential to minimize impacts of these invasive animals. Eradication is rarely possible on a landscape scale (a notable exception is the elimination of wild pigs from Marin County, possible only because of its relative isolation from sources in Sonoma County). Wild pigs have been eliminated locally with management techniques including pig-proof fences, trapping, and hunting within the fences, as was accomplished at the Blue Oak Ranch Reserve in the Mt. Hamilton Range. Controlling population size and density of such wide-ranging animals is generally more feasible through the use of professional and recreational hunters and trappers. Because pigs have high reproductive rates, success is only temporary in most areas, so management must be ongoing.

Red foxes have been controlled in the Baylands through trapping programs; local successes can slow the spread of this invasive animal into the uplands. Such control and eradication programs, particularly for mammals, can be hampered by opposition from animal rights groups.



Cait Hutnik / Lighttofofform.com

Bullfrogs can be managed by draining ponds for short periods (which does not eliminate native California Red-legged Frogs), but long-term suppression requires coordination across the landscape. Similarly, non-native fish can be eliminated from ponds by one-time draining. Elimination from streams is more difficult, but poisoning and electro-fishing can be used in limited circumstances.

Starlings are nearly impossible to control. However, the provision of appropriately-designed nest boxes has been effective in maintaining populations of bluebirds and other cavity nesters.

Feral cats can be controlled through trapping. However, social constraints and animal rights activists make local control programs difficult to implement, especially near populated areas. A long-term solution to this problem requires consistent public education.

Prevention of new insect pests is the first line of defense. New infestations can rapidly grow out of control, so early detection and control of insect pests is essential. When management treatment is widespread, as with the aerial spraying of pesticides for the Mediterranean Fruit Fly in the early 1980s, the potential for impacts on non-target insects must be considered.

## Policy and Institutional Responses

Prevention of new introductions is essential through quarantines and inspections. The California Department of Food and Agriculture and county agriculture departments provide this function for agricultural pests. Early detection and rapid response programs are important at the local, regional, and statewide scales.

Management of wild pig and turkey populations can be accomplished by tailoring hunting regulations to reduce these species. Public education can help overcome resistance to such control programs by animal rights organizations. The USDA Animal and Plant Health Inspection Service (APHIS) and California Department of Food and Agriculture have set high standards for release of biocontrol insects to avoid risks to native plants.

## Monitoring

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Monitoring the distribution, abundance, and local impacts of key non-native animals provides important information for control and management responses. Early detection and rapid response is the only way to prevent further invasions.

## Conclusions, Management Recommendations, and Research Needed

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1. Non-native animals are here to stay.
2. Their impacts on native ecosystems can be reduced through local and regional management programs aimed at individual species.
3. Key research topics include identifying the full range of impacts from current problem species, assessing which relatively newer introduced species are most likely to produce broad-scale impacts, and establishing damage thresholds for certain species to inform control measures.

## Additional Resources on Non-native Animals

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### General information on invasive species

Department of Fish and Game Invasive Species Program – [www.dfg.ca.gov/invasives](http://www.dfg.ca.gov/invasives)

California Fish and Game Commission Policy on Introduction of Non-native Species – [www.fgc.ca.gov/policy/p4misc.asp](http://www.fgc.ca.gov/policy/p4misc.asp)

California Department of Food and Agriculture Pest Detection / Emergency Projects – [www.cdffa.ca.gov/phpps/pdep](http://www.cdffa.ca.gov/phpps/pdep)

USDA Animal and Plant Health Inspection Service – [www.aphis.usda.gov/import\\_export/index.shtml](http://www.aphis.usda.gov/import_export/index.shtml)

### Bullfrogs

Rebecca A, Doubledee RA, Muller EB, Nisbet RM. 2003. “Bullfrogs, Disturbance Regimes, and the Persistence of California Red-Legged Frogs.” *The Journal of Wildlife Management* Vol. 67, No. 2 (Apr., 2003), pp. 424-438.

[www.columbia.edu/itc/cerc/danoffburg/invasion\\_bio/inv\\_spp\\_summ/Rana\\_catesbeiana.htm](http://www.columbia.edu/itc/cerc/danoffburg/invasion_bio/inv_spp_summ/Rana_catesbeiana.htm)

[www.bullfrogcontrol.com](http://www.bullfrogcontrol.com)

**Insects** – [www.caforestpestcouncil.org](http://www.caforestpestcouncil.org)

**Red fox** – [icwdm.org/handbook/carnivor/foxes.asp](http://icwdm.org/handbook/carnivor/foxes.asp)

**Wild pigs** – [icwdm.org/handbook/mammals/wildpigs.asp](http://icwdm.org/handbook/mammals/wildpigs.asp)

**Wild turkeys** – [www.dfg.ca.gov/wildlife/hunting/uplandgame/docs/turkplan\\_04.pdf](http://www.dfg.ca.gov/wildlife/hunting/uplandgame/docs/turkplan_04.pdf)  
[www.dfg.ca.gov/keepmewild/turkey.html](http://www.dfg.ca.gov/keepmewild/turkey.html)

# Viability Summary 9

## Pathogens and Disease

### Process

Pathogens such as viruses, bacteria, and fungi are present in all wild populations of plants and animals, and are normal causes of disease and mortality. But pathogenic diseases can become epidemics, spread rapidly, and cause high mortality. Emerging diseases such as Sudden Oak Death (SOD) and the chytrid fungus that is decimating amphibian populations worldwide have become particularly virulent; these and other diseases can pose major threats to the viability not only of host species, but of entire ecosystems.

### Distribution

Diseases are present in all ecosystems and all species. Disease dynamics are extremely complex, and are a function of host population density, vector movements, immunity (or lack thereof), and climate. Some virulent wildlife diseases – including canine distemper and feline leukemia – are transmitted via domestic animals. Plant pathogens can be airborne, waterborne, or spread by humans and other animals. Diseases can also be disseminated from distant locales via national and international commerce with the Bay Area; for example, Sudden Oak Death was likely introduced on nursery stock from Europe (Cooke 2007).

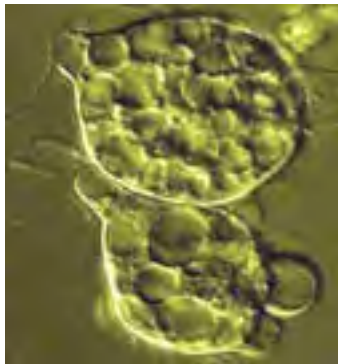
The dispersal of disease starts with small spreading foci that expand and grow and throw off more foci to start new infections. Some carriers of disease are not themselves susceptible, making these spreading foci difficult to identify. For example, Douglas-fir trees can harbor the pitch canker fungus for as long as a year without showing symptoms, meanwhile allowing the spores to spread to more susceptible host plants (Gordon 2007).

### Ecological Impacts and Threats

At normal levels, pathogens are an integral part of populations and ecosystems. However, several epidemic diseases pose specific risks to the viability of both plant and animal biodiversity targets. Links for more information are provided in *Additional Resources*.

#### Plant Disease

1. **Sudden Oak Death (SOD)** is a pathogenic fungus (*Phytophthora ramorum*) that was introduced from nursery stock and has spread across much of the Pacific coastal region. SOD kills tanoaks, live oaks, California black oak, and other oak species (though some oak species are not susceptible, such as blue and valley oak). California bay trees act as a widespread reservoir (foliar host) for the dissemination of the disease. The loss of acorn resources affects bird and mammal populations. SOD is vastly changing the composition of forests and will lead to vegetation type conversions and altered successional pathways. The best source of information about this disease is from the California Oak Mortality Task Force.
2. **Pitch canker** is a fungal disease (*Fusarium circinatum*) that can affect all native California pines and has caused especially high mortality in Monterey pines. This is of particular concern in the Conservation Lands Network, as one of only three native stands of this tree is in San Mateo County, and planted stands are spread across the region. The UC Davis Statewide Integrated Pest Management Program is a good online source of information for pitch canker.
3. **Fungal diseases** such as manzanita rust (*Phytophthora cinnamomi*) have impacted several rare endemic manzanitas, including pallid manzanita (*Arctostaphylos pallida*) in the East Bay Hills. Fire may be required to rejuvenate some manzanita stands by



www.flickr.com/photos/ajct1/4137845171

destroying infected branches and promoting a new generation of manzanita seedlings. The Recovery Plan for Chaparral and Scrub Communities East of San Francisco Bay includes pallid manzanita.

## Animal Disease

1. **Chytrid fungus** (*Batrachochytrium dendrobatidis*) is decimating amphibian populations worldwide. The fungus is present in the Bay Area, but, so far local frog and salamander populations do not appear to be impacted as severely as they have been elsewhere.
2. **West Nile Virus** (*Flavivirus*) is transmitted by mosquitoes and infects birds and other animals, but is especially virulent and threatening to corvids – crows, jays, and relatives. This virus has severely reduced Yellow-billed Magpie populations in the Central Valley (Crosbie *et al.* 2008); the populations in the Mt. Hamilton Range appear to have suffered less than others because of the general aridity and lack of mosquitoes. Humans are also susceptible to this virus, which is a public health concern.
3. **The rabies virus** (*Lyssavirus*) occurs naturally in wild animals, and can be transmitted to unvaccinated domestic pets and humans. Rabies itself is not a direct threat to wildlife populations. Inappropriate human responses to rabies are more of a threat. The rare human rabies infection by bats has historically been used as an excuse to reduce or eliminate bat populations even though bat populations have a low incidence of carrying rabies (<1%; Klug *et al.* 2011).
4. **Canine and feline distemper** viruses can reduce populations of foxes, coyotes, bobcats, mountain lions, raccoons, and other carnivores. Both wildlife and domestic pets serve as reservoirs.
5. **Feline leukemia** (*Gammaretrovirus*) is common in domestic and feral cat populations. This disease has apparently eliminated the western spotted skunk from nearly the entire Bay Area (D. Johnston pers. comm. 2009). Bobcats and mountain lions are also susceptible to feline leukemia.
6. **Bubonic plague** (*Yersinia pestis*), a bacterial disease, is endemic in ground squirrel colonies, where outbreaks can devastate local populations. Ground squirrel is a key species in grasslands, and elimination of ground squirrels for plague control threatens their ecological role as prey and as creators of burrows for other animals. This is also a public health threat, as the bacterium that causes plague can spread to humans from rats and other wild animals.



Peter LaTourrette / www.birdphotography.com

## Design and Management Responses

Diseases of both plants and animals can be transmitted long distances. Conservation of distinct plant and animal populations in different regions, as embodied in the Conservation Lands Network, provides isolation, and thus some buffer against the spread of disease. For example, large pond networks spread across many environments may provide refuge against the chytrid fungus for amphibians (Muths *et al.* 2007, S. Bobzien pers. comm. 2010). When animal diseases devastate local populations, connectivity is important to facilitate recolonization from neighboring populations.

Management of fungal diseases like Sudden Oak Death is largely a matter of prevention. Once established, these diseases are difficult to contain. Individual trees with SOD can be treated with fungicides, but treatment is expensive and infeasible on a landscape scale. As canopy trees die and canopies become more open, landscapes are more susceptible to invasive weeds that require control. Removal and proper sanitary disposal of dead trees from heavily used areas and trails is an essential ongoing management issue.

The animal diseases that are spread by domestic cats and dogs to wild animals can be controlled, in part, through regular vaccinations. In the case of West Nile Virus and Bubonic Plague, local control of mosquito and rat populations are important management tools to protect both wildlife and human health.



## Policy and Institutional Responses

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Once disease is established, controlling its spread is very difficult. Restrictions on public access to stop the spread of Sudden Oak Death, for example, are controversial – and may not even be effective given how far the disease has spread.

The single most important policy response is prevention of new disease introductions via quarantines, permits, and inspections. The USDA Animal and Plant Health Inspection Service (APHIS) issues permits and provides technical assistance. The California Department of Food and Agriculture plays a similar role at the state level.

## Monitoring

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Because the appearance and spread of epidemics can be rapid, disease monitoring requires constant vigilance. The California Oak Mortality Task Force has been monitoring the spread of this disease over the last decade, and provides a model for other monitoring programs. Although it is rarely done, regular monitoring of wildlife populations can identify disease outbreaks before they become epidemic. In the absence of regular monitoring, reactive responses may be too little and too late.

## Conclusions, Management Recommendations, and Research Needed

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1. Diseases are found in all wild plant and animal populations, posing an ever-present risk of epidemics.
2. Plant diseases can transform ecosystems by eliminating dominant species, resulting in vegetation type conversions that can be susceptible to invasive, non-native plants.
3. Epidemic animal diseases, which may be transmitted from domestic animals, can devastate local populations. Some of these diseases also affect humans.
4. Prevention of new diseases is the first line of defense, followed by early detection and rapid response. Managing the impacts of established diseases requires ongoing adaptive management.
5. Research needs are many, including identification of new diseases at early stages, methods of prevention and treatment, and status of known diseases (e.g., chytrid fungus) in wildlife populations.



Dave Pizzo, UC Davis

## **Additional Resources on Pathogens and Disease**

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### **General Information**

US Department of Agriculture Animal and Plant Health Inspection Service - [www.aphis.usda.gov](http://www.aphis.usda.gov)

California Department of Food and Agriculture - [www.cdfa.ca.gov](http://www.cdfa.ca.gov)

### **Plant Pathogens and Disease**

California Oak Mortality Task Force - [www.suddenoakdeath.org](http://www.suddenoakdeath.org)

Best Management Practices from the California Oak Mortality Task Force - [www.suddenoakdeath.org/diagnosis-and-management/best-management-practices](http://www.suddenoakdeath.org/diagnosis-and-management/best-management-practices)

UC Davis Statewide Integrated Pest Management Program Pitch Canker Management Guidelines -

[www.ipm.ucdavis.edu/PMG/PESTNOTES/pn74107.html](http://www.ipm.ucdavis.edu/PMG/PESTNOTES/pn74107.html)

Recovery Plan for Chaparral and Scrub Communities East of San Francisco Bay - [www.fws.gov/sacramento/ea/Documents/Chaparral%20Draft%20Recovery%20Plan%20WEB.pdf](http://www.fws.gov/sacramento/ea/Documents/Chaparral%20Draft%20Recovery%20Plan%20WEB.pdf)

### **Animal Pathogens and Disease**

Wildlife Disease Association - [www.wildlifedisease.org](http://www.wildlifedisease.org)

Center for Vectorborne Diseases, UC Davis - [www.cvec.ucdavis.edu/about](http://www.cvec.ucdavis.edu/about)

Overview of Amphibian Diseases - [www.amphibiaweb.org/declines/diseases.html](http://www.amphibiaweb.org/declines/diseases.html)

### **Chytrid fungus and other amphibian disease –**

[microbiology.usgs.gov/wildlife\\_health\\_amphibians.html](http://microbiology.usgs.gov/wildlife_health_amphibians.html)

[www.ccadc.us/docs/AmphibianDiseaseBrochure.pdf](http://www.ccadc.us/docs/AmphibianDiseaseBrochure.pdf)

**Insects –** [www.caforestpestcouncil.org](http://www.caforestpestcouncil.org)

### **West Nile Virus**

[www.magpiemonitor.org/West\\_Nile\\_Virus.html](http://www.magpiemonitor.org/West_Nile_Virus.html)

[www.vetmed.ucdavis.edu/vgl/wildlife/projects/magpies.html](http://www.vetmed.ucdavis.edu/vgl/wildlife/projects/magpies.html)

[www.westnile.ca.gov](http://www.westnile.ca.gov)

### **Rabies and bats**

[www.batcon.org/index.php/bats-a-people/bats-and-rabies.html](http://www.batcon.org/index.php/bats-a-people/bats-and-rabies.html)

[www.cdc.gov/rabies/bats/index.html](http://www.cdc.gov/rabies/bats/index.html)



John Bienapfl, UC Davis

# CHAPTER 10

## The Conservation Lands Network: Summary and Conclusions



Stuart B. Weiss

Following the fine filter focus teams' review of the Coarse Filter Conservation Lands Network (CLN) and subsequent adjustments, the Project Team reviewed the nearly final Conservation Lands Network one last time to determine whether any important targets were missed and how well the CLN met the coarse and fine filter goals. This review included a systematic visual inspection as well as gap analyses to measure the nearly final CLN's success in meeting the vegetation type and fine filter goals.

These reviews prompted a few modifications to the Conservation Lands Network, and produced the final version presented in this report – the Conservation Lands Network 1.0, which meets the vast majority of the goals for the coarse and fine filter conservation targets. These reviews also led to the creation of Areas for Further Consideration to highlight areas outside of the CLN with high-value targets and/or where connectivity could be improved, but where current data does not reveal which lands to add to the CLN.

This chapter summarizes the Conservation Lands Network 1.0, the adjustments made to create this version, Fragmented Areas, Areas for Further Consideration, and results from the gap analyses.

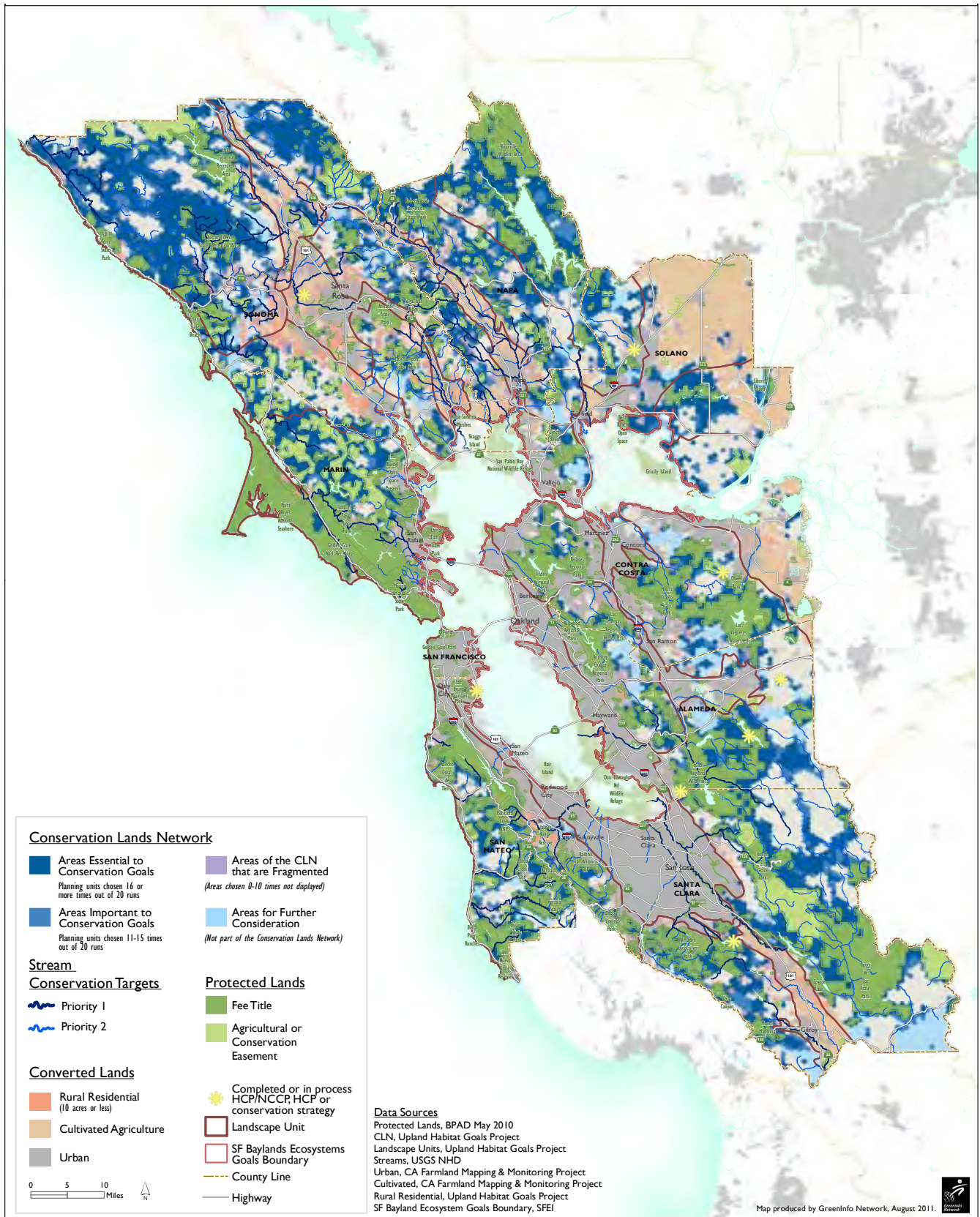
### The Conservation Lands Network 1.0

The final version of the Conservation Lands Network is shown in Figure 10.1. Dubbed the *Conservation Lands Network 1.0* to underscore that it is a work in progress, it incorporates much that is currently known about the distribution of biodiversity in the Bay Area. The CLN identifies areas that support irreplaceable rare and endemic biodiversity, while also encompassing vast tracts of intact common vegetation types. It meets the conservation goals for the vast majority of nearly 1,400 vegetation type and fine filter species targets, is relatively well-connected, and explicitly includes the stream and riparian network.

