2 Methods

This section summarizes the methods used for defining the boundary of the Foothills Area, inventorying resources, and assessing the conservation status of resources.

2.1 Foothills Area Boundary

The Foothills Area was defined to encompass most of the extent of characteristic landforms and vegetation of the Sierra Nevada and Cascade foothills (e.g., blue oak woodlands and other habitats), to have a continuous boundary that was not convoluted or otherwise complex, and to be within the boundary of the Sierra Nevada Conservancy (SNC) Region. For this purpose, the western (lower elevation) boundary of the SNC Region and the eastern (upper elevation) boundary of the Sierra Nevada and Cascade foothills in *The Jepson Manual: Higher Plants of California* (The Jepson Manual, Hickman 1993) were used and connected by northern and southern boundaries along the Highway 299 corridor and near Jawbone Canyon Road, respectively.

In maps and assessments, the Foothills Area was subdivided into five subregions that correspond to SNC subregions. These subregions include portions of the following counties:

- North: Shasta County;
- North Central: Tehama, Plumas, Sierra, and Butte counties;
- Central: Yuba, Nevada, Placer, and El Dorado counties;
- South Central: Amador, Calaveras, Tuolumne, and Mariposa counties; and
- Southern: Fresno, Tulare, and Kern counties.

2.2 Resources Inventoried

This section describes the mapping and tabulation of Foothills Area resources for this report from existing databases, technical and scientific studies, and GIS data layers. Additional information regarding GreenInfo Network's GIS methods is provided in Appendix A. Appendices B, C, and D provide tables summarizing wildlife, vegetation (and plant species), and hydrologic data, respectively. For species referred to in this report, scientific names are provided in Appendix B-I and Appendix C-I.

2.2.1 Special-Status Animals

The distribution and richness of special-status animals was considered in this report's assessment of wildlife resources. Special-status animals have status under the Federal Endangered Species Act (ESA), California Endangered Species Act (CESA), or other statute, or otherwise have been recognized as sensitive by U.S. Fish and Wildlife Service (USFWS) or California Department of Fish and Game (CDFG).

The following sources were consulted in the preparation of lists of special-status animals: California Natural Diversity Data Base List of Special Animals (2011), Jennings and Hayes (1994), Moyle et al. (1995), Shuford and Gardali (2008), Williams (1986), and Zeiner et al. (1990). For all special-status animals, associated habitats were compiled and Foothills Area counties within their geographic range identified (Appendix B-II).

2.2.2 Vegetation

The vegetation data mapped for this report were compiled from two sources: (1) CDFG vegetation maps of the Lassen Foothills and Northern Sierra Foothills developed from 3.28-foot (1-meter) resolution, 2005 aerial imagery (CDFG 2007, 2009a); and (2) Existing Vegetation (eVeg) maps of the entire study area developed by U.S. Forest Service (USFS) primarily from 98.4-foot (30-m) resolution, 1997–2007 Landsat Thematic Mapper data, but also 16.4-foot (5-meter) resolution imagery and other information (USFS 2010). Because the CDFG maps are more precise and accurate than the eVeg maps, eVeg maps were used only for areas not covered by the CDFG maps (i.e., south of central El Dorado County).

CDFG and eVeg map data were reclassified into a set of major vegetation types between which differences are significant for wildlife habitat values and other valued ecological services. These types correspond to one or more categories of the California Wildlife Habitat Relationships (CWHR) classification of land cover. Appendix C-II provides a crosswalk between this report's classification and the CWHR classification; it also provides a crosswalk to the corresponding categories in the recent California Native Plant Society (CNPS) mapping of the foothills of the northern Sierra and eVeg. The reclassified data were further grouped into map units and are displayed by Vegetation (V) Maps V-1 through V-5.

There are several important considerations for interpreting the vegetation data presented in this report. First, the relative amounts of different vegetation types in the North and North Central versus Southern Foothills Area are confounded with differences between the CDFG and eVeg data sources. For example, in landscapes with low densities of blue oaks, the finer scale of the CDFG maps distinguishes more grassland patches than the coarser-scale USFS data. Second, small or narrow features tend to be underrepresented in these regional maps, particularly the coarser-scale eVeg data. The Landsat data that are the primary basis of eVeg maps have a 98.4-foot resolution, and the minimum map unit of the eVeg maps is 2.5 acres; thus, riparian vegetation, which primarily exists as a narrow corridor, is probably substantially underrepresented. Third, errors frequently occur in assigning vegetation types to areas delineated on a map. Even in the relatively accurate CDFG data, which is very accurate for a regional vegetation map, nearly one-quarter of all of map units are misclassified (CDFG 2009a).