Because the coarse filter (vegetation type) goals captured the needs of most fine filter target species, the Coarse Filter Conservation Lands Network required only minimal adjustment. The project's application of Marxan, along with carefully chosen geographic stratifications, targets, and constraints, produced coherent local networks within the landscape units that – in the aggregate – form the Conservation Lands Network.

Of the approximately 4.3 million acres in the study area, the Conservation Lands Network encompasses roughly 2.2 million acres, which includes 970,000 acres of existing protected land (BPAD 2010). These and other land categories are summarized in Figure 10.2. The 900,000 acres of Essential Lands identified by the CLN generally contain high-value conservation targets, are located adjacent to existing protected lands, or play key roles in local connectivity. The 200,000 acres of Important Lands are common vegetation types and may be interchangeable with other potential conservation lands with similar biodiversity values. The 120,000 acres of Fragmented Areas contain high-value conservation targets, but the exact configuration of lands to include in the CLN requires fine-scale review. Similarly, the 160,000 acres in Areas for Further Consideration contain high-value targets and/or are important for connectivity but require fine-scale review to determine which areas should be added to the Conservation Lands Network.

**Figure 10.1 ■ The Conservation Lands Network 1.0.** A high-resolution, zoomable version of this map is available at [www.BayAreaLands.org](http://www.BayAreaLands.org).



The Other Lands category (690,000ac) is comprised of areas not included in the CLN, but exclusive of Urban, Cultivated Agriculture, and Rural Residential areas. Other

Lands and some of the Areas for Further Consideration are an interesting mix: some are common vegetation types that have a level of de facto protection because of remoteness, ruggedness, and land use policies. Other areas are heavily-impacted common vegetation types near development. These areas support some native biodiversity and can contribute to the goals, but, because of their location, lack of known rare conservation targets, lower conservation suitability, or other factors, they were not included in the CLN.

**Figure 10.2 ■ Conservation Lands Network 1.0 Acreage.** Acreages represent upland habitats within the nine-county study area (exclusive of baylands). The Upland Habitat Goals Study Area is approximately 4.3 million acres.

<b>Land Type</b>	<b>Acres (rounded to nearest 10,000)</b>
<b>Within the Conservation Lands Network (CLN)</b>	
Existing Protected Lands (BPAD 2010)	970,000
Essential Areas added by the CLN	900,000
Important Areas added by the CLN	200,000
Fragmented Areas added by the CLN	120,000
<b>Conservation Lands Network Total</b>	<b>2,200,000</b>
Areas For Further Consideration	160,000
<b>Converted Lands in Study Area (excludes Baylands)</b>	
Urban	720,000
Cultivated Agriculture	370,000
Rural Residential	150,000
<b>Converted Lands Total</b>	<b>1,240,000</b>
Other Lands	690,000
<b>Study Area Total</b>	<b>4,300,000</b>

Achieving the vision of the Conservation Lands Network is a long-term process that will take decades. While the ultimate configuration will be different than presented here, the overall shape and size will likely remain recognizable. The CLN has built-in flexibility, so that as new, more accurate data are developed and more lands conserved, it can be updated to reflect the best opportunities for biodiversity conservation. It is also possible that some of the design rules for the CLN may change over time. For example, climate change may lead to adjustments in how targets are chosen and prioritized. Adaptive management is vital to success – goals, implementation, and stewardship approaches must be evaluated and modified at regular intervals. Biennial report cards will evaluate progress, update the Conservation Lands Network, and make any necessary adjustments to stewardship recommendations.

# Final Adjustments Made to Create Conservation Lands Network 1.0

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## Fine Filter Targets Added to the Conservation Lands Network

Because the Vegetation Focus Team set high goals (90%, 75%, and 50%) for every vegetation type in every landscape unit, most of the fine filter conservation targets were well covered by the Coarse Filter Conservation Lands Network. To address the few exceptions, a number of spatially explicit fine filter targets were included in the last run of the Marxan software, thereby reconfiguring the CLN to include a specified percentage of these targets. Some of these additional fine filter targets were data points; others were areas (polygons).

### Fine Filter Point Data Targets (total number of targets is 426):

1. Plant fine filter point targets (CNDDDB) – 90% goals for top 15 species, 75% for remaining species (see Appendix B (*Data and Methods*, Chapter 4) for plant fine filter target selection methodology).
2. Northern Spotted Owl territories (PRBO Conservation Science) – 75% goal.
3. Alameda Whipsnake occurrences (Karen Swaim, Swaim Biological Inc.) – 75% goal.
4. Ponds (National Hydrology Dataset and National Wetlands Inventory) – 75% goal in the smaller landscape units of American Canyon, Montezuma Hills, Middle East Bay Hills, and South East Bay Hills; 50% goal for the other landscape units.

### Fine Filter Polygon Targets (total number of targets is 384):

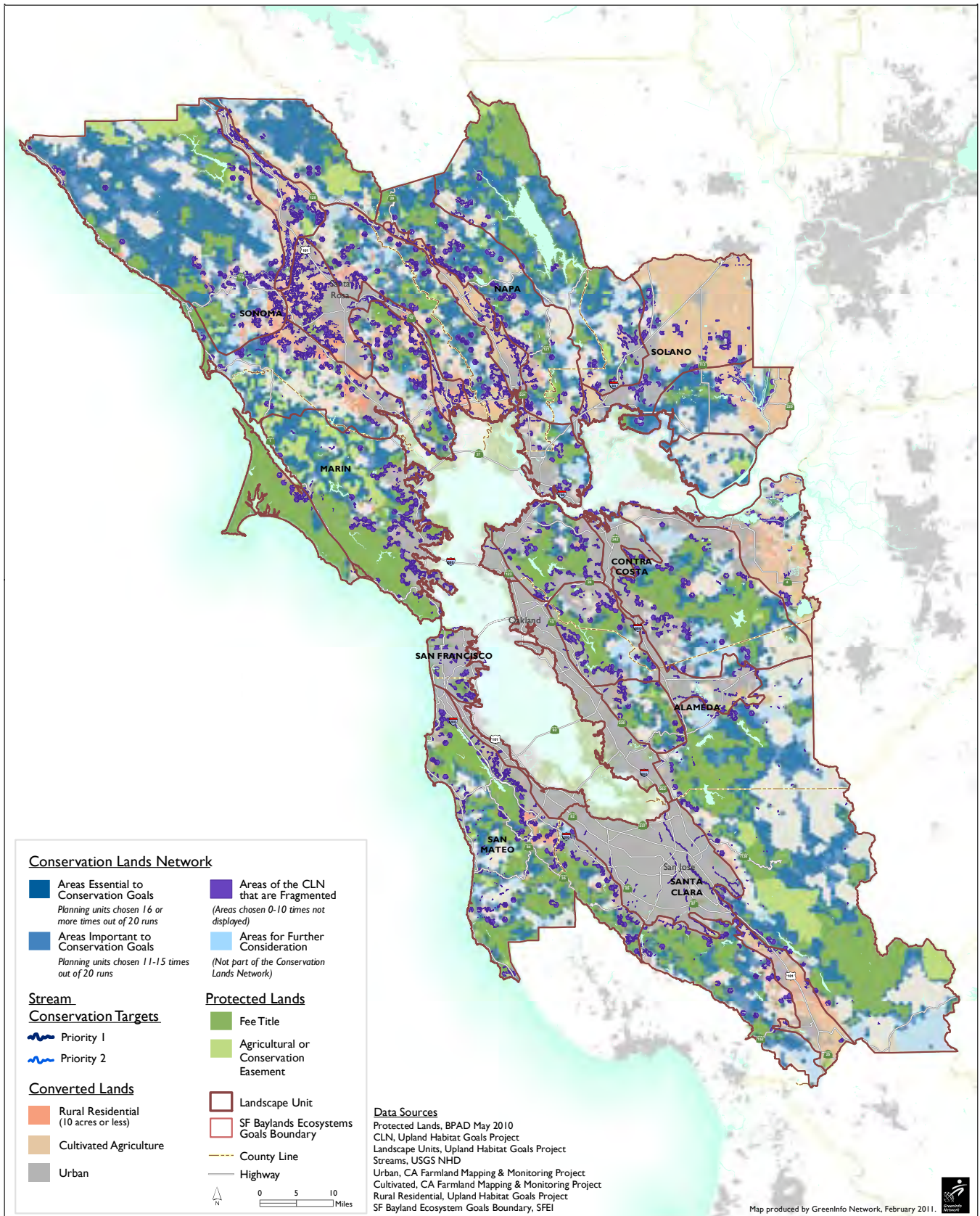
1. Old-growth redwoods and other old-growth conifers (Save the Redwoods League) – 90% goal.
2. Vernal pools (Department of Fish and Game) – 90% goal.
3. Plant fine filter polygon targets (CNDDDB) – 90% goals for top 15 species, 75% for remaining species (see Appendix B, *Data and Methods*, Chapter 4 for plant fine filter target selection methodology).
4. Laguna de Santa Rosa sensitive plants (Laguna de Santa Rosa Foundation) – 90% goal.

## Fragmented Areas of the Conservation Lands Network

Fragmented Areas in the CLN resulted when Converted Lands (Urban, Cultivated Agriculture, and Rural Residential land uses) were removed from the CLN after the final Marxan run. Marxan included Converted Lands in the CLN because high-value conservation targets were located in hexagons containing Converted Lands. As shown in Figure 3.9, if 25% or more of a 100ha hexagon was removed during the erasing process, the hexagon was labeled a *Fragmented Area* (Figure 10.3).

**While any selected area of the CLN requires site visits and biological surveys before conservation actions are taken, this is especially important for Fragmented Areas.** Fragmented Areas flag parts of the Conservation Lands Network with substantial land cover conversion, and ground truthing is crucial because the target locations may be inaccurate due to map scale, erasure of Converted Lands, or incomplete data. Furthermore, the targets may not be viable because of surrounding land uses. In cases where irreplaceable conservation features are found, restoration may be necessary for these areas to meet conservation goals of the CLN.

**Figure 10.3 ■ Fragmented Areas of the Conservation Lands Network.**



## Areas for Further Consideration

In general, the Conservation Lands Network 1.0 captures a coherent and representative network across the landscape units. However, the final review revealed a number of areas where the CLN failed to capture important biodiversity targets, develop a viable local configuration, or provide local (within-landscape unit) connectivity. In these cases, Stuart Weiss, PhD, project Science Advisor, and Ryan Branciforte, Bay Area Open Space Council Director of Conservation Planning, identified planning units (100ha hexagons) and labeled them *Areas for Further Consideration*.

These areas, highlighted in light blue in Figure 10.4, illustrate where the CLN may have fallen short for various reasons. Areas for Further Consideration were not added to the CLN because data is insufficient to determine which are most important. Decisions regarding specific lands to add to the Conservation Lands Network will require better biological data. A few key points about the Areas for Further Consideration should be noted:

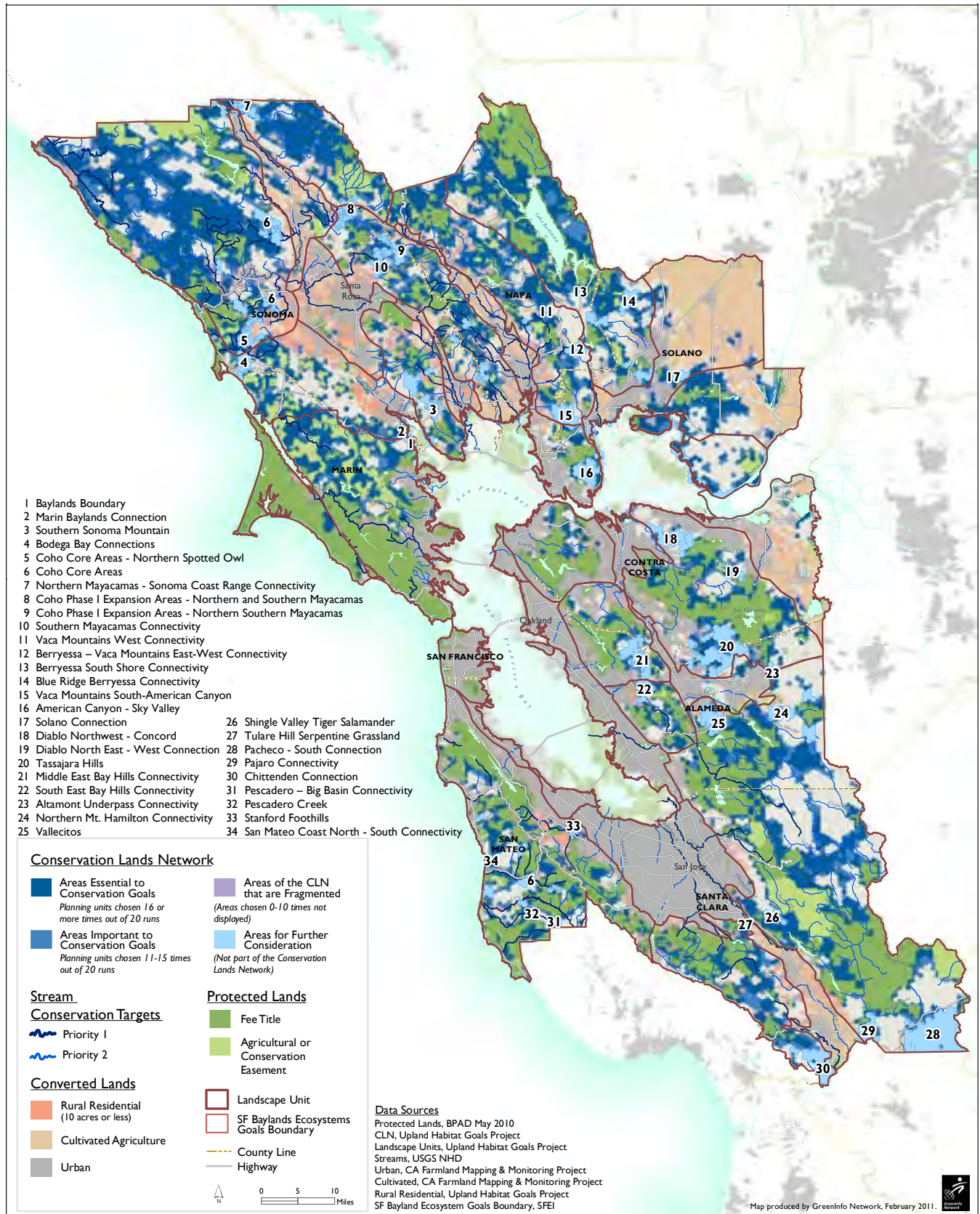
- A total of 700 planning units comprising approximately 160,000 acres were identified in 34 Areas for Further Consideration.
- These areas are generally Rarity Rank 3 matrix (common) vegetation types; many also contain ponds, an important conservation target.
- Regional and local connectivity were the primary reason for labeling Areas for Further Consideration; other areas had concentrations of important conservation targets.
- As Areas for Further Consideration are evaluated and the high biodiversity lands are added to the Conservation Lands Network, the CLN will be reconfigured.
- The Areas for Further Consideration are deliberately spatially broad, but it is anticipated that, once biological surveys are completed, only a portion of each highlighted planning unit will be added to the CLN.
- Reviewing Areas for Further Consideration will be an ongoing process; the conservation community is encouraged to provide feedback that will inform future updates to the CLN.

Each Area for Further Consideration, the reason for its inclusion, and the number of planning units it encompasses is described below. The numbers correspond to those in Figure 10.4. Note that some of the Areas for Further Consideration are composed of several discontinuous areas.

1. **Baylands Boundary** (40 planning units). All planning units along the baylands boundary, exclusive of those in Urban or Cultivated Agriculture uses, are important to cope with sea level rise and provide connections between baylands and uplands. All of these are in the North Bay, with the greatest opportunities in the Montezuma Hills and Solano Delta Landscape Units. Small slivers around the Petaluma River were also included.
2. **Marin Baylands Connection** (3 planning units). These planning units in the Marin Coast Range Landscape Unit provide local connectivity from inland areas to the Baylands.
3. **Southern Sonoma Mountain** (27 planning units). These planning units provide local connectivity within the Sonoma Mountain Landscape Unit, including across Highway 116, and include many ponds that may support California Red-legged Frog. The goal is to create a network of protected ponds for metapopulation viability.
4. **Bodega Bay Connections** (13 planning units). These planning units provide a key regional linkage from the Coastal Grasslands Landscape Unit to the Sonoma Coast Range Landscape Unit via the shortest path.
5. **Coho Core Areas – Northern Spotted Owl** (13 planning units). These planning units in the Sonoma Coast Range Landscape Unit cover both Coho Core Areas and known territory for Northern Spotted Owl.



**Figure 10.4 ■ Areas for Further Consideration in the Conservation Lands Network.**



6. **Coho Core Areas** (60 planning units). These planning units complete Coho Core Area watersheds in the Sonoma Coast Range and Santa Cruz Mountains North Landscape Units that did not fall within the Conservation Lands Network.
7. **Northern Mayacamas – Sonoma Coast Range Connectivity** (15 planning units). These planning units form an important regional connection north of Cloverdale across Highway 101 and the Russian River between the Sonoma Coast Range and North Mayacamas Mountains Landscape Units.
8. **Coho Phase I Expansion Areas – Northern and Southern Mayacamas** (14 planning units). This area establishes regional connectivity between the Northern and Southern Mayacamas Landscape Units, and falls within Coho Phase I Expansion Area watersheds identified in the draft coho recovery plan.
9. **Coho Phase I Expansion Areas – Northern Southern Mayacamas** (15 planning units). These planning units provide connectivity in the northern part of the Southern Mayacamas Landscape Unit and cover Coho Phase I Expansion Areas.
10. **Southern Mayacamas Connectivity** (32 planning units). These units offer local connectivity within the Southern Mayacamas Landscape Unit and include Priority 1 steelhead watersheds.
11. **Vaca Mountains West Connectivity** (4 planning units). This area provides internal connectivity within the Vaca Mountains West Landscape Unit.
12. **Berryessa – Vaca Mountains East-West Connectivity** (9 planning units). These planning units establish east-west connectivity between the Blue Ridge Berryessa and Vaca Mountains West Landscape Units.
13. **Berryessa South Shore Connectivity** (4 planning units). This area creates a wider east-west linkage just south of Lake Berryessa in the Blue Ridge Berryessa Landscape Unit.
14. **Blue Ridge Berryessa Connectivity** (21 planning units). These planning units establish local connectivity within the Blue Ridge Berryessa Landscape Unit.
15. **Vaca Mountains South-American Canyon** (21 planning units). This area provides a regional connection from the southern end of the Vaca Mountains West Landscape Unit across Highway 12 to the American Canyon Landscape Unit.
16. **American Canyon – Sky Valley** (20 planning units). These planning units in the American Canyon Landscape Unit include good grassland habitat that supports Callippe Silverspot Butterfly. The ponds within the grasslands support California Red-legged Frog and Western Pond Turtle.
17. **Solano Connection** (15 planning units). This area – mostly within the Solano Plains Landscape Unit and including Lagoon Valley – forms an east-west connection across Highway 80 from the Blue Ridge Berryessa Landscape Unit through the Solano Plains and Solano Delta Landscape Units and to the Montezuma Hills Landscape Unit. This is the only opportunity to connect the Montezuma Hills Landscape Unit to the rest of the region.
18. **Diablo Northwest – Concord** (30 planning units). These planning units are in the Mt. Diablo Range Landscape Unit, extending northwest from Black Diamond Mines Regional Park to include the proposed open space within the Concord Naval Weapons Station, as well as a complex of ponds with many known occurrences of California Red-legged Frog and California Tiger Salamander.
19. **Diablo North East-West Connection** (8 planning units). These planning units are the shortest distance to establish east-west connectivity in the northern part of the Mt. Diablo Range Landscape Unit.
20. **Tassajara Hills** (58 planning units). This large area in the southern Mt. Diablo Range Landscape Unit spans the grasslands and ponds of the Tassajara Hills, and affords local connectivity and important grassland habitat for species such as Burrowing Owl, badger, and numerous ponds for California Red-legged Frog, California Tiger Salamander, and Western Pond Turtle.
21. **Middle East Bay Hills Connectivity** (29 planning units). These planning units provide connectivity within the Middle East Bay Hills Landscape Unit in both north-south and east-west directions.



Stuart B. Weiss

22. **South East Bay Hills Connectivity** (12 planning units). The selected planning units afford local connectivity at the northern end of the South East Bay Hills Landscape Unit, including potential connections to the few crossings of Highway 580 to the Middle East Bay Hills Landscape Unit.
23. **Altamont Underpass Connectivity** (5 planning units). These planning units contain two opportunities – a seasonal stream and a railroad – for essential connections between the Mt. Diablo Range and Mt. Hamilton Landscape Units at the eastern edge of the Tri-Valley Landscape Unit.
24. **Northern Mt. Hamilton Connectivity** (28 planning units). These planning units in the Mt. Hamilton Landscape Unit provide important local and regional connectivity from Altamont Pass south and west into the Mt. Hamilton Range, and include many ponds that likely support California Red-legged Frog and California Tiger Salamander. They supplement the connectivity provided by wind farms for many terrestrial species in this crucial linkage area.
25. **Vallecitos** (24 planning units). This area in the northwestern part of the Mt. Hamilton Landscape Unit supports known populations of California Red-legged Frog, California Tiger Salamander, Western Pond Turtle, and Callippe Silverspot Butterfly.
26. **Shingle Valley Tiger Salamander** (8 planning units). These planning units in the Mt. Hamilton Landscape Unit support California Tiger Salamander and California Red-legged Frog in a series of ponds, connect the serpentine grasslands of Coyote Ridge with the interior of the Mt. Hamilton Range, and are within the range of tule elk.
27. **Tulare Hill Serpentine Grassland** (1 planning unit). A section of serpentine grassland on Tulare Hill in the Sierra Azul Landscape Unit was protected after Marxan was run for the final time. As a result, it was not included in the CLN. Tulare Hill forms a key part of a potential linkage across Coyote Valley from the Santa Cruz Mountains to the Mt. Hamilton Range. It will be included in the first update of the Conservation Lands Network.
28. **Pacheco – South Connection** (90 planning units). This extensive area in the Mt. Hamilton Landscape Unit south of Pacheco Pass on Highway 152 has little biological documentation, but provides key regional connections to San Benito County to the south. The many ponds in this area support California Red-legged Frog, California Tiger Salamander, and Western Pond Turtle.
29. **Pajaro Connectivity** (21 planning units). Also in the Mt. Hamilton Landscape Unit, these planning units provide connectivity to Soap Lake Basin, a largely agricultural floodplain with the Pajaro River riparian zone. This area may provide a linkage between the Santa Cruz Mountains and Mt. Hamilton Range.
30. **Chittenden Connection** (34 planning units). This area at the southern end of the Sierra Azul Landscape Unit provides key regional connections between the southern Santa Cruz Mountains across the Pajaro River at Chittenden Gap to San Benito and Monterey Counties.
31. **Pescadero Big Basin Connectivity** (5 planning units). These planning units in the Santa Cruz Mountains North Landscape Unit establish direct connectivity between the Pescadero Creek watershed and Big Basin State Park in Santa Cruz County.
32. **Pescadero Creek** (5 planning units). This area in the Santa Cruz Mountains North Landscape Unit provides connectivity in the Pescadero Creek watershed to the coast.
33. **Stanford Foothills** (4 planning units). These planning units on the eastern edge of the Santa Cruz Mountains North Landscape Unit are a mix of locally unique low-elevation grassland and oak woodland that connect the foothills west of Stanford University, conserving habitat for California Red-legged Frog and California Tiger Salamander.
34. **San Mateo Coast North – South Connectivity** (12 planning units). Also in the Santa Cruz Mountains North Landscape Unit, these planning units offer a series of north-south linkages along the San Mateo Coast.



Kathy Switky

## Results of the Conservation Lands Network Gap Analyses

After the fine filter review and recommended adjustments, a gap analysis was performed on the nearly final Conservation Lands Network to assess whether the goals had been met. The gap analysis compared the acreage goals of each vegetation type in every landscape unit to the actual acreages included in the Conservation Lands Network. Two additional gap analyses were conducted: one for the fine filter targets using point data, and the other for the fine filter targets using area data.

Because the Upland Habitat Goals methodology configured Marxan to meet all of the goals even if it meant selecting lands of lower conservation suitability, the vast majority of goals were met or exceeded by the Conservation Land Network. Nearly all of the missed targets fall within Converted Lands; when percentage of goals attained is calculated without targets in the Converted Lands, the success rate increases substantially. In the few instances where coarse filter vegetation type goals were not met, two main factors were the cause:

1. The 50% goal for the Rarity Rank 3 common vegetation types gives Marxan a lot of flexibility in selecting areas to meet this goal. In areas comprised primarily of Rank 3 vegetation types with no fine filter targets (such as the Montezuma Hills), the result is that many planning units are selected 8, 9, or 10 times, but still fall below the threshold of 11 times for inclusion in Important Lands.
2. Small patches of vegetation (<100ac) in fragmented valley bottoms were removed from the CLN when Converted Lands were erased after the final Marxan run creating Fragmented Areas.

Similarly, not all fine filter target goals were met by the CLN. This was primarily due to two factors: the post-Marxan erasure of Converted Lands, and low numbers of occurrences (1 - 5) for many species where the loss of a single occurrence greatly affects the percentage goal achieved.

In evaluating the effectiveness of the CLN to meet the established conservation targets, the Project Team relaxed the success criteria for achieving the goals from 100% to 95% for coarse filter targets, and to 90% for fine filter targets relying on species occurrences in the California Natural Diversity Database (CNDDB). The reasons for the slightly lower criteria are the potential for mapping and/or vegetation type classification errors, and in recognition of the loss of some targets when Converted Lands were erased from the last Marxan run.

### Coarse Filter Target Gap Analysis Results

The Conservation Lands Network more than met the goals for vegetation types across the study area (Figure 10.5). For many vegetation types, the CLN significantly exceeds the acreage goals because Marxan selects an entire 100ha hexagon when a target species is present. Gap analysis results for all vegetation type by landscape unit conservation targets are detailed in Appendix C (see last column: Actual Acreage in CLN).



**Figure 10.5 ■ Summary of Vegetation Type (Coarse Filter) Acreage Goals Compared to Acreage in the Conservation Lands Network.** The column labeled *Actual Acreage in CLN* includes protected lands that are part of the CLN. The table does not include non-native vegetation types, Cultivated Agriculture, or Rural Residential land uses, although some of these land cover types are included in the CLN. Additionally, some baylands are included in the CLN where hexagons were selected to insure connectivity in these areas.

Vegetation Type	Total Acreage	Acreage Goals by Rarity Rank			Total Acreage Goals	Protected Acreage	Acreage to Meet Goals	Actual Acreage in CLN*
		1 (90%)	2 (75%)	3 (50%)				
Barren / Rock	6,654	287	4,751	0	5,038	1,378	3,684	5,622
Bishop Pine Forest	7,224	3,481	8	1,673	5,162	3,968	2,569	6,894
Black Oak Forest / Woodland	4,193	2,381	1,160	0	3,541	333	3,208	3,866
Blue Oak / Foothill Pine Woodland	32,516	376	24,073	0	24,449	12,184	12,266	25,672
Blue Oak Forest / Woodland	191,358	1,487	6,742	90,358	98,587	70,637	29,847	137,426
California Bay Forest	48,913	1,525	11,645	15,846	29,016	27,266	6,854	44,376
Canyon Live Oak Forest	7,154	166	5,227	0	5,393	1,459	3,941	6,068
Central Coast Riparian Forest	13,704	12,334	0	0	12,334	5,187	7,175	13,015
Chamise Chaparral	91,771	1,296	31,110	24,426	56,831	43,942	12,895	74,124
Coast Live Oak Forest / Woodland	213,052	529	21,136	92,141	113,806	91,461	28,477	152,137
Coastal Salt Marsh / Coastal Brackish Marsh	1,880	1,692	0	0	1,692	899	815	1,720
Coastal Scrub	90,173	3,681	41,706	15,237	60,625	59,813	12,587	79,124
Coastal Terrace Prairie	870	783	0	0	783	12	771	835
Cool Grasslands	72,283	14,767	41,906	0	56,674	41,948	18,373	61,620
Coulter Pine Forest	266	239	0	0	239	68	179	258
Douglas-Fir Forest	163,145	3,517	5,674	75,836	85,027	65,960	35,355	134,229
Dune	771	694	0	0	694	489	222	747
Grand Fir	216	194	0	0	194	53	141	213
Hot Grasslands	269,259	0	0	134,629	134,629	54,433	81,104	154,223
Interior Live Oak Forest / Woodland	8,923	8	6,686	0	6,694	4,639	2,216	7,673
Juniper Woodland and Scrub / Cismontane Juniper Woodland	197	178	0	0	178	197	0	197
Knobcone Pine Forest	6,755	466	4,678	0	5,144	2,320	2,824	5,906
McNab Cypress	9,677	8,710	0	0	8,710	5,101	3,701	9,663
Mixed Chaparral	15,139	0	11,354	0	11,354	3,995	7,362	11,959
Mixed Conifer / Pine Forest	430	0	323	0	323	135	188	384
Mixed Montane Chaparral	145,329	1	31,061	51,957	83,018	44,452	39,350	113,994
Moderate Grasslands	143,794	0	0	71,897	71,897	62,570	13,651	114,236
Montane Hardwoods	327,514	178	17,296	152,128	169,601	90,190	80,304	228,695
Monterey Cypress Forest	91	0	0	42	42	53	3	82
Monterey Pine Forest	1,958	0	0	979	979	1,593	155	1,917
Native Grassland	1,165	1,049	0	0	1,049	877	172	1,144
Oregon Oak Woodland	37,876	1,448	27,201	0	28,649	4,812	23,836	29,718
Permanent Freshwater Marsh	2,361	2,125	0	0	2,125	498	1,631	2,157
Ponderosa Pine Forest (Non-Maritime)	11,521	30	8,616	0	8,646	2,626	6,172	9,173
Pygmy Cypress Forest	106	96	0	0	96	106	0	106
Redwood Forest	172,431	5,906	53,829	47,048	106,783	49,623	57,867	125,814
Sargent Cypress Forest / Woodland	2,955	2,660	0	0	2,660	2,318	519	2,943

Vegetation Type	Total Acreage	Acreage Goals by Rarity Rank			Total Acreage Goals	Protected Acreage	Acreage to Meet Goals	Actual Acreage in CLN*
		1 (90%)	2 (75%)	3 (50%)				
Semi-Desert Scrub / Desert Scrub	45,901	87	34,353	0	34,440	26,222	9,547	37,626
Serpentine Barren	1,149	1,034	0	0	1,034	707	349	1,148
Serpentine Conifer	8,095	7,285	0	0	7,285	3,273	4,021	7,665
Serpentine Grassland	16,632	14,671	248	0	14,919	5,992	8,927	15,341
Serpentine Hardwoods	16,863	15,177	0	0	15,177	5,572	9,614	15,784
Serpentine Knobcone Pine	457	411	0	0	411	238	185	455
Serpentine Leather Oak Chaparral	39,386	11,810	19,697	0	31,508	18,195	13,344	38,081
Serpentine Riparian	135	121	0	0	121	57	64	118
Serpentine Scrub	1,026	924	0	0	924	551	375	973
Sycamore Alluvial Woodland	97	87	0	0	87	68	25	96
Tanoak Forest	28,065	25,259	0	0	25,259	2,044	23,218	26,476
Valley Oak Forest / Woodland	6,795	6,115	0	0	6,115	2,729	3,405	6,378
Warm Grasslands	516,149	0	3,964	255,432	259,396	130,235	129,160	309,172
Wet Meadows	205	185	0	0	185	46	139	192
<b>Total</b>	<b>2,784,579</b>	<b>155,450</b>	<b>414,444</b>	<b>1,029,629</b>	<b>1,599,523</b>	<b>953,526</b>	<b>702,787</b>	<b>2,027,435</b>

\* Includes protected lands (BPAD 2010)

The CLN meets or exceeds the coarse filter target goals 95% of the time for all but 29 of the 556 targets, yielding a 94.8% success rate overall. The four coarse filter targets with the highest missed acreage goals are:

1. **Hot Grasslands in the Montezuma Hills Landscape Unit.** The Conservation Lands Network meets only 71% of the goal in this landscape unit, coming up 5,106 acres short (~21 hexagons). The Montezuma Hills Landscape Unit is comprised primarily of Warm Grasslands, a Rarity Rank 3 with a 50% goal, and few Rarity Rank 1 or fine filter targets that must be included in the CLN. This situation leaves Marxan great flexibility and few constraints for selecting hexagons in Hot Grasslands. The end result is Marxan chose many hexagons 8, 9, or 10 times, but did not reach the minimum of 11 times to be added to the CLN. These factors leave the CLN fragmented and discontinuous in the Montezuma Hills Landscape Unit.

Extensive dry land farming, wind farms, and virtually unknown biodiversity values make any Marxan-generated network suspect without ground surveys. More detail about the Montezuma Hills Landscape Unit can be found at [www.BayAreaLands.org/gis/landscape-unit-maps.php](http://www.BayAreaLands.org/gis/landscape-unit-maps.php).

2. **Hot Grasslands in the Mt. Hamilton Landscape Unit.** The CLN meets 83% of the goal for Hot Grasslands in the Mt. Hamilton Landscape Unit, falling 3,780 acres short (~15 hexagons). Hot Grasslands in the Mt. Hamilton Range Landscape Unit are a Rarity Rank 3 with a 50% goal; these are widely distributed and total nearly 46,000 acres. Thus Marxan had much flexibility and few constraints so while many planning units were chosen 8, 9, or 10 times, they did not reach the minimum of 11 times to be added to the Conservation Lands Network. Two Areas for Further Consideration in this landscape unit, Northern Mt. Hamilton Connectivity and Pacheco-South Connection, contain several thousand acres of Hot Grasslands, some of which will eventually be added to the CLN.

3. **Warm Grasslands in the North Contra Costa Valley Landscape Unit.** The CLN met only 65% of the goal for Warm Grasslands in the North Contra Costa Valley Landscape Unit. Falling 508 acres short of the goal is significant in this small landscape unit. This acreage shortfall is anticipated to be more than met if the open space proposed for the Concord Naval Weapons Station is transferred to the East Bay Regional Park District.

4. **Warm Grasslands in the Middle East Bay Hills Landscape Unit.** The CLN just misses the goal at 93%, some 395 acres short. This shortfall can be attributed to the Marxan algorithm. Additional areas added from the Middle East Bay Hills Area for Further Consideration will likely compensate for this.

The remaining 25 vegetation type targets for which the acreage goals were not met are located in developed valleys and Fragmented Areas. The missed vegetation target areas are small (less than 100ac), and vegetation mapping inaccuracy at these fine scales casts doubt on the actual location and identity of the vegetation type. Detailed fine-scale planning in developed valleys is not appropriate for the regional scale of the Upland Habitat Goals Project.

### Fine Filter Point Target Gap Analysis Results

Two categories of fine filter point data – ponds and species occurrences (CNDDDB and other sources) – were included in Marxan as conservation targets. The complete table of fine filter point and polygon targets by landscape unit can be reviewed at [www.BayAreaLands.org/gis/tables.php](http://www.BayAreaLands.org/gis/tables.php).

1. **Pond Gap Analysis.** Pond goals were set at 50% (based on the total number of ponds in each landscape unit) for all but American Canyon, Montezuma Hills, Middle, and South East Bay Hills Landscape Units, where the goal was 75%. Pond goals were met in 15 of 29 non-urban landscape units, leaving 14 landscape units short (Figure 10.6). The gaps occurred mainly in landscape units with developed valleys and fragmented habitat, and in smaller landscape units such as the East Bay Hills and Sonoma Mountain.

**Figure 10.6 ■ Landscape Units not Meeting Pond Conservation Goals.** Gap analysis showed that in 14 landscape units, the Conservation Lands Network (CLN) did not meet the pond conservation goals (50% or 75%). These gaps were reduced when available ponds (those not in Converted Lands) were considered, and reduced even further when Areas for Further Consideration (AFC) were added. Only four landscape units (highlighted) did not meet the conservation goals after these adjustments.