Only a portion of available information on vegetation attributes is displayed in this report's maps or summarized in its tables. This report's vegetation types and map units are combinations of multiple map units in the CDFG and USFS maps. In contrast, the CDFG map in particular distinguishes many specific alliances and associations based on Sawyer et al. (2009), and provides rarity rankings for these vegetation types. The eVeg map provides additional structural information (e.g., tree size and canopy cover). Furthermore, related studies, such as the study that developed the CDFG classification for the northern Sierra Nevada foothills (Klein et al. 2007a, b), provide additional information. Additional information in map data sources and supporting studies can be particularly relevant to a conservation effort.

2.2.3 Endemic and Special-Status Plants

The distribution and richness of endemic and special-status plants was considered in this report's assessment of botanical resources. Endemics are taxa (species, subspecies, or varieties) that in nature exist only within a defined region, which in this case is the Foothills Area. Special-status plants have status under ESA, CESA, or other statute, or otherwise have been recognized as sensitive by USFWS or CDFG.

Plants were identified as endemic to the Foothills Area based on their geographic ranges in *The Jepson Manual* (Hickman 1993, Viers et al. 2006). Because the western, northern, and southern boundaries of the Foothills Area differ from the boundaries of the Cascade and Sierra Nevada foothills in Hickman (1993), and because the distribution of many of these plants is not well documented, these taxa are not necessarily all endemic to the Foothills Area of this report. Nonetheless, these plants indicate the distribution and richness of botanical resources unique to the Foothills Area.

Special-status plants were identified on the basis of their inclusion in the CNPS Online Inventory of Rare and Endangered Plants (CNPS Inventory; CNPS 2011) and their geographic range in Hickman (1993). (Many of these special-status plants were also identified as endemic to the Foothills Area.) CDFG and CNPS jointly manage the review groups that evaluate plants for inclusion in the inventory and the assignment of a California Rare Plant Rank to each included taxa.

For all endemic and special-status plants, associated habitats were compiled and Foothills Area counties within their geographic range identified. For taxa included in the CNPS Inventory, the inventory's habitats were the basis for associated habitats. These habitats were crosswalked to the corresponding categories in this report's land cover classification. For endemic species not included in the CNPS Inventory, associated habitats were based on habitat descriptions in Hickman (1993), Munz and Keck (1968), and plant collections included in the Consortium of California Herbaria's online database (CCH Database; CCH 2011); and associated habitats were based on the habitat descriptions of two or more plant collections, or one plant collection and the habitat description in Munz and Keck (1968). Associations with serpentine soils were based on the database compiled by Safford et al. (2005).

Foothills Area counties within each taxa's geographic range were compiled from the CNPS Inventory, and for taxa not in the CNPS Inventory, Munz and Keck (1968) and the CCH Database were used to identify county distribution. Distribution among regions of the Foothills Area was based on this compilation of county distribution. The compiled list of endemic and special-status plants, and their associated vegetation types and distribution among subregions, is provided in Appendix C-III.

2.2.4 Invasive Plants

Hundreds of nonnative plants have been introduced and subsequently spread in the Foothills Area from before the Gold Rush to the present. A number of these species displace native plants, alter physical ecosystem processes (such as fire regimes and nutrient cycling), and degrade wildlife habitats. A list of the invasive plants causing the greatest effects in the Foothills Area was compiled from the invasive species with negative

ecological impacts rated "High" or "Moderate" in the *California Invasive Plant Inventory* (Cal-IPC 2006). For each of these invasives, the affected subregion(s) and vegetation types were identified from the habitat description in the *California Invasive Plant Inventory* and distribution information in *The Jepson Manual* (Hickman 1993) and CCH Database (2011). This list of invasive plants, and their associated vegetation types is provided in Appendix C-IV.

2.2.5 Hydrology

Maps and a database of watersheds, water bodies, and major water course features were compiled from the following sources:

- CalAtlas watersheds in the CalWater 2.2.1 GIS dataset (California Department of Water Resources [DWR] 2009a);
- U.S. Geological Survey 30-meter digital elevation model (USGS 2010a);
- California Department of Fish and Game waterbodies data for lakes and reservoirs (CDFG 2009b);
- CalAtlas dams and reservoir data in the CalGeoNames dataset (DWR 2009b);
- Geographic Names Information System for reservoir names (USGS 2011a); and,
- National Hydrography Dataset (USGS 2011b) for perennial, intermittent, and ephemeral rivers and streams.