Landscape Unit (LU)	% Goal	Total Ponds in LU	Total Ponds in CLN	% Total in CLN	Total # of Available Ponds	% of Available Ponds in CLN	Total Ponds in AFCs	Total Ponds in AFCs + CLN	% Total in AFCs + CLN	% of Available Ponds in CLN + AFCs
American Canyon	75%	126	74	59%	103	72%	12	86	68%	83%
Contra Costa Delta*	50%	113	19	17%	44	43%	No AFCs	19	17%	43%
Middle East Bay Hills	75%	129	66	51%	102	65%	25	91	71%	89%
Napa Valley*	50%	223	29	13%	45	64%	No AFCs	29	13%	64%
Russian River Valley*	50%	145	59	41%	106	56%	No AFCs	59	41%	56%
Santa Clara Valley*	50%	112	27	24%	63	43%	7	34	30%	54%
Santa Rosa Plain*	50%	122	40	33%	52	77%	No AFCs	40	33%	77%
Solano Plains*	50%	138	36	26%	65	55%	No AFCs	36	26%	55%
Sonoma Coast Range**	50%	261	103	39%	209	49%	No ponds in AFCs	103	39%	49%
Sonoma Mountain	75%	285	119	42%	228	52%	32	151	53%	52%
Sonoma Valley*	50%	101	23	23%	35	66%	No AFCs	23	23%	66%
South East Bay Hills	75%	157	103	66%	137	75%	14	117	75%	85%
Southern Mayacamas Mountains	50%	585	233	40%	437	53%	46	279	48%	64%
Tri-Valley*	50%	66	12	18%	36	33%	No AFCs	12	18%	33%

\* Heavily fragmented valley bottom landscape units

\*\* Poor data – available only from National Hydrographic Database, not National Wetland Inventory



Erasing the Converted Lands from the final Marxan configuration reduced the number of ponds included in the CLN, leaving goals in some landscape units unmet. If only those ponds located outside of Converted Lands (available ponds) are considered, the CLN met the 50% goal for landscape units outside of developed valleys. These landscape units generally have larger numbers of ponds (more than 100) so it is important to achieve the conservation goals for them.

Even including available ponds, a few landscape units fell short of the goals. Including some Areas for Further Consideration in key landscape units (Middle East Bay Hills, Sonoma Mountain) will ensure that additional ponds will be added to the CLN once biological surveys are completed for these areas.

In considering pond networks within landscape units, it is important to keep the total number of ponds in the CLN in mind, since the viability of amphibian metapopulations depends on the number of ponds, as well as how those ponds are managed (see Chapter 8, *Fine Filter: Amphibians, Reptiles, and Invertebrates*).

2. **CNDDDB and Other Species Occurrences Gap Analysis.** Goals for these fine filter targets were either 90% or 75% of the total number in each landscape unit. These data included CNDDDB and other occurrence records for plant fine filter point targets, Northern Spotted Owl Territories, and Alameda Whipsnake. Of the total 426 species occurrence point data, all but 85 met their goals. Areas where goals were not met are generally valleys with significantly fragmented habitats; most of these were the result of the erasure of Converted Lands containing targets. Forty-three occurrences were located only in Converted Lands, and hence were erased after the final Marxan run. For other occurrences, the total numbers in some landscape units were between one and five, so erasing a single occurrence led to a failure to meet the goals.

However, if only the occurrences outside of Converted Lands (the available occurrences) were used to calculate success in attaining the goals, just one of the 417 occurrence targets failed to meet the goals. The incompleteness of CNDDDB, lack of good occurrence data, and the complex conservation problems in areas with Converted Lands indicate a need for detailed surveys for many of these species.

### Fine Filter Polygon Target Gap Analysis Results

The vast majority – 320 out of a total of 384 – of fine filter polygon goals were met or exceeded. Fine filter polygon targets included old-growth redwood, other old growth, vernal pools, Laguna de Santa Rosa sensitive plants, and CNDDDB species area data with 75% and 90% goals. Of the 64 fine filter polygon targets that failed to meet the goal, all but five met their goal once target areas in Converted Lands were removed from the calculation.

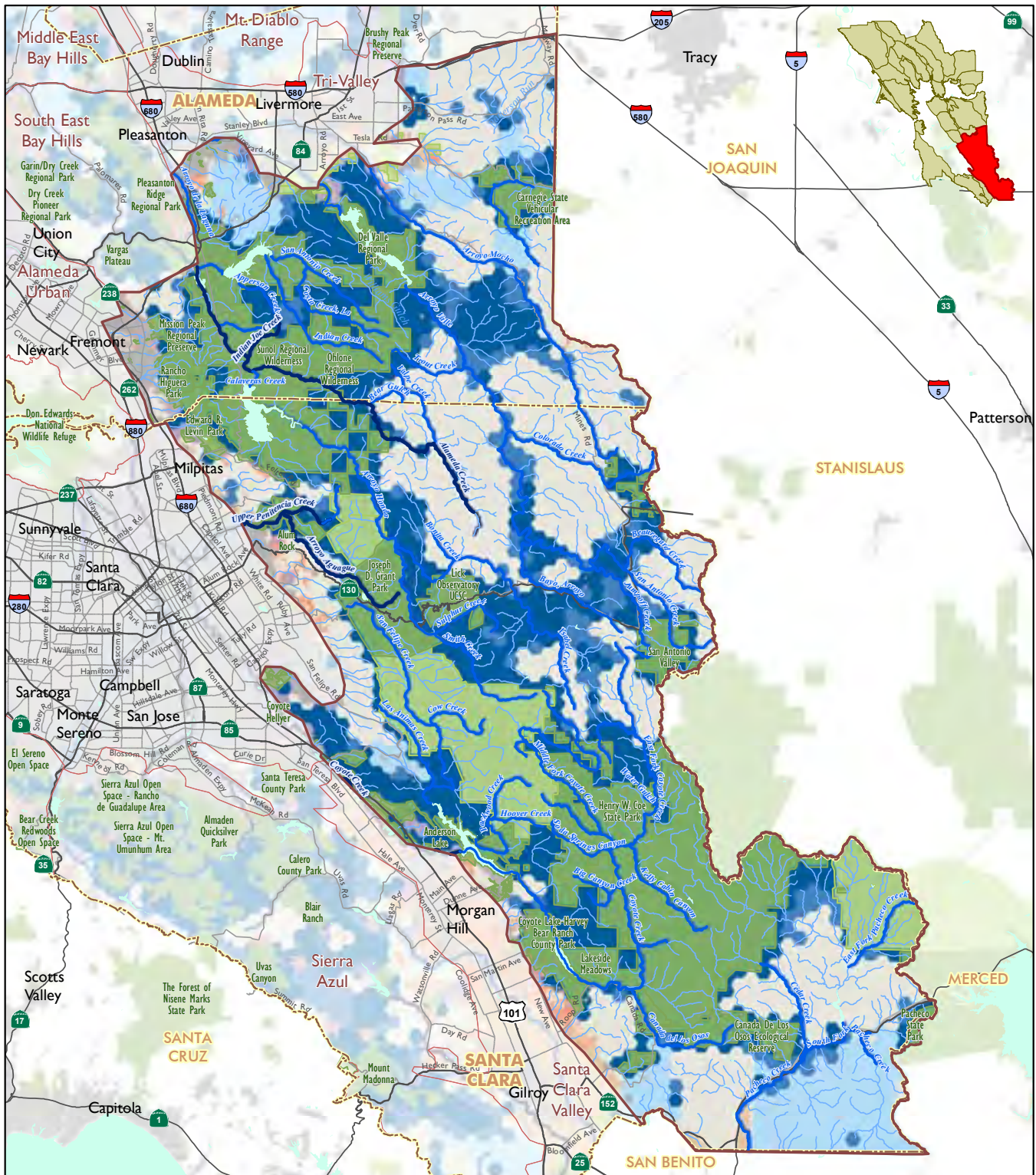
Like all the conservation targets, fine filter polygon targets were similarly affected by the erasure of Converted Lands, especially in heavily developed and fragmented valley floors. The biases of CNDDDB reporting (described in Chapter 4, *Coarse Filter: Vegetation*) may play a role; it is likely that more surveys and reporting – and thus more CNDDDB records – occur in Fragmented and Rural Residential Areas. Fine-scale planning for these polygon targets is required, especially in Fragmented Areas. A table of the fine filter polygon occurrences can be found at [www.BayAreaLands.org/gis/tables.php](http://www.BayAreaLands.org/gis/tables.php).

## Landscape Unit Conservation Lands Network and Vegetation Maps

Maps presenting the Conservation Lands Network and vegetation maps for each landscape unit are available for review at [www.BayAreaLands.org/gis/landscape-unit-maps.php](http://www.BayAreaLands.org/gis/landscape-unit-maps.php). Examples of these maps are in Figures 10.7 and 10.8.



**Figure 10.7 ■ Conservation Lands Network for the Mt. Hamilton Landscape Unit.** Detailed maps such as this example are available online ([www.BayAreaLands.org/gis/landscape-unit-maps.php](http://www.BayAreaLands.org/gis/landscape-unit-maps.php)) for each landscape unit within the study area.

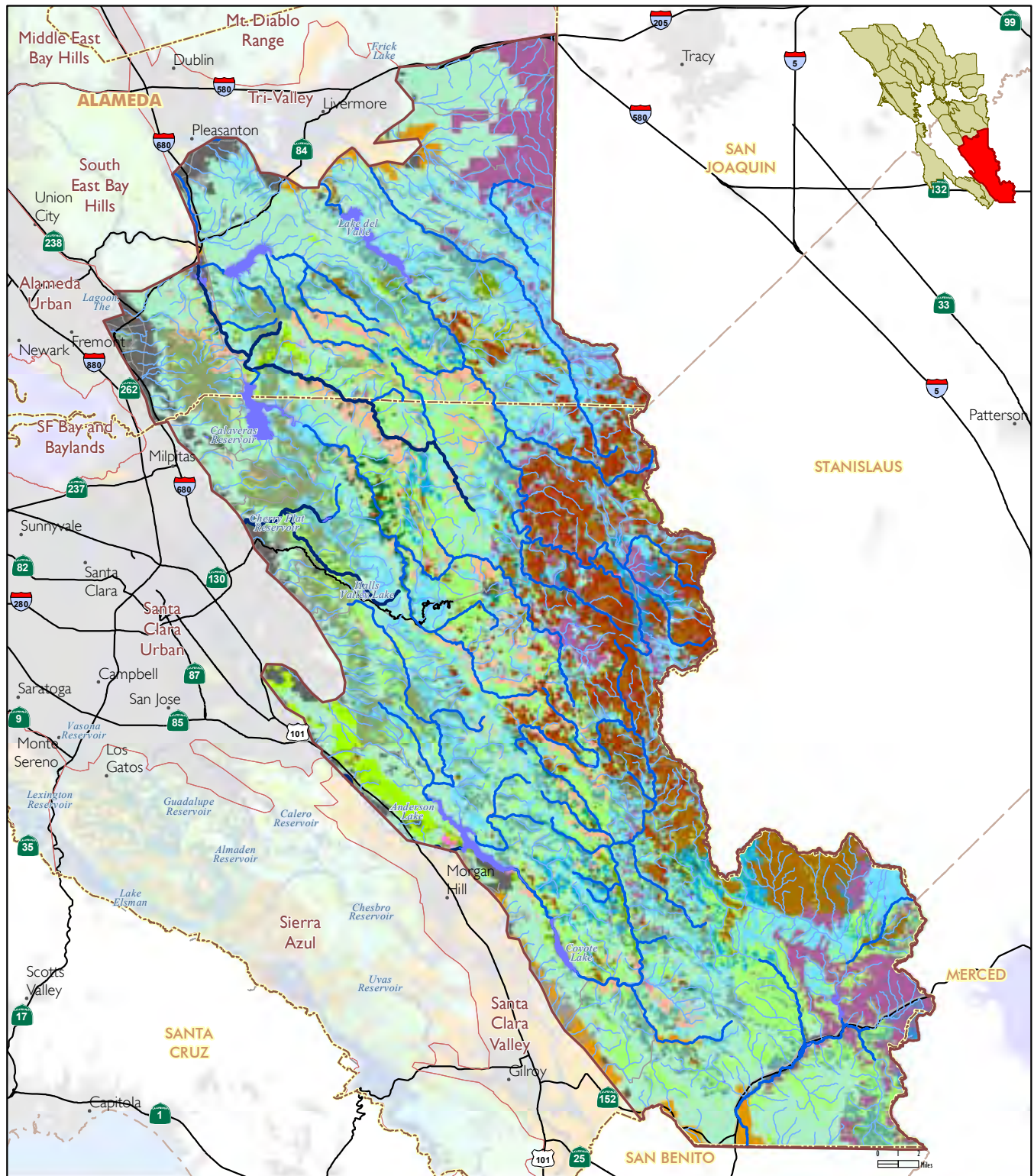


### Conservation Lands Network for Mount Hamilton Landscape Unit

Conservation Lands Network		Stream Conservation Targets	Converted Lands	Protected Lands
	Areas Essential to Conservation Goals Planning units chosen 16 or more times out of 20 runs			
	Areas Important to Conservation Goals Planning units chosen 11-15 times out of 20 runs			
	Fragmented Areas of the CLN (Areas chosen 0-10 times not displayed)			
	Areas for Further Consideration			

Map produced by GreenInfo Network for BAOSC, April 2011.

**Figure 10.8 ■ Vegetation Map for the Mt. Hamilton Landscape Unit.** Detailed maps such as this example are available online ([www.BayAreaLands.org/gis/landscape-unit-maps.php](http://www.BayAreaLands.org/gis/landscape-unit-maps.php)) for each landscape unit within the study area.



**Vegetation for Mount Hamilton Landscape Unit**

Barren / Rock	Central Coast Riparian Forest	Cultivated Agriculture	Montane Hardwoods	Semi-Desert Scrub / Desert Scrub	Serpentine Riparian	Water	Landscape Unit Boundary	Stream Conservation Targets Priority 1
Black Oak Forest / Woodland	Chamise Chaparral	Eucalyptus	Non-Native / Ornamental Conifer	Serpentine Barren	Serpentine Scrub	Priority 2		
Blue Oak / Foothill Pine Woodland	Coast Live Oak Forest / Woodland	Hot Grasslands	Non-Native / Ornamental Grass	Serpentine Conifer	Sycamore Alluvial Woodland	Priority 3		
Blue Oak Forest / Woodland	Coastal Scrub	Mixed Chaparral	Non-Native Ornamental Conifer / Hardwood Mixture	Serpentine Grassland	Urban			
California Bay Forest	Coulter Pine Forest	Mixed Montane Chaparral	Ponderosa Pine Forest (Non-Maritime)	Serpentine Hardwoods	Valley Oak Forest / Woodland			
		Moderate Grasslands	Rural Residential	Serpentine Leather Oak Chaparral	Warm Grasslands			

# CHAPTER 11

## Interpreting the Conservation Lands Network



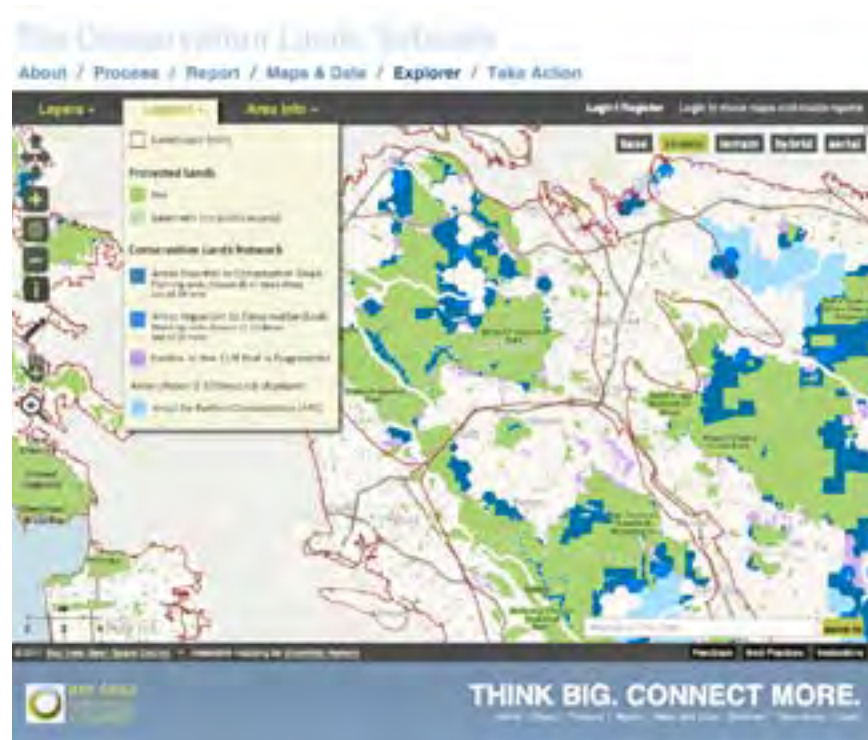
Annie Burke

### Introduction

The creation of a shared vision for biodiversity conservation is a valuable asset for the San Francisco Bay Area. The Conservation Lands Network (CLN) and the goals it represents will be realized through the completion of many smaller projects carried out over several decades by many partners using a variety of conservation tools. The CLN can serve as a guide for these conservation actions by offering insights into the biodiversity value of a specific property, serving as a preliminary conservation plan for a subregion, or identifying appropriate mitigation lands.

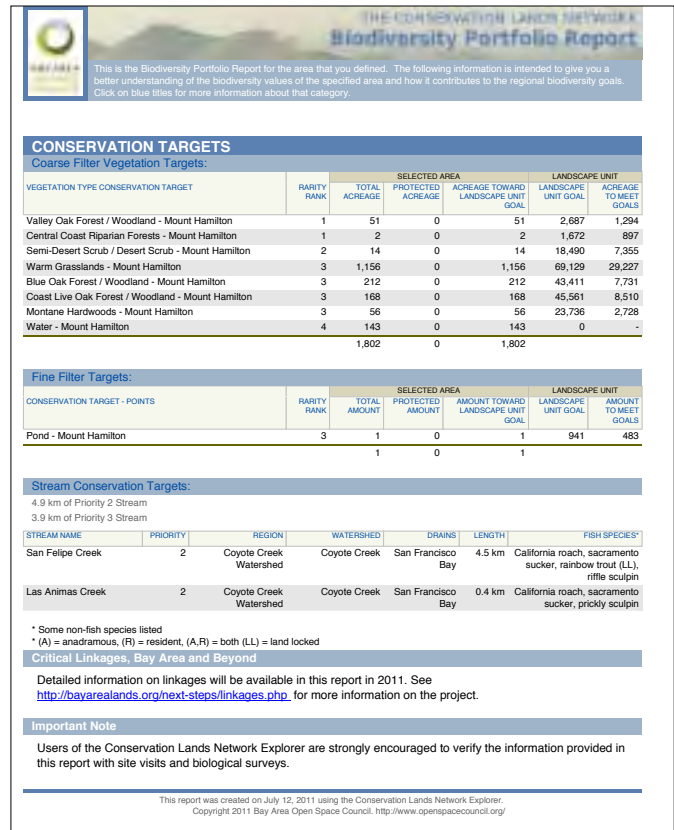
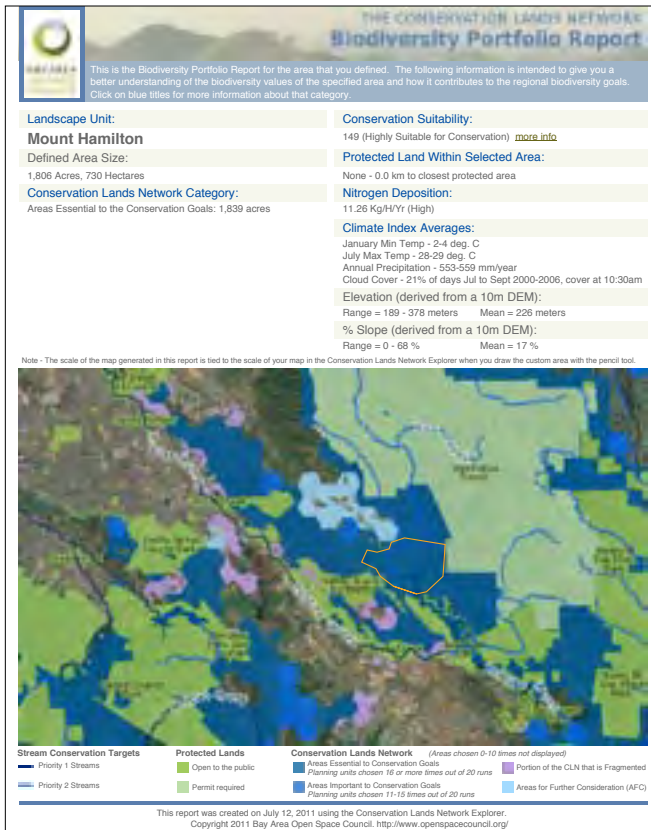
Another significant advancement is the development of the Conservation Lands Network Explorer (Figure 11.1), an online tool that makes the maps and underlying data of the CLN readily available. CLN Explorer provides real-time guidance for interpreting the results for an area of interest. After selecting an area of interest, the user can create a Biodiversity Portfolio Report (Figure 11.2) that summarizes key attributes of the selected area. The website [www.BayAreaLands.org](http://www.BayAreaLands.org) also offers the downloadable CLN GIS Database for custom analyses. The website, CLN Explorer, and CLN GIS Database will be updated at least every two years to reflect changes to the Conservation Lands Network.

**Figure 11.1 ■ Screenshot of Conservation Lands Network Explorer.** CLN Explorer allows the user to easily access the Conservation Lands Network and the underlying data. It can be accessed at [www.BayAreaLands.org/explorer](http://www.BayAreaLands.org/explorer).



**Applying the Conservation Lands Network** to specific areas or properties **MUST** be followed by further investigation, including site visits and biological surveys, due to the scale and coarseness of the data.

**Figure 11.2 ■ Biodiversity Portfolio Report from CLN Explorer.** After selecting an area of interest, users can create a summary report such as this at [www.BayAreaLands.org/explorer](http://www.BayAreaLands.org/explorer).



By itself, the Conservation Lands Network will not make final decisions for practitioners – individual and collective professional judgments are essential. Users must understand the methodology, strengths, and limitations of Marxan (the site selection software used to identify conservation lands) so the CLN is applied at the correct spatial scales and in an adaptive, flexible manner.

The recommendations of the Conservation Lands Network should therefore serve as a starting point for a deeper investigation of local resources to understand why an area was, or was not, included in the CLN. This chapter offers guidance and a series of questions for effective and appropriate interpretation and use of the CLN and associated tools. More detailed methodology discussions are in Chapter 3 (*Approach and Methodology*), Chapter 4 (*Coarse Filter: Vegetation*), and Appendix B (*Data and Methods*).

While one of the primary purposes of the CLN is to support proactive conservation, the reality is that land conservation is frequently driven by opportunity. The Conservation Lands Network and CLN Explorer provide a regional framework for assessing biodiversity values within which practitioners can explore every opportunity for land conservation, regardless of whether it falls within the CLN. Although other open space values such as agriculture, recreation, and community separators are not explicitly included in the CLN, these should also be factored into conservation decisions.

## The Conservation Lands Network is a Regional Plan

The Conservation Lands Network is a regional biodiversity plan covering 4.3 million acres and employing 100ha planning units. The project used the best available data, but when applied to particular sites, the data may be incomplete and generally coarse. Small patches of unique vegetation and narrow linear features such as riparian forests are not well mapped.

In some cases, surrogates were used to fill data gaps. For example, poorly-mapped riparian vegetation was included in the CLN through the addition of blue line streams from the National Hydrography Dataset (NHD). Another data source, the California Natural Diversity Database (CNDDDB) is known to be incomplete (Chapter 4, *Coarse Filter: Vegetation*), and many occurrences of rare, threatened, and endangered species are not mapped. For these reasons, site visits and field surveys are essential before committing to conservation actions based on the CLN alone.

## The Conservation Lands Network is Dynamic

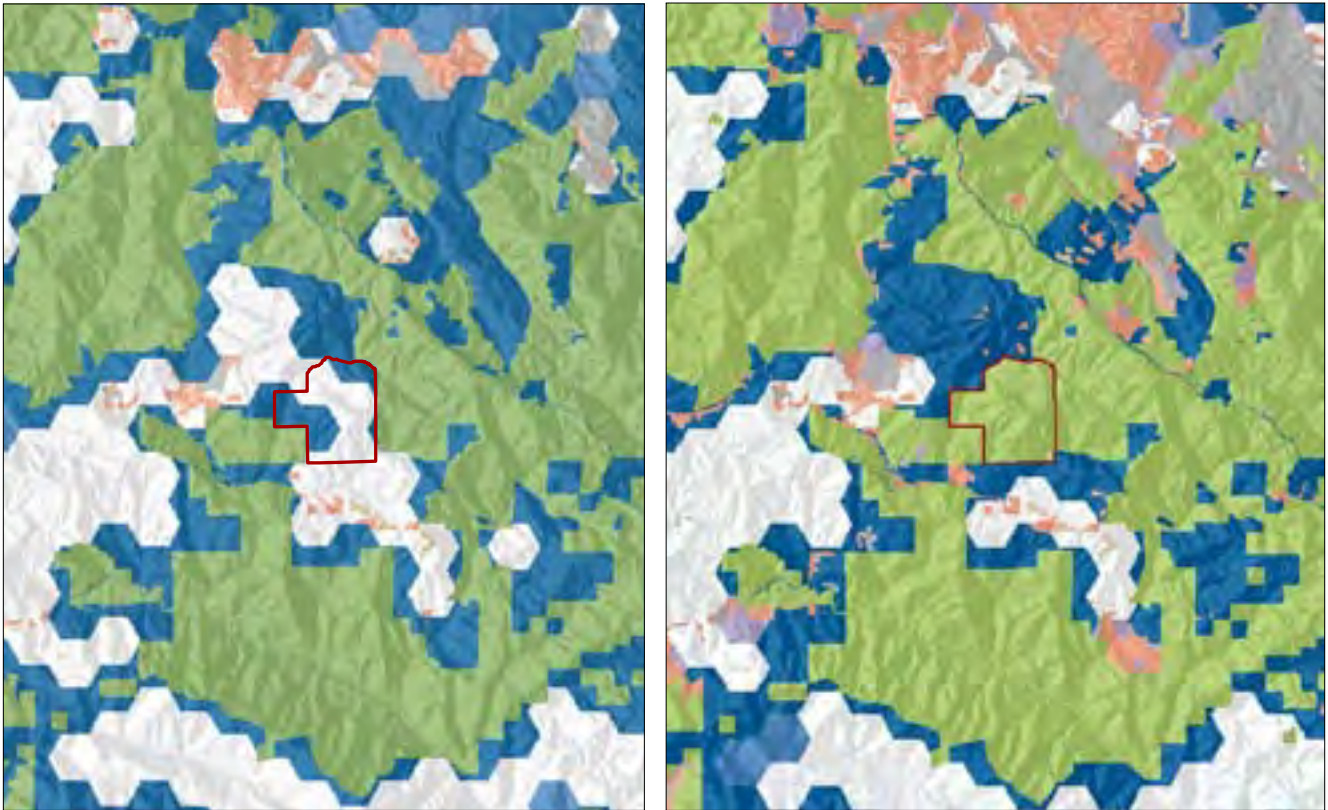
Many of the datasets and assumptions used to design the Conservation Lands Network will change over time. New and/or more accurate data will be gathered, more land will be conserved, and land uses will change. In addition, the software used to identify the CLN, Marxan, develops a somewhat different configuration each time it is run even though it uses the same data and directives every time (Chapter 3, *Approach and Methodology*). Planned biennial updates will incorporate new data and re-run Marxan so that the CLN stays as current as possible.

**Keep in mind the following points about Marxan’s selection of conservation areas when reviewing the Conservation Lands Network:**

- 1. Marxan selects land for inclusion in the CLN in a specific order.** The Upland Habitat Goals Project locked in existing protected lands to force Marxan to build the CLN from existing protected lands. This was accomplished by adding a hexagon to the CLN if at least 10% of its area consisted of protected lands. Marxan selects lands in the following order:
  - Existing protected lands, which are locked-in
  - Areas adjacent to existing protected lands
  - High-value conservation targets (90% and 75% goals)
  - Common or Rarity Rank 3 areas that are adjacent to protected lands and have high ecological integrity
- 2. Lands adjacent to existing protected areas are given higher priority in Marxan.** The net effect of locking in protected lands and the selection order described above is that lands adjacent to protected lands are assigned a higher priority than non-adjacent areas with similar or possibly higher biodiversity values. This is especially true for Rarity Rank 3 conservation targets where the 50% goal presents more flexibility in the selection of lands to be included in the CLN. Protected areas thus greatly affect the configuration of the CLN. When Marxan is re-run in the future to update the CLN, newly-conserved lands will similarly be locked in, therefore “attracting” adjacent hexagons for addition to the CLN.

Figure 11.3 illustrates such a configuration change using the example of Peninsula Open Space Trust’s purchase of the 1,047-acre Mindego Ranch. The map on the left is an early Marxan run that did not include Mindego Ranch as a protected land; only part of the property was selected by Marxan. In the map on the right, Mindego Ranch was labeled as a protected area, resulting in its inclusion along with all of the adjacent, intersecting hexagons with at least 10% of their area in protected lands.
- 3. New data on species distribution will change the biodiversity conservation values of some areas.** As the region becomes better surveyed, new data on the distribution of conservation targets will change the conservation value of the associated planning units and hexagons. These changes will in turn alter the CLN configuration when Marxan is re-run with the new data.

**Figure 11.3 ■ The Impact of Protected Lands on the Conservation Lands Network.** The map on the left depicts the Conservation Lands Network before Mindego Ranch, outlined in red, was conserved. Locked-in existing protected lands are shown in green; blue areas represent Essential and Important Areas of the CLN. The map on the right shows the change in the configuration of the CLN after the conservation purchase of the property. Notice the additional hexagons included in the CLN northwest and southeast of property due primarily to their adjacency to protected lands.



4. **Some conservation targets are always high priority.** Marxan selects some hexagons nearly all of the time (Areas Essential to Conservation Goals) because they have “irreplaceable” conservation targets such as Rarity Rank 1 vegetation types with a 90% goal. For example, all of the serpentine vegetation types have a 90% conservation goal, and therefore nearly all were included in CLN 1.0.
5. **Biodiversity values vary across the landscape; each piece of land has the potential to meet some conservation goals.** With multiple runs of Marxan, the number of times a hexagon is selected (unless it is locked in as a protected area) is a relative measure of its biodiversity value. Hexagons included in Areas Essential to Conservation Goals (selected 16 or more times by Marxan) are highest priorities, and Areas Important to Conservation Goals (selected 11 - 15 times) are the next priorities. However, lower-value areas (those selected less than 11 times) should not be ignored. Such areas may contain common targets, and biological surveys may uncover the presence of higher-value targets. Additionally, some conservation targets fall within the fragmented areas with Urban, Cultivated Agriculture, or Rural Residential land uses, but may still contribute to meeting biodiversity goals. In all cases, careful review is critical to determine whether conservation targets will be viable in the long term.
6. **Options for conservation lands are greater for common vegetation types.** Common (matrix) vegetation types are given a Rarity Rank 3 with a 50% conservation goal. Many alternative network configurations can fulfill this goal within each landscape unit. Therefore, for these lands, alternative configurations of the Conservation Lands Network can be considered when opportunities arise. Conservation practitioners can query CLN Explorer to learn more about the biodiversity values on properties of interest, and use that information to determine whether lands inside or outside of the CLN will meet conservation goals.

## Using the Conservation Lands Network to Guide Conservation Actions

Using CLN Explorer is the best first step toward understanding a property's contribution to meeting conservation goals. It is important to understand why a property was or was not included in the CLN. Either CLN Explorer or the downloadable CLN GIS Database can be utilized to review the property's vegetation types (coarse filter targets), fine filter targets, adjacency to existing conservation lands, and suitability for conservation. A Biodiversity Portfolio Report (Figure 11.4) generated by CLN Explorer offers a wealth of information that can be used for this purpose.

Although CLN Explorer provides valuable information about a selected area, it does not provide a definitive picture of its conservation value; users can meet the intent of the Conservation Lands Network in ways not specified by CLN 1.0. There is no single systematic approach that can be applied to all properties when evaluating a selected area's potential contribution to biodiversity conservation. In the end, conservation practitioners must rely on professional judgment and consultation with the conservation community to weigh the quantitative information in CLN Explorer, the Biodiversity Portfolio Report, and any additional GIS analyses against qualitative information on the location, feasibility, and viability of the selected area for biodiversity conservation. Other open space values supported by the selected area should also be considered.

When reviewing the report results, ask the following questions to fully understand the contribution of a property or area to the CLN goals – regardless of whether the area is included in the CLN. Red boxes and numbers in Figure 11.4 indicate where answers to these questions can be found in the Biodiversity Portfolio Report.

### **1. Does all or part of the selected area fall within the Conservation Lands Network? Is part or all of the area chosen within the Areas Essential for Meeting Biodiversity Goals, Important Areas, Fragmented Areas, or Areas for Further Consideration?**

This can be determined by reviewing the map in the Biodiversity Portfolio Report as well as the Conservation Lands Network Category section (Figure 11.4, #1). Areas falling within the Essential Areas will generally be strong candidates for biodiversity conservation, but this does not preclude further investigation. Because they do not have the highest-value conservation targets, the occurrence of Important Areas and Areas for Further Consideration in a selected area may allow for more flexibility in the CLN configuration depending on the results of site visits and biological surveys. Fragmented Areas are discussed below.

### **2. If the selected area falls within the Conservation Lands Network, why was it selected?**

- a. **Is the selected area adjacent to existing protected lands?** The conservation practitioner can determine if the selected area is adjacent to protected lands by reviewing the map on CLN Explorer, the map included in the Biodiversity Portfolio Report, or the section titled “Protected Land Within Selected Area” (Figure 11.4, #2a). If there are no protected lands within the selected area, this section of the report will show the distance to the nearest protected land so the user can evaluate the potential for making a connection to protected areas.

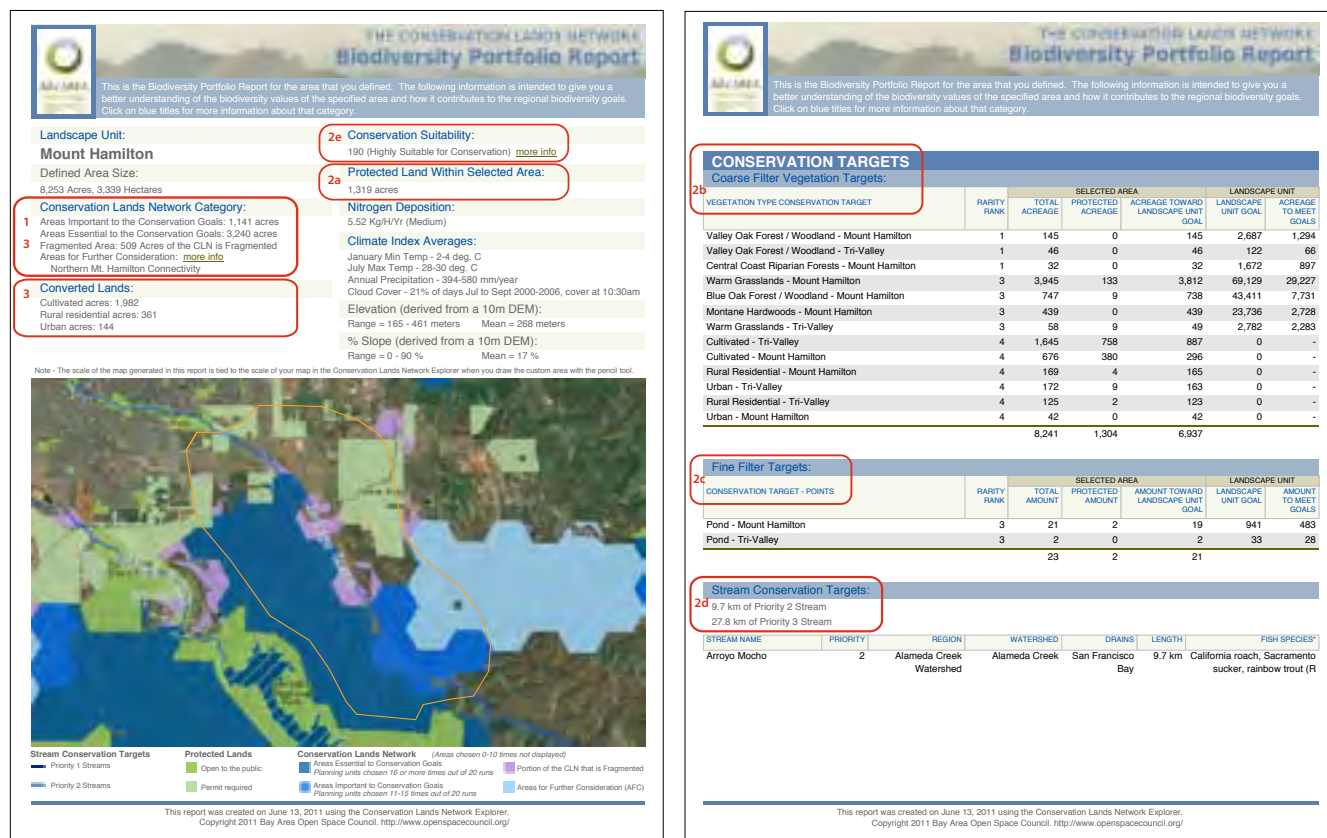
Because Marxan automatically adds to the CLN those hexagons with 10% or greater area in protected lands, it is possible that the main conservation value of an area within the CLN is its adjacency to an existing protected area. The user can review the Biodiversity Portfolio Report to determine whether there are other conservation targets that also contributed to its selection.



Lech Naumovich Photography

- b. What are the vegetation types (coarse filter targets) within the selected area? Areas with large swaths of Rarity Rank 1 vegetation types are almost guaranteed to be in the CLN because of the 90% conservation goal. Areas with Rarity Rank 2 vegetation types are more likely to be included in the CLN because of the 75% conservation goal. If the property is all Rarity Rank 3, its inclusion is likely attributable to other factors such as proximity to protected lands, conservation suitability, and/or the presence of fine filter targets. The section of the Biodiversity Portfolio Report called “Conservation Targets / Coarse Filter Conservation Targets” (Figure 11.4, #2b) lists each of the coarse filter targets within the selected area, along with their Rarity Rank and contribution to the landscape unit acreage goals.
- c. What are the fine filter targets within the selected area? The presence of high-value fine filter targets such as particular plants or animals with 90% or 75% goals (e.g., Alameda Whipsnake or Northern Spotted Owl) may be the reason an area is in the CLN. High concentrations of ponds, which have 75% or 50% conservation goals (depending on the landscape unit), also may drive an area’s inclusion in the CLN. The section of the Biodiversity Portfolio Report called “Fine Filter Targets” (Figure 11.4, #2c) lists each fine filter target in the selected area and its contribution to the landscape unit goals.

**Figure 11.4 ■ Features of the Biodiversity Portfolio Report.**



- d. Are there Priority 1 or 2 streams within the selected area? All streams are conservation targets and included in the CLN. Lands encompassing and immediately adjacent to streams, especially Priority 1 and 2 streams, are of high conservation value. If a Priority 1 or 2 stream occurs within the selected area, the Biodiversity Portfolio Report includes a Stream Conservation Targets section (Figure 11.4, #2d). The user can determine which streams are in or near a selected area by turning on the Stream Conservation Targets data layer in CLN Explorer.