Watershed boundaries from the CalAtlas data, at the hydrologic unit level of detail, were used to organize all the surface hydrologic data, with some grouping of subwatersheds along the lowest elevation margin of the Foothills Area to best fit major groundwater basin boundaries. Watershed elevation ranges, including the subset of elevation ranges within the Foothills Area, were determined by comparison with the USGS Digital Elevation Model (DEM). Water bodies (polygons) and rivers and streams (lines) within all source GIS datasets were intersected with the Foothills Area boundary (polygon) and the watersheds (polygons) to create a spatially organized database of all related hydrologic parameters. Specific queries of the USGS DEM were made to calculate reservoir elevations.

This spatially organized database of hydrologic parameters was supplemented with available published data from the California Water Plan (DWR 2009c), California's Groundwater (DWR 2003), and California Department of Water Resources' Integrated Regional Water Management program (DWR 2011a, b), along with watershed-specific parameters provided in scientific literature (CCC 2009, Cayan et al. 2007, Null et al. 2010). These combined data formed the basis for descriptive and comparative tables and graphs regarding surface hydrology, groundwater, and water use and management, in Section 5.1, "Hydrology."

2.2.6 Documented Special-Status Plant and Animal Distributions

For most special-status plants and animals, little occupied habitat is known to exist, compared to the size of the entire landscape. This occupied habitat is the location of the known populations of these special-status species. It also may represent the only suitable or best quality habitat for many special-status taxa. Therefore, it is of particular importance for conservation. For that reason, the California Natural Diversity Data-

base (CNDDB) catalogs the location of occupied habitat for special-status plants and animals, and the California Cooperative Anadromous Fish and Habitat Data Program (CalFish) documents the location of aquatic habitat occupied by anadromous fish. For animals, CNDDB (2008) and CalFish 2007 data (CalFish 2010) for documented occupied habitat are displayed by Ecological Landscape of Animals (LA) Maps LA-1through LA-5. For plants, CNDDB (2008) data for documented occupied habitat are displayed by Ecological Landscape of Plants (LP) Maps LP-1 through LP-5.

For CNDDB data, only the central point (centroid) of an area of occupied habitat (an occurrence) is displayed on the maps. Nonetheless, at the scale of these maps, the centroid symbols can cover a much larger area than has been documented as occupied. Also, some centroids on the maps represent occurrences of multiple special-status species.

CNDDB data, particularly for terrestrial plants and animals, has a major bias: habitat is only documented in areas that are surveyed for a species, and in the Foothills Area, which is primarily privately owned, extensive areas have not been surveyed for special-status species. Furthermore, developing areas are surveyed to fulfill regulatory requirements. In these areas, occupied habitat has been documented prior to development, and may subsequently have been eliminated or degraded. Therefore, CNDDB data do not provide complete, accurate documentation of the current, overall distribution of habitat occupied by special-status plants and animals. Rather, these data indicate only a portion of the locations that are potentially important for the conservation of special-status plants and animals.

2.2.7 Riparian Corridors

Riparian corridors were identified along waterways likely to have perennial flow, support riparian vegetation, or both. Such waterways were mapped on the basis of the National Hydrography Dataset (NDHD; USGS 2011b). As described in Appendix D, lines representing Foothills Area waterways were created from NHDH named and perennial waterways, and connecting waterways and waterbodies. Mapped and assessed riparian corridors were the areas within 328 feet (100 m) of these Foothills Area waterways. The width of this buffer was selected to include the waterway itself, riparian and wetland vegetation on the active floodplain, and adjacent upland areas that affect the waterway (e.g., shading or adding woody debris to the waterway) or provide habitat for wildlife moving along or associated with the riparian zone (e.g., refugia).

2.2.8 Botanically Significant Landscapes

This report's assessment of botanical resources included botanically significant landscapes, areas known to support endemic and special-status plants because of their substrate (underlying rock and soil). These areas were underlain by serpentinite, gabbro, or Ione Formation rocks, or have mapped vernal pool complexes (because soils have developed layers that impede drainage).

Mapping of vernal pool complexes was based on Holland (2009), who mapped vernal pool complexes extending over areas greater than 40 acres. This map of vernal pool complexes also includes those that have been disturbed or were converted to developed or agricultural land uses. (In the North and North Central subregions of the study area, and in northern El Dorado County, a more

precise mapping of existing vernal pools is provided by CDFG [2009a].)