- e. **What is the Conservation Suitability Index?** The Conservation Suitability Index is a composite indicator of ecological integrity based on parcelization, distance to paved roads, and human population density. Areas with high Conservation Suitability are more likely to be included in the CLN. The Biodiversity Portfolio Report displays the area's Conservation Suitability along with a description of the score as high, moderate, low, or poor. (Figure 11.4, #2e). Where there are fewer small parcels and roads and the population density is low, Conservation Suitability is high – as indicated by a low number for the Conservation Suitability Index.

### **3. Does the selected area include Fragmented Areas with Urban, Rural Residential, or Cultivated Agriculture uses nearby?**

Fragmented Areas are the result of the erasure of Urban, Rural Residential, and Cultivated Agriculture lands (collectively, Converted Lands) from the final Marxan configuration of the CLN, which leaves only the location of the conservation target and/or protected area in the CLN (Figure 3.9). Fragmented Areas are generally of lower conservation suitability, but are included in the CLN where high conservation value (Rarity Rank 1 or 2) conservation targets (coarse or fine filter) are present and when these areas are needed to meet the 90% or 75% conservation goals. Because Fragmented Areas require more detailed treatment than is possible at the scale of the CLN, the conservation practitioner must not only determine whether the targets exist as shown on the map, but also evaluate the viability of the target if the surrounding land uses are incompatible. Site visits and biological surveys are required to determine the conservation suitability of these Fragmented Areas. The Conservation Lands Network Category of the Biodiversity Portfolio Report (Figure 11.4, #3) shows the acreage of Fragmented Areas and Converted Lands (Cultivated Agriculture, Rural Residential, and Urban) within the selected area.

### **4. If the selected area falls outside of the Conservation Lands Network, how would its conservation contribute to meeting the goals?**

If the selected area is not within the CLN, there are several approaches for evaluating its potential contribution to meeting the goals. Reviewing CLN Explorer and the Biodiversity Portfolio Report (as described above, for coarse and fine filter conservation targets, priority streams, conservation suitability, and proximity to protected lands) can help assess the area's conservation values. Can the selected area be connected to an existing protected area? Do roads or Urban, Cultivated Agriculture, or Rural Residential land uses impact the viability of the targets?



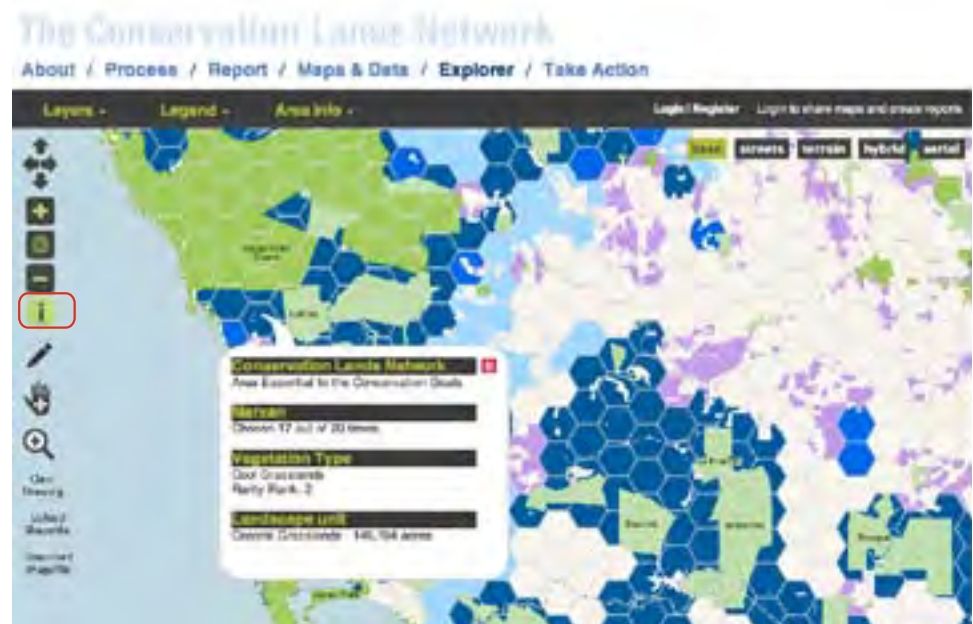
Stuart B. Weiss



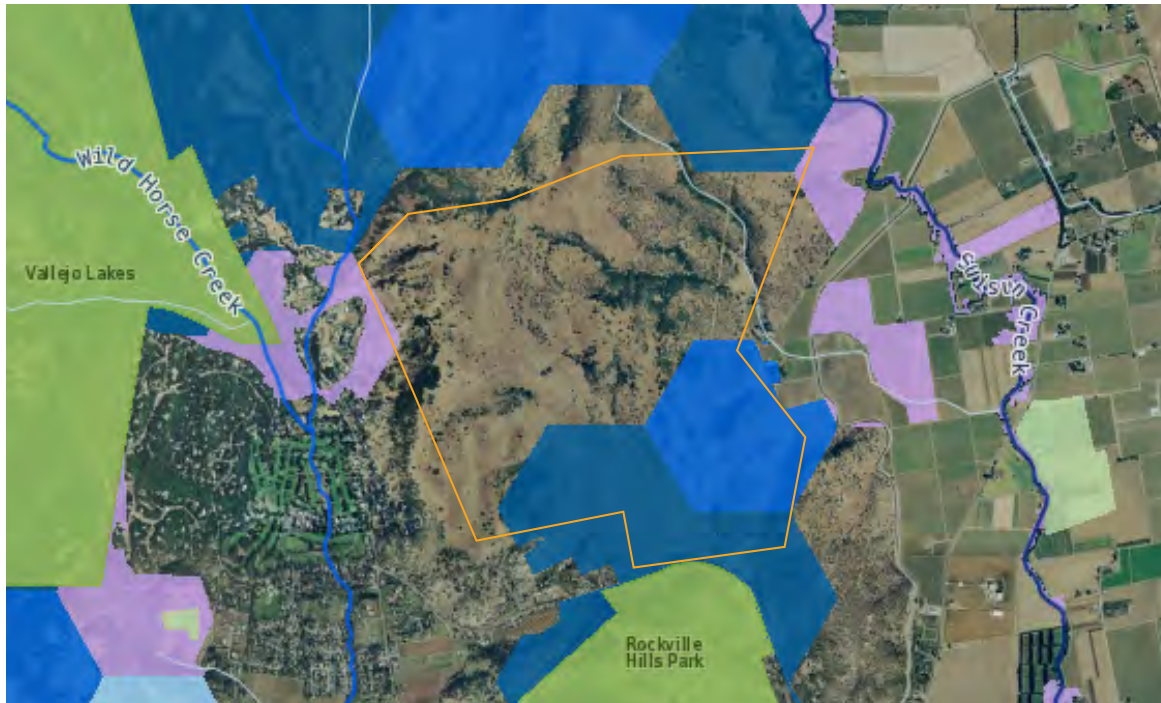
Additional information about lands outside of the CLN can be gleaned from CLN Explorer and the Biodiversity Portfolio Report by asking the following questions:

- **How many times was the selected area selected by Marxan for inclusion in the Conservation Lands Network?** The number of times the planning unit(s) underlying the selected area was (were) selected by Marxan is another indicator of conservation value. Areas Essential to the Conservation Goals were selected by Marxan 16 to 20 times out of 20 runs; Important Areas were selected 11 to 15 times. Therefore, planning units selected closer to 11 times have a higher potential conservation value, based on the data used to identify the CLN. Figure 11.5 illustrates how the CLN Explorer ID tool can be used to find the number of times a planning unit was selected by Marxan.
- **Are there additional datasets not included in the Upland Habitat Goals Project analysis that might increase the conservation value of the selected area?** The project used the best available data but was not able to seek out smaller datasets for all of the conservation targets. Existing data or site surveys of the selected area might reveal the presence of high-value conservation target species. If a high-value target is found on the area, the conservation practitioner must determine whether a connection can be made to protected lands or other lands within the CLN, and if not, whether the target will be viable without such a connection in light of the surrounding land uses.
- **If the area were to be conserved, how would the configuration of the Conservation Lands Network change?** Because there may be many options to meet the goals in common vegetation types (Rarity Rank 3 with a 50% conservation goal), lands not included in the CLN can be considered if they contain conservation targets that would contribute to meeting the goals, are ecologically intact or could be restored, and can be connected to protected lands or other lands identified in the CLN. Figure 11.6 is an excerpt of a Biodiversity Portfolio Report for a property proposed for conservation that is not entirely within the CLN. The report shows that the property is adjacent to existing protected lands, and forms a linkage to other Essential and Important Areas. The report also indicates the presence of the rare plant, Mt. Diablo fairy-lantern, and that if the property is conserved, the goal for this species will be met for this landscape unit.

**Figure 11.5 ■ Using CLN Explorer to Determine the Number of Times Marxan Selected a Planning Unit.** The red box highlights CLN Explorer’s ID tool that can be used to select any location on the map to pull up key information about that hexagonal planning unit, including how many times it was chosen by Marxan in the creation of the CLN.



**Figure 11.6 ■ Evaluating the Conservation Value of a Property.** These excerpts from a Biodiversity Portfolio Report excerpt are for a property (outlined in orange) that is only partially located within the Conservation Lands Network. However, careful review of the report indicates that conserving this property would provide connections to existing protected lands, and protect an occurrence of Mt. Diablo fairy-lantern, a rare plant.



CONSERVATION TARGETS							
Coarse Filter Vegetation Targets:							
VEGETATION TYPE CONSERVATION TARGET	RARITY RANK	SELECTED AREA			LANDSCAPE UNIT		
		TOTAL ACREAGE	PROTECTED ACREAGE	ACREAGE TOWARD LANDSCAPE UNIT GOAL	LANDSCAPE UNIT GOAL	ACREAGE TO MEET GOALS	
Coast Live Oak Forest / Woodland - Vaca Mountains West	2	44	0	44	2,960	2,218	
Hot Grasslands - Vaca Mountains West	3	783	0	783	7,717	5,165	
Blue Oak Forest / Woodland - Vaca Mountains West	3	400	0	400	5,253	3,444	
Montane Hardwoods - Vaca Mountains West	3	91	0	91	27,180	17,526	
Mixed Montane Chaparral - Vaca Mountains West	3	9	0	9	10,391	3,855	
		1,327	0	1,327			
Fine Filter Targets:							
CONSERVATION TARGET - POINTS	RARITY RANK	SELECTED AREA			LANDSCAPE UNIT		
		TOTAL AMOUNT	PROTECTED AMOUNT	AMOUNT TOWARD LANDSCAPE UNIT GOAL	LANDSCAPE UNIT GOAL	AMOUNT TO MEET GOALS	
Mt. Diablo fairy-lantern - Vaca Mountains West ( <i>Calochortus pulchellus</i> )	2	1	0	1	1	1	
Pond - Vaca Mountains West	3	2	0	2	252	208	
		3	0	3			



# CHAPTER 12

## Charting the Course: Implementing the Conservation Lands Network



Marshall Leaman

Collaboration and coordination are the keys to achieving the bold vision of the Conservation Lands Network (CLN). Bay Area conservationists, having already conserved 1.2 million acres, are no strangers to the type of collaboration and outreach that builds consensus and results in success. The CLN represents a tangible shared vision for coordinating actions and strengthening the political will vital to make this vision a reality.

The region is well on its way toward implementation with 44% or 970,000 acres of the CLN already conserved (approximately 200,000 acres of protected lands are in the baylands and outside of the study area). With 125 individuals from 43 agencies and organizations involved in the creation of the Conservation Lands Network, there is a solid foundation of support for its implementation.

**To achieve the Conservation Lands Network goals, the best first step is to use it and the supporting tools – CLN Explorer, GIS Database, and website – as guides for selecting lands for biodiversity conservation.** Conserving large tracts of interconnected lands and managing for biodiversity will maintain key ecosystem services such as clean water, clean air, climate change adaptation, carbon sequestration, crop pollination, and erosion control – as well as the open space, outdoor recreation, and scenic beauty for which the Bay Area is known.

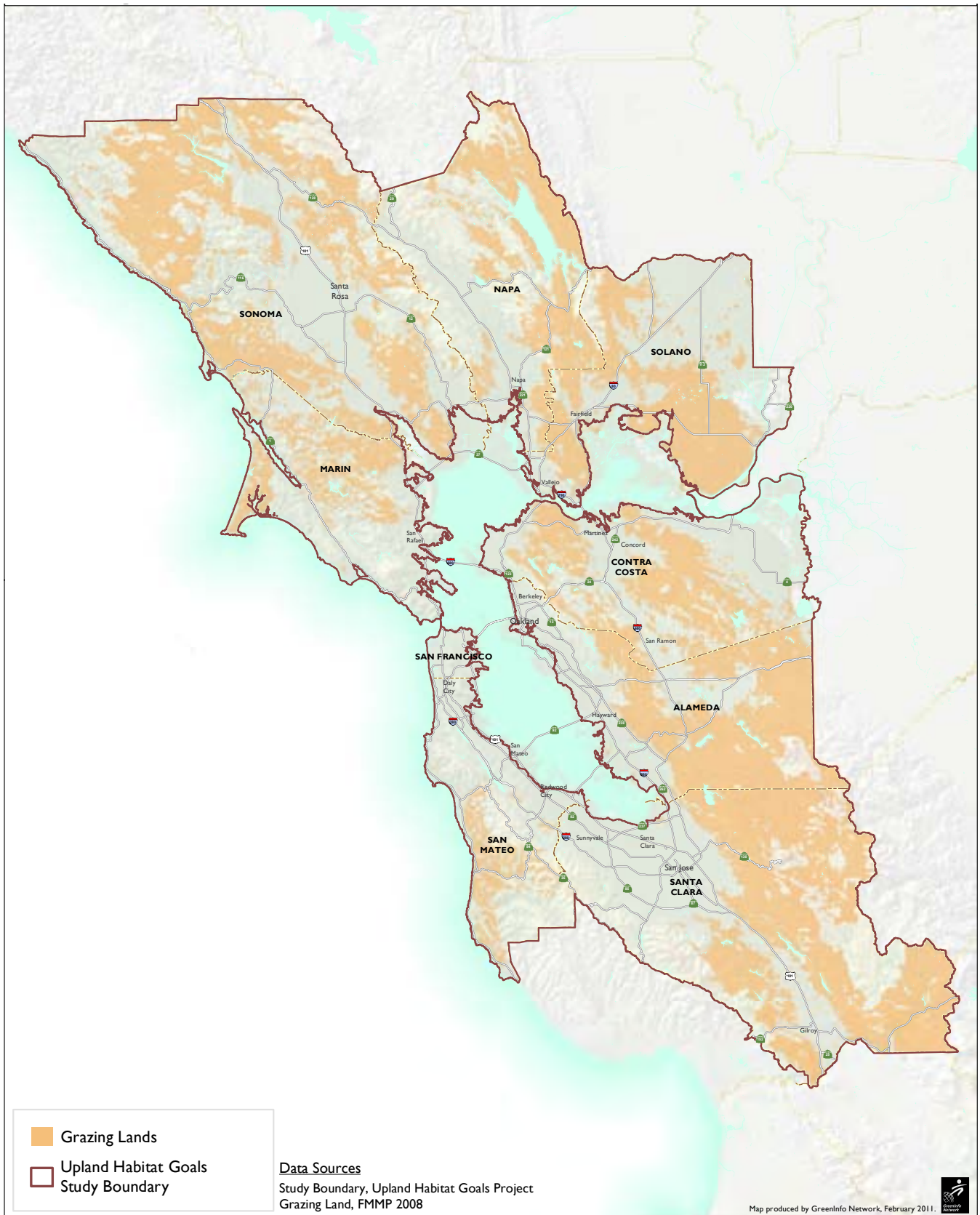
Each focus team developed detailed Recommended Conservation Actions (found at the end of the Coarse and Fine Filter chapters, Chapters 4-8). This chapter summarizes and adds to these recommendations to create a road map for successfully meeting the challenge presented by the Conservation Lands Network – to conserve regional biodiversity and sustain the ecological processes vital to thriving populations of plants, fish, and wildlife.

The steps to implementation cross five broad categories – land conservation, stewardship, public policy, outreach and education, and funding.



Cait Hutnik / LighttoMorn.com

**Figure 12.1 ■ Grazing Land Within the Upland Habitat Goals Study Area.** Approximately 670,000 acres of grazing land fall within the boundaries of the Conservation Lands Network (FMMP Grazing Land).





## Land Conservation: Count Both Public and Private Lands

The Conservation Lands Network, by necessity, includes both public and private lands. It is not feasible or desirable for resource agencies and nonprofit conservation organizations to purchase land or conservation easements for all of the unprotected areas of the CLN. Working lands will be an important part of the Conservation Lands Network. For example, approximately 670,000 acres of unprotected land within the CLN are rangeland (Figure 12.1), presenting the opportunity to work with ranchers to ensure these lands continue to provide vital habitat.

Choosing to conserve one's property is a landowner's prerogative. The Conservation Lands Network does not change that. Where there are willing sellers, the purchase of fee interest or conservation easements is one way to implement the CLN. A variety of tools are needed to build the CLN.

1. Conserve key parts of the Conservation Lands Network through outright purchase or acquisition of conservation easements from willing sellers. Easements should state biodiversity conservation as one of the purposes, and easement holders should have the financial resources to monitor and enforce the terms.
2. Support ranchers and forestland owners to sustain the economic viability of their operations so their lands continue to provide valuable habitat. Selling a conservation easement can offset operating costs of working lands. Voluntary landowner technical and financial assistance programs for natural resource management encourage landowners to enhance or restore wildlife habitat on their lands.
3. Restore riparian ecosystem functions by conserving and restoring stream and riparian habitat, and by establishing stream buffers that are as wide as possible. Streams are integral to ecosystem health, and nearly all have been severely degraded. Riparian areas are especially important in an era of climate change, as they offer cool, shady areas as refugia from increasing temperatures, and connect many ecological zones, giving plants and animals room to move.
  - Restore watershed functions by encouraging the development of comprehensive, multi-stakeholder watershed plans that forge the partnerships vital to coalescing action around large, complex issues.
  - Focus on conserving stream headwaters, which are especially important for stream health. Many headwater areas are used as grazing land, underscoring the importance of support for ranchers.
  - Make riparian buffers as wide as possible to maximize the ecological functions these areas support. Buffers can be established by purchasing fee interest or conservation easements from willing sellers or through policies.
  - Remove barriers to fish migration, restore stream channel complexity, and secure seasonal water releases – all actions vital to the restoration of healthy assemblages of native fish populations.
  - Implement the recommendations of the Recovery Plan for the Evolutionarily Significant Unit of the Central California Coast Coho Salmon and Priority Recovery Actions for the Central California Coast Steelhead Distinct Population Segment.
4. Maximize conservation investments by aligning local initiatives, including mitigation of development impacts, with the CLN. Coordinate efforts early to maximize the benefits.

## Stewardship: Manage for Diverse Biological Resources and Ecological Processes

The FishNet 4C Program coordinates actions across six counties – Mendocino, Sonoma, Marin, San Mateo, Santa Cruz, and Monterey – to conserve riparian habitat and stream corridors in response to the federal listing of coho and steelhead. County participants in the program include county supervisors, staff from planning, public work, parks, open space, and water agencies. Their efforts focus on implementing on-the-ground fish passage and restoration projects, employing best management practices during maintenance activities, and incorporating aquatic habitat protections into land use regulations and policies.

[www.fishnet4c.org](http://www.fishnet4c.org)

In addition to conserving land, stewardship, monitoring, and adaptive management are essential to maintain and restore the ecological processes on which biodiversity depends.

Well-managed grazing of grasslands and oak woodlands, habitats identified by focus team experts as essential for many conservation targets, is an especially important management tool. Grazing restricts the growth and spread of non-native invasive plants, giving native plants a chance to thrive. Non-native invasive plants threaten native biodiversity and their spread is exacerbated by nitrogen deposition, climate change, and fire suppression.

1. Provide technical and financial support for sound stewardship on private lands. Studies indicate that many public and private rangelands lack a management plan (Sulak *et al.* 2007). Numerous programs are offered for ranchers by the Natural Resources Conservation Service (NRCS), US Fish and Wildlife Service, California Department of Fish and Game, University of California Cooperative Extension, and the USDA Farm Services Agency. CAL FIRE, USDA Forest Service, and University of California (UC) Cooperative Extension offer financial and technical assistance to forest landowners.
2. Provide additional funding for stewardship of public lands. Stewardship funding has never been adequate, and has been far outpaced by acquisition funding.
3. Adopt and implement best management practices for public and private range and forest lands. The NRCS, UC Cooperative Extension, and resource conservation districts all have grazing land best management practices. CAL FIRE and the USDA Forest Service have best management practices for forest lands.
4. Implement long-term adaptive management plans to assess and improve management effectiveness. Ongoing monitoring is the only way to fully comprehend species and ecosystem responses to management actions. Consistent sources of funding are needed for monitoring programs.
5. Encourage the expansion of wildlife- and fish-friendly farming practices and programs. Cultivated agricultural practices are not always compatible with biodiversity values, but programs such as the Fish Friendly Farming certification program can help farmers reduce or even eliminate impacts.

## Public Policy: Adopt and Enforce Strong Policies to Conserve and Maintain Biodiversity

The Fish Friendly Farming certification program, operating in Mendocino, Sonoma, Napa and Solano Counties, was established for grape growers managing their operations to restore fish and wildlife habitat and improve water quality. The program recently expanded to include rangeland. The program offers training and workshops that culminate in certification of a farm conservation plan by a panel composed of National Marine Fisheries Service, Regional Water Quality Control Board, and the County Agricultural Commissioner.

[www.fishfriendlyfarming.org](http://www.fishfriendlyfarming.org)

Land use and regulatory policies are important tools for protecting resources and many supportive policies are already in place. Streams within the Coastal Zone, as defined by the 1976 California Coastal Act, have the strongest protections. Slope ordinances limiting development on steep hillsides reduce sediment and contaminants flowing into streams. The Total Maximum Daily Load (TMDL) process administered by Regional Water Quality Control Boards under the federal Clean Water Act improves water quality. The creation of biological resources overlay zones in general plans can reduce impacts of development.

1. Encourage the inclusion of the Conservation Lands Network in city and county general plans as well as transportation plans. The push to develop a regional Sustainable Community Strategy by the Joint Policy Committee to comply with the greenhouse gas emission reductions mandated in AB32 and SB375 is a great opportunity to use policies to implement the Conservation Lands Network.
2. Encourage federal, state, and local governments to enforce existing policies and adopt new regulations where needed to limit development on sensitive lands, encourage compatible forestry and agricultural uses, require stream and watershed protection during forest and agricultural operations, reduce sedimentation and nonpoint source pollution, and mandate buffers along stream corridors.



CAL FIRE and the California Board of Forestry oversee the enforcement of forest practice regulations established in the 1973 Forest Practice Act, which regulates timber harvesting practices on all private forest lands. These regulations contain stringent protections and their enforcement is vital for streams.

The City of Oakland and the Alameda County Flood Control and Water Conservation District created the Collaborative Creek Improvement Program to restore, preserve, and improve Oakland's creeks. The program emphasizes community outreach and involvement, and offers training and implementation for alternative flood control, riparian restoration, and water quality improvement.

[www2.oaklandnet.com/  
Government/o/PWA/o/FE/s/ID/  
OAK024746](http://www2.oaklandnet.com/Government/o/PWA/o/FE/s/ID/OAK024746)

3. Coordinate the application and enforcement of land protection policies within city, county and regional agencies to maximize efficiency and ensure consistency.
4. Encourage the adoption and enforcement of policies that offer incentives to ranchers to stay in production. The Williamson Act is a good example of a policy providing tax breaks for lands in agricultural production.
5. Support the inclusion of stormwater management plans in city and county general plans to reduce sediment and non-point source pollution in runoff.
6. Support collaborative programs (such as the Collaborative Creek Improvement Program) that focus on reducing sediment and non-point source pollutants in runoff.

## Outreach and Education: Spread the Word

The Upland Habitat Goals Project included representatives from resource agencies, conservation nonprofits, universities, landowners, and environmental consulting firms early in the process of creating the Conservation Lands Network. A *Partner Outreach Plan* (Appendix A) guided outreach to many more stakeholders for information and input. These steps laid the groundwork for the sustained effort needed to get the information and tools in the hands of those who can make the CLN a reality.

1. Inform policymakers and funders about the Conservation Lands Network and their roles in seeing it come to fruition.
2. Coordinate with existing habitat and water quality programs such as the San Francisco Estuary Project, San Francisco Bay Joint Venture, and the Subtidal Habitat Goals Project to communicate the project goals and how agencies, organizations, landowners, and individuals can work together to reach them.
3. Partner with Resource Conservation Districts, Natural Resources Conservation Service, California Rangeland Trust, and similar organizations to communicate project goals and available resources to ranchers and farmers.
4. Encourage implementing partners to draw a connection to the Conservation Lands Network and its goals when announcing conservation projects and initiatives.

## Funding: Create New and Expand Existing Funding Sources

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An objective of the Conservation Lands Network is to assist conservationists with the allocation of limited resources, including funding. To make the CLN a reality, it is imperative to use existing resources efficiently – and increase the amount of funding available.

1. Increase public and private funding for existing programs that support land and conservation easement acquisition and habitat restoration. Such programs include the San Francisco Bay Area Program of the California Coastal Conservancy, California Wildlife Conservation Board, California State Parks, California Department of Conservation, regional open space and park districts, and federal grant programs like the Land and Water Conservation Fund. New sources include bonds, local funding measures, and budget appropriations at all levels.
2. Increase funding for voluntary incentive programs that offer technical and financial assistance to farmers, ranchers, and forestland owners interested in improving the habitat value of their lands. These programs are offered by the Natural Resources Conservation Service, CAL FIRE, US Fish and Wildlife Service, UC Cooperative Extension, California Department of Fish and Game, and the Farm Services Agency.
3. Provide consistent funding for stewardship, monitoring, and adaptive management – all essential to maintaining and improving the management of public and private lands. Managing for invasive plants, in particular, is critical to maintaining biodiversity, but requires long-term funding to be effective.
4. Ensure adequate funding for the research needs identified during the goal-setting process to improve the accuracy and effectiveness of the Conservation Lands Network in future updates.



# CHAPTER 13

## Research Needs, Measuring Success, and CLN 2.0



Stuart B. Weiss

The factors that shape the Conservation Lands Network (CLN) are continually shifting. Periodic updates are essential as new lands are conserved, biological surveys are completed, and conservation planning principles evolve. Further refinements to the CLN will inevitably be made as the data gaps are filled and results from adaptive management programs indicate where changes are needed to reach biodiversity conservation goals.

In the years ahead, the Upland Habitat Goals Project will coordinate with other entities to identify quantitative and qualitative indicators of biodiversity for monitoring and evaluation, update the CLN at least every two years, incorporate other key regional information such as climate change, linkages, and development risk, and address data gaps.

### Research Needs

During the course of developing the Conservation Lands Network, the Project Team and focus team members identified a number of data gaps and needs for future research. These data gaps, which are listed at the end of each of the coarse and fine filter chapters, are compiled here.

**Vegetation map.** An up-to-date vegetation map using the Manual of California Vegetation (MCV) classification system could improve the integrity of the CLN. The Coarse Filter Vegetation Map is a composite of several sources, but is predominantly drawn from CalVeg – the only vegetation map covering nearly all of the Bay Area. CalVeg is known to have spatial inaccuracies and lacks sufficient detail for annual grasslands, shrub communities, riparian corridors, and isolated wetlands (Chapter 4, *Coarse Filter: Vegetation*). It also lacks any detail about the current structure of the vegetation classes.

A few regions of the Bay Area are already mapped using MCV (Napa County, National Park Service lands, Midpeninsula Regional Open Space District lands), but most areas are not. MCV vegetation maps provide useful indicators of ecological diversity for specific sites, and allow for more refined local conservation planning. While the complex, fine classification distinctions in MCV are difficult to use for regional conservation planning, the data could be aggregated to coarser classification levels.

**Species occurrence information.** More complete and spatially accurate occurrence data for key target species would improve the effectiveness of Conservation Lands Network recommendations. With few exceptions, species occurrence data used for the fine filter analyses were derived from the California Natural Diversity Database, which is notably incomplete and has known spatial inaccuracies.

The advent of electronic GPS units and smartphones equipped with GPS capabilities presents the opportunity to vastly increase occurrence data. Online databases such as eBird ([www.ebird.org](http://www.ebird.org), developed by the Cornell Lab of Ornithology and the National Audubon Society) are enabling mass datasets on species abundance and distribution. Similarly, [iNaturalist.org](http://iNaturalist.org) – and its companion smartphone application – encourages volunteer naturalists to upload observations to increase occurrence data.

1. **Riparian habitat and fish.** A significant data gap is a comprehensive map of riparian vegetation types for the nine-county Bay Area. Fortunately, the San Francisco Estuary Institute is nearing completion of its Bay Area Aquatic Resource Inventory ([www.sfei.org/BAARI](http://www.sfei.org/BAARI)), a very detailed base map of the region's wetlands, open water, streams, tidal marshes, mudflats, and riparian areas. This database fills this research need and will significantly enhance the quality of the stream and riparian area data in the next version of the Conservation Lands Network.

Additional research needs:

- Native fish restoration strategy. The methodology used in the restoration strategy summary *San Francisco Estuary Watersheds Evaluation: Identifying Promising Locations for Steelhead Restoration in Tributaries of the San Francisco Estuary* (Becker et al. 2007) identified Anchor Watersheds and Essential Streams for steelhead. The Riparian/Fish Focus Team recommended the completion of a similar study that focuses on native fish assemblages using the data from Leidy 2007.
  - In-stream flow analyses. The timing and quantity of in-stream flows is essential information for restoring healthy assemblages of native fish. In-stream flow analyses are needed to determine adequate water supplies and timing for release. These analyses must also include the process for implementing the in-stream flow recommendations, which will vary from one stream to the next.
  - Stream protection ordinances. Policy protections are the first line of defense; these are especially important in Urban, Cultivated Agriculture, and Rural Residential areas. A survey of adopted city and county stream protection ordinances will determine gaps, identify ordinances that are most effective, and can be used to develop model ordinances and zoning regulations.
  - Flood easements. Many public agencies hold flood easements for the purposes of flood management, groundwater recharge, and other public purposes. These easements have not been surveyed and are not included in the Bay Area Protected Areas Database, and yet they may represent additional protected areas not currently reflected in the Conservation Lands Network. A survey of the location and protections afforded by flood easements would present a more accurate picture of protected lands for consideration in a future version of the CLN.
2. **Mammals.** A thorough presence-absence survey of mammal targets at or below the landscape-unit level would contribute to a more accurate CLN and provide a modern species distribution baseline to guide conservation actions. The highest priority surveys are for the following species: ringtail, shrew mole, porcupine, western spotted skunk, fog shrew, California kangaroo rat, Heerman's kangaroo rat, San Joaquin pocket mouse, long-tailed weasel, and red-backed vole. Establishing range limits for these species would be particularly useful. For some key species, such as mountain lion and badger, population-level monitoring of species abundance can provide insights into population viability, movements of individuals, and responses to management actions.
  3. **Birds.** Digitizing data from local Audubon chapters' bird counts and Breeding Bird Atlases, and converting these data into a GIS layer, would allow this wealth of information to inform future versions of the CLN. The quality and quantity of bird data could also be improved by encouraging skilled birders to systematically upload observations to appropriate websites for selected species (e.g., eBird) where data are sparse or unavailable.
  4. **Amphibians, reptiles, and invertebrates.** Little is known about many of the invertebrates selected as conservation targets. Additional metapopulation studies of California Red-legged Frog, California Tiger Salamander, and other pond-dwelling species are needed to estimate metapopulation viability and to guide landscape-scale pond management, restoration, and creation. Targeted biological surveys for selected taxa (to be determined) would enhance the ability to assess coverage of the CLN and stewardship needs. Digitization of existing records for butterflies, both common and rare, would provide opportunities to use these well-known taxa as surrogates for other species.



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**Historical baseline.** A thorough assessment of historical habitat distribution would provide an important baseline for calculating acreage lost and estimating the rate of succession. With the exception of the San Francisco Estuary Institute historical ecology studies for a few areas, there is little historical information describing vegetation of the Bay Area prior to extensive habitat disturbance after the arrival of Europeans. The Wieslander Vegetation Type Mapping Project, a collaboration between UC Berkeley and UC Davis, has digitized and georeferenced the Wieslander maps, facilitating historical analysis. These datasets have many conservation applications, including establishment of a historic baseline from the 1920s and 30s, rate of habitat loss since then, and the rate of succession in key habitats such as coastal grasslands and oak woodlands.

**Stewardship classification for the Bay Area Protected Areas Database (BPAD).**

Accurate stewardship information on existing protected lands is a fundamental data gap. Not all protected lands are managed with biodiversity as the primary objective; ideally, stewardship information would influence whether lands are included in the CLN. The Upland Habitat Goals Project partially compensated for this data gap by removing lands from the BPAD that do not contribute to biodiversity (e.g., cultivated agriculture, publicly-owned golf courses) for the analysis.

GreenInfo Network, developer of the California Protected Areas Database (CPAD), may help fill this gap. GreenInfo Network is applying the USGS Gap Analysis Program (GAP) conservation status rankings to CPAD entries, and intends to improve the method for determining these ranks by incorporating specifics about management plans for protected areas. The addition of this stewardship data will offer valuable information for future versions of the Conservation Lands Network.

**Site surveys and linkage analysis for the Areas for Further Consideration.**

The 34 Areas for Further Consideration require site visits and additional information to determine which of these lands should be included in the CLN for target species and connectivity. Biological surveys and fine-scale, within-landscape unit linkage analyses for these areas (and others that may be discovered as the CLN is implemented) are needed to refine the CLN.



**Rangeland mapping.** The mapping of rangelands would allow for better analysis of the role of these important lands in maintaining biodiversity in the CLN. The task would involve developing consensus on an approach for mapping rangelands, including identifying and mapping lands that are actively grazed or have the potential to be grazed.

**Rangeland sustainability indicators.** Developing rigorous but feasible sustainability and stewardship indicators to guide grazing management plans for public and private lands could further increase the biodiversity values of rangelands both in and outside of the CLN. Rangelands support a significant percentage of the biodiversity extant in the Bay Area. Rangeland science and practice, especially as it relates to native biodiversity, has undergone a revolution in recent decades. The Central Coast Rangeland Coalition developed draft Indicators of Sustainable Rangeland Stewardship (Ford and Huntsinger 2007 DRAFT); this document awaits additional funding for completion. The approach under development could be useful for increasing the biodiversity of rangelands throughout the Bay Area.

**Mapping of unpaved roads.** Accurate mapping of unpaved roads would help identify areas where habitats are fragmented and prone to erosion. In the development of the CLN 1.0, the project used the National Overview Road Metric Euclidean Distance (NORM ED) dataset to evaluate distance to roads. This dataset only includes paved roads, and yet many miles of unpaved roads also significantly impact watershed and ecological integrity. A map and assessment of the condition of unpaved roads in the region would reveal areas of high conservation suitability and others where efforts should be focused to reduce erosion and sedimentation of nearby streams.

**Policy protection data layer.** A spatial database representing lands that are protected by policy would improve the accuracy of future versions of the CLN and allow for more strategic use of limited resources for conservation. Currently the Bay Area Protected Areas Database includes only lands protected by fee or conservation easements. Policy protections can provide protection by reducing the threat of development (although perhaps only temporarily). Since many lands are protected through various policies, including hillside development ordinances and scenic viewsheds, including these in future updates of the CLN will provide a more complete picture of current protections.

**Development threat assessment.** Quantification and mapping of development threats would allow future versions of the CLN to target areas in need of immediate protection. This could be accomplished through collaboration with Greenbelt Alliance, UC Davis, and others to complete build-out scenarios and/or land use growth projection models to ascertain areas at higher risk of urban, suburban, and rural residential development.

**Regulatory and flood control easement assessment.** Systematic tracking of regulatory and flood control easements – as well as regular monitoring and enforcement – would help future versions of the CLN reflect the contribution of these easements to biodiversity conservation. Regulatory easements are typically created by land use or other regulatory agencies as a condition of permit approvals. Flood control easements are held by water or flood control agencies to accommodate high flows. These easements are not systematically tracked, and in the case of regulatory easements, they may not even be monitored or enforced. The inventory, mapping, and review of these easements to determine their potential contribution to biodiversity (and whether they can be monitored and enforced) is recommended. Selecting a county as a pilot project for such a study would help craft an efficient approach to reviewing these types of easements.

## Measuring Success – Biennial Report Cards

The Upland Habitat Goals Project will issue a biennial report card, which will include a comprehensive update to the Conservation Lands Network, describe the changes to the CLN, and measure progress toward achieving the biodiversity conservation goals.

A number of quantitative and qualitative elements will be identified to assess success. Qualitative elements to be reviewed will be determined as the report template is developed, but the Project Team anticipates building on the monitoring and evaluation work of other organizations. For example, the San Francisco Bay Joint Venture is developing a monitoring and evaluation plan that encompasses riparian areas.

At a minimum, each biennial report will cover the following:

1. Lands protected since the previous version of the Conservation Lands Network, as captured by the most recent version of the Bay Area Protected Areas Database.
2. Progress toward meeting vegetation type (coarse filter) goals.
3. Contributions to the conservation of all streams and Anchor and Coho Core Area Watersheds.
4. Progress toward attaining measurable fine filter goals such as number of ponds and CNDDDB occurrences.
5. For linkages:
  - Progress toward implementing the connections developed by *Critical Linkages: The Bay Area and Beyond*.
  - Progress toward between-landscape unit connectivity not included in Critical Linkages, as measured by presence or absence and by the width and length of newly-conserved linkages.
  - Progress toward within-landscape unit connectivity and protection of large, contiguous complexes of conserved land, as measured by changes in the size of the largest complex within a landscape unit.

The updated Conservation Lands Network will be produced using Marxan, the Bay Area Protected Areas Database, and expert opinion, and will include:

1. New conservation target occurrence data (CNDDDB and other sources as available), and other new datasets (such as SFEI's Bay Area Aquatic Inventory data).
2. Description of new data added to the analysis and to the CLN GIS Database.
3. Acreage within the CLN converted to urban and cultivated agriculture uses, as indicated by current FMMP Urban and Cultivated Agriculture data.



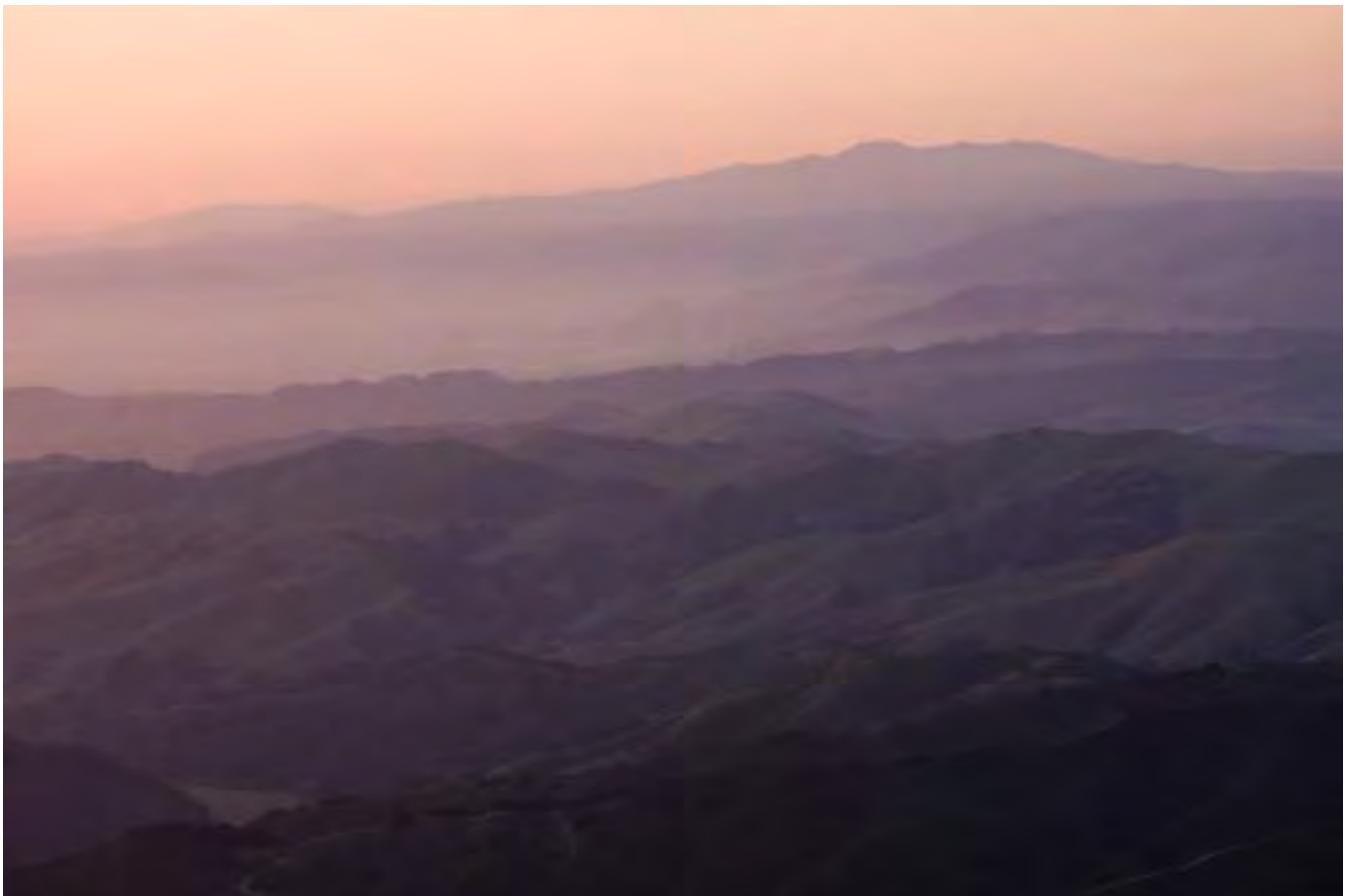
## Conservation Lands Network 2.0

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The first comprehensive update to the Conservation Lands Network – version 2.0 – will be released as part of the first Conservation Lands Network biennial report, slated for completion in 2013.

Prior to the release of the first biennial report and CLN 2.0, the linkages identified by *Critical Linkages: The Bay Area and Beyond* will be added to the Conservation Lands Network. These revisions will enhance connectivity for focal species within the CLN and to regions beyond the study area boundaries.

Similarly, recommended adjustments that may emerge from the climate change work completed under Dr. David Ackerly's direction will be incorporated before the release of the first biennial report. Climate change modifications will increase the resilience of conserved species as climatic conditions shift as predicted by climate change models.



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# Glossary

**Anadromous** ■ Fish that spend most of their lives in ocean waters, but run upstream to spawn in fresh water; for example, Chinook salmon and steelhead.

**Adaptive management** ■ A dynamic, structured process of iterative decision-making that allows for integration of feedback, new information, and environmental changes in order to meet management objectives.

**At-risk species** ■ Species not included on federal threatened, endangered, and imperiled species lists but on local or state lists. For example, American Badger is listed as a Species of Special Concern by the California Department of Fish and Game.

**Bay Area Protected Areas Database (BPAD)** ■ A database of protected lands in the nine-county San Francisco Bay Area that is maintained by the Bay Area Open Space Council and GreenInfo Network.

**Baylands Ecosystem Habitat Goals** ■ A regional, ecosystem-based vision for habitat protection in the San Francisco Bay Area's baylands. Baylands are defined as the lands that lie between the elevations of the high and low tides, including those areas that would be covered by the tides in the absence of levees and other structures.

Completed in 1999 by the San Francisco Estuary Institute, it used available scientific knowledge to identify the types, amounts, and distribution of wetlands and related habitats needed to sustain diverse and healthy communities of fish and wildlife resources in the San Francisco Bay Area. The project provided a biological basis to guide a regional wetlands planning process for public and private interests seeking to preserve, enhance, and restore the ecological integrity of wetland communities.

Together with the Upland Habitat Goals Project and the Subtidal Habitat Goals Project, this is one of a trio of documents articulating a vision for habitat protection and restoration throughout the Bay Area.

**Biodiversity** ■ The complex of living organisms, their physical environment, the interactions among these organisms, and how they array themselves in the physical environment (Noss 1990, Redford and Richter 1999).

**Biogeography** ■ The study of the distribution of organisms through space and time.

**Boundary Length Modifier (BLM)** ■ A setting in the Marxan model specifying how much emphasis should be placed on minimizing the overall reserve system boundary length. This setting impacts the overall compactness of the reserve design.

**California Natural Diversity Database (CNDDDB)** ■ A GIS dataset of status and locations of rare plants and animals in California maintained by California Department of Fish and Game.

**CalVeg** ■ A hierarchical classification system devised in the late 1970s by the Pacific Southwest Region of the US Forest Service to describe and map natural vegetation throughout California.

**CalWater** ■ A GIS dataset managed by the Natural Resources Conservation Service (NRCS). This dataset is the official watershed delineations used by state and federal agencies in California.

**Climate change** ■ Recent changes in global patterns of temperature and precipitation, often referred to as global warming, and linked to increasing concentrations of greenhouse gases resulting from human activity such as the burning of fossil fuel and deforestation.

**Connectivity** ■ The continuity of the landscape such that animals and populations of plants can move unimpeded by natural or anthropogenic barriers.

**Conservation goals** ■ The quantitative protection levels for conservation targets in the Conservation Lands Network.

**Conservation lands** ■ Areas protected for natural resource values by public purchase or easement, or private lands with a cooperative agreement and some level of stewardship for biodiversity.

**Conservation Lands Network (CLN)** ■ The configuration of Bay Area habitats and linkages needed to meet the goals for biodiversity conservation. This includes lands already protected as well as those proposed for conservation; it is a guide and not a list of priority properties. The Conservation Lands Network is best explored through the maps and CLN Explorer tool available at [www.BayAreaLands.org](http://www.BayAreaLands.org).

**Conservation Lands Network Explorer** ■ The web-based interactive mapping tool that offers ready access to the project's data and recommendations to everyone, regardless of GIS skill level. A conservation practitioner or planner can outline a property or area of interest to display a Biodiversity Portfolio Report for the property, which includes details such as vegetation types, conservation targets and suitability, priority streams, and Conservation Lands Network status. Accessible at [www.BayAreaLands.org](http://www.BayAreaLands.org).

**Conservation planning** ■ A systematic scientific approach to deciding where and when to implement conservation activities – land protection by various means and stewardship – using the best available knowledge.

**Conservation suitability** ■ A GIS dataset (input into the Marxan model) that indicates ecological integrity across the study area. Population density, distance to roads, and parcelization are combined to develop the Conservation Suitability layer. See also *Suitability*.

**Conservation targets** ■ Species, vegetation types, and other natural features (e.g., serpentine soils, streams) captured within the Conservation Lands Network.

**Cultivated agriculture** ■ Land that is being plowed and managed for crops. Also called *intensive agriculture*.

**Distinct population segment** ■ The portion of a fish species' distribution that has unique genetic and ecological characteristics; also applied to terrestrial vertebrates.

**Ecosystem** ■ The sum of a natural community and its environment treated together as a functional system that transfers and circulates energy and matter (Groves 2003).

**Endangered species** ■ The designation for a population of plants or animals at risk of extinction. Under the Endangered Species Act of 1973, the US Fish and Wildlife Service can designate species as endangered or threatened throughout all or a significant portion of their range, and the conservation of the ecosystems on which they depend. A species or population is considered endangered if it is in danger of extinction throughout all or a significant portion of its range. A species is considered threatened if it is likely to become an endangered species within the foreseeable future. Similarly, the California Endangered Species Act (CESA) allows the California Department of Fish and Game to designate state-listed threatened, endangered, or candidate species.

Internationally, the IUCN Red List of Threatened Species uses the term endangered species as a specific category of imperilment, a category between critically endangered and vulnerable.

**Endemic species** ■ Species whose entire distribution is restricted to an ecoregion or small geographic region within an ecoregion; limited geographic range makes them vulnerable to extinction. For example, California Giant Salamander is endemic to the Bay Area.

**Evolutionarily Significant Unit (ESU)** ■ Portions of species' distributions that have unique lineages and genetic adaptations; usually applied to anadromous fish such as steelhead and salmon.

**Flagship species** ■ Species that are used to garner public support for conservation efforts; these are typically endangered large mammals or other charismatic species. For example: Tule Elk.

**Focal species** ■ A suite of umbrella species that can be used to develop explicit guidelines for determining the composition, quantity and configuration of habitat patches at the landscape scale for restoration purposes. This includes four categories:

- **Area-limited species:** Many patches of habitat are too small to support breeding pairs or socially functional groups of these species; for example, mountain lion.
- **Resource-limited species:** Populations are limited by the supply of particular resource, often food – for example, Muir's Hairstreak Butterfly, which feeds on mistletoes on Sargeant and McNab Cypress.
- **Dispersal-limited species:** Suitable habitat patches exist for these species, but the inter-patch distance is too great or inhospitable to allow dispersal among patches –for example, shrew mole, which exists in isolated pockets of very moist coniferous forest.
- **Process-limited species:** These species depend upon particular disturbance regimes or ecological processes, and their populations may be limited when the process is altered (e.g., plant species dependent upon fire for regeneration) – for example, Black-chinned Sparrow, which requires early successional chaparral after fires.

**Focus Teams** ■ The group of local experts who worked to create the Conservation Lands Network to ensure the conservation of plants, mammals, fish, riparian habitat, birds, amphibians, reptiles, and invertebrates.

**Game species** ■ Animals hunted for sport or food.

**Geographic Information System (GIS)** ■ A complex database used to store, manage, and analyze spatial information. A GIS system allows storage, mapping, and analysis of data to facilitate problem-solving. The Upland Habitat Goals project involved the collection and creation of a number of GIS datasets, all of which are available at [www.BayAreaLands.org/gis/all-datasets.php](http://www.BayAreaLands.org/gis/all-datasets.php).

**Geomorphology** ■ The scientific study of the forces that shape the Earth's landscapes and landforms.

**Habitat** ■ Specific areas of an ecosystem used by individual species. May be defined by vegetation, temperature, exposure, topography, etc.

**Habitat Conservation Plan (HCP)** ■ An agreement required under the Federal Endangered Species Act, along with an Incidental Take Permit, when non-federal activities will result in take of threatened or endangered wildlife. A Habitat Conservation Plan is intended to ensure that the take is minimized and mitigated.

**Indicator species** ■ Surrogate species whose traits are used as an index to the condition of other species for which those characteristics are too difficult or expensive to measure.

**Invasive species** ■ A plant or animal species that is not native to an ecosystem, and whose introduction causes, or is likely to cause, environmental damage. Invasive plants – also known as *exotics*, *invasive exotics*, *non-natives*, or *weeds* – often outcompete native plants and threaten native biodiversity. Invasive animal species can disrupt predator-prey balances.

**Keystone species** ■ A species that plays a pivotal role in the viability of its community or ecosystem.

**Landscape unit** ■ A geographic division of the Upland Habitat Goals Project study area; developed by the project team to create spatially coherent units that are based on physiographic features such as mountain ranges and valley bottoms.

**Linkage** ■ A specific area or region that supports connectivity between habitats.

**Management** ■ On-the-ground actions taken to influence ecological processes and species. See also *Stewardship*.

**Marxan** ■ Conservation planning software designed to assist in developing a near-optimal spatial reserve design that achieves specified biodiversity representation goals. Marxan was developed at the University of Queensland and can be downloaded at no cost at [www.uq.edu.au/marxan](http://www.uq.edu.au/marxan).

**Metapopulation** ■ A population comprised of several spatially separated subpopulations linked by immigration and emigration; also known as a *population of populations*.

**Minimum mapping unit** ■ The smallest size area to be represented discretely in a given map system.

**Mitigation lands** ■ Lands set aside to offset impacts of development projects, often along with management monies and endowments.

**National Hydrography Dataset (NHD)** ■ A GIS dataset of information about surface water features –including lakes, ponds, streams, rivers, springs and wells – and maintained by the United States Geologic Survey (USGS).

**Natural Community Conservation Planning (NCCP)** ■ A cooperative program of the California Department of Fish and Game, begun in 1991 and designed to conserve natural communities at the ecosystem level and thus protect habitats and species. An NCCP is run by a local agency, and involves landowners, environmental organizations, and other public and private partners to develop a conservation plan with support from the Department of Fish and Game and the US Fish and Wildlife Service.

**Near-optimization** ■ For many complex problems there is not one optimal solution; near optimization attempts to reach a set of satisfactory solutions that approach optimality.

**Nitrogen deposition** ■ The process by which nitrogen-containing air pollution fertilizes ecosystems, a complex transfer from the atmosphere to the land and water surface through wet deposition in precipitation, or dry deposition directly to surfaces.

**Optimization algorithm** ■ A mathematical process that makes tradeoffs and reaches a solution that has maximum benefit and minimum cost.

**Pacific Flyway** ■ The major north-south route for birds migrating along the west coast of the Americas, from Alaska south to Patagonia. The San Francisco Bay Estuary serves as a critical rest stop for millions of birds each year.

**Peer review** ■ A process commonly used in academia in which experts in a given field evaluate and comment upon the work of their colleagues, thus adding accuracy and credibility.

**Population** ■ A group of plants or animals of a particular species living in a given geographic area and that are more likely to breed with each other than with individuals in other populations.

**Protected areas** ■ Lands protected by fee or easement preventing conversion to uses incompatible with biodiversity conservation. These lands are part of the Bay Area Protected Areas Database, BPAD. Also called *existing protected lands*.

**Rarity ranking** ■ A classification of rarity or commonness of vegetation type conservation targets used to set higher or lower conservation goals in local areas.

**Riparian corridor** ■ The plant community growing alongside a river, stream, lake, lagoon, or other freshwater body. As the interface between land and water, these habitats provide important habitat for a number of species. All streams and riparian corridors are included in the Conservation Lands Network.

**San Francisco Bay Joint Venture (SFBJV)** ■ One of 18 Joint Ventures established under The Migratory Bird Treaty Act and funded under the annual Interior Appropriations Act. It brings together public and private agencies, conservation groups, development interests, and others to restore wetlands and wildlife habitat in San Francisco Bay watersheds and along the Pacific coasts of San Mateo, Marin, and Sonoma counties.

**Serpentine** ■ An ultramafic soil type derived from serpentinite rock. These nutrient-poor soils with a low calcium-magnesium ratio are inhospitable to the European grass species that have invaded most of California's native grasslands. As a result, serpentine grasslands in the Bay Area host a number of rare and endangered species, many of which are endemic.

**Steering Committee** ■ The group of experts from 22 natural resource agencies and organizations who provided direction and guidance to the Project Team on all aspects of the Upland Habitat Goals Project. The Steering Committee established project objectives to guide the structure, approach, and final recommendations.

**Stewardship** ■ The conceptual and institutional framework, and operational capacity, that provide for effective management of biological resources across the landscape. See also *Management*.

**Subtidal Habitat Goals** ■ A regional, ecosystem-based vision for habitat protection of the San Francisco Bay Area's subtidal ecosystem – submerged lands. Led by the California Coastal Conservancy/Ocean Protection Council, Bay Conservation and Development Commission, NOAA Fisheries and Restoration Center, and the San Francisco Estuary Partnership, it offers a vision for how to move forward with science-based subtidal research, protection, and restoration, through an adaptive phased project approach to learn more about subtidal ecosystem services, functions, and interactions between habitat types.

Together with the Upland Habitat Goals Project and the Baylands Ecosystem Habitat Goals Project, this is one of a trio of documents articulating a vision for habitat protection and restoration throughout the Bay Area.

**Succession** ■ The sequence of changes in the composition and structure of a plant community over time. Also called *ecological succession*.

**Suitability** ■ A GIS dataset and input into the Marxan model that assess ecological integrity across the study area. Population density, distance to roads, and parcelization are combined to develop the final Conservation Suitability layer. See also *Conservation suitability*.

**Target species** ■ Species identified in the fine filter phase of the Upland Habitat Goals Project for conservation within the Conservation Lands Network. These included plants, mammals, birds, fish, amphibians, reptiles, and invertebrates, and represent species that would not likely be conserved by efforts that emphasize community or ecosystem approaches or species whose life history requirements infer insights into the conservation needs of other species in the region (Groves 2003).

**Threatened, Endangered, and Imperiled species** ■ Species listed in the World Conservation Union's (IUCN) Red List of Threatened Species, the US Endangered Species Act's Threatened and Endangered Species, the California Department of Fish and Game's Threatened and Endangered Species, or the NatureServe/Natural Heritage Program classification of imperiled species. See also *Endangered Species*.

**Total Maximum Daily Load (TMDL)** ■ The amount of pollutant in a body of water allowed as determined by guidelines in the US Clean Water Act.

**Umbrella species** ■ A species whose habitat requirements are broad enough that its protection also protects many other associated species.

**Upland habitats** ■ As used in this project, refers to all habitats found above the baylands, which were the subject of the Baylands Ecosystem Habitat Goals and therefore not included in the Upland Habitat Goals Project.

**Vegetation types** ■ The classifications of complex vegetation patterns into discrete types, useful for planning and management purposes.

**Viability** ■ The ability of a conservation target to dynamically maintain its distribution and abundance through time in a given place or region.

**Watershed** ■ An area of land in which draining water converges to a single place, often a stream, river, or ocean.

**Weed** ■ An invasive or non-native plant species.

**Working landscapes** ■ Landscapes in which some compatible commercial land uses – typically grazing or forestry – are pursued at the same time as conserving biodiversity.



**San Francisco Bay Area**  
**Upland Habitat Goals Project Report**  
[www.BayAreaLands.org](http://www.BayAreaLands.org)

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