The location of botanically significant landscapes underlain by serpentinite, gabbro, or Ione Formation rocks was based on GIS data for the Geologic Map of California (Department of Conservation 2000). This GIS data source is based on a coarse-scale statewide paper map (Department of Conservation 1977), and thus, provides only a coarse-scale map of these landscapes. However, watershed drainage, plant populations, and the effects of adjacent activities are not confined to the exact boundaries of a patch of a particular substrate, but rather extend across the surrounding landscape. Furthermore, many of these geologic features occupy large areas of many square miles. Thus, this data source is appropriate for identifying landscapes of botanical significance. It is not reliable for site-specific evaluations.

Finer-scale and more precise geologic and county soil surveys are available for much of the Foothills Area (though not all as GIS data), and could be applied in evaluations of specific sites.

2.3 Conservation Status

The conservation status of the major vegetation types, riparian corridors, documented occurrences of special-status species, and botanically significant landscapes was interpreted from land cover, ownership type, housing density, parcel size, and projected growth. Areas of urban and agricultural land cover were considered to be most altered and degraded. These areas were identified on the basis of the land cover mapping described above. The basis for housing density and change in housing density, parcel size and large land ownerships, and protection status data are described in the following sections. The conservation status of major vegetation types, riparian corridors, and botanically significant landscapes is summarized in Appendix C-V through Appendix C-XXI.

2.3.1 Housing Density

Housing density indicates the overall level of human influence and is associated with the extent of roads, hydrologic alteration, habitat modification and fragmentation, spread of nonnative species, and human and pet disturbance. Housing density was derived from Theobald (2005), who redistributes housing density within U.S. Census Bureau census blocks based on road distribution, and location of water features and protected areas. (Census blocks are bounded by physical features or political boundaries, and range in size from a city block to several square miles in rural areas.) This data source assigns land to five housing density categories. The data are displayed by Housing Density (HD) Maps HD-1 through HD-5. In assessing conservation status, the commercial/industrial, urban/suburban, and exurban categories were considered substantially altered and degraded.

Theobald (2005) used the Spatially Explicit Regional Growth Model (SERGoM) to project change in housing density from 2000 to 2030. This model estimates housing density from projected population growth, historical population-housing density relationships, and travel time to the nearest urban core. Areas with a projected increase in housing density during 2000–2030 were considered to be more at risk of resource loss or degradation than other areas. These areas (i.e., areas predicted to a greater density category during 2000–2030) are displayed by Housing Density Maps HD-1 through HD-5.

2.3.2 Parcel Size and Large Land Holdings

Parcel size indicates both human influence and conservation opportunities. For land outside of urban, suburban, and exurban areas, areas fragmented into smaller parcel sizes was considered to be at greater risk of resource loss or degradation than areas in larger land holdings. Conversely, areas in larger land holdings were considered to represent better opportunities for conservation than land in smaller sized land holdings.

Parcel data were compiled by GreenInfo Network from each county in the Foothills Area. Areas occupied by water bodies and roads were removed from the data layer, and parcels were then classified into six size categories: <10, 10–40, 40–80, 80–160, 160–320, and >320 acres. The distribution of parcel size categories in the Foothills Area is displayed by Parcel Fragmentation (PF) Maps PF-1 through PF-5. Maps do not display parcel size data for protected areas, and the parcel size of protected areas was not considered in analyses of conservation status or conservation opportunities.

Large land holdings represent particularly important conservation opportunities. Privately-owned areas 320 acres or more in size with a single owner were identified from county parcel data. As described in greater detail in Appendix A, county parcel data sets (except for Amador County) include ownership attributes that were used to identify adjacent parcels (i.e., adjoining or separated by narrow features such as roads) that likely had the same owner. The location of large land holdings is displayed by Large Land Holdings (LH) Maps LH-1 through LH-5.

2.3.3 Protection Status

Protection status was based on U.S. Geological Survey GAP Analysis Program (GAP) status in GreenInfo Network's California Protected Areas Database (CPAD, GreenInfo 2011). Areas were considered "Protected" if their GAP status was 1, 2, or 3 (USGS 2010b). These are public lands and privately protected lands. These areas have permanent protection from conversion of natural vegetation, and protect species federally listed as threatened or endangered species. These status categories differ in management of uses and natural disturbance.

- Gap Status 3 has management that may include resource extraction (e.g., mining, logging) and uses that may degrade natural communities.
- Gap Status 2 management does not include resource extraction, but may include uses that degrade communities.
- GAP Status 1 management does not include resource extraction or uses that may degrade communities, and unlike GAP Status 1 or 2 allows natural disturbance events to proceed without interference or mimics such disturbance through management.

Most protected land in the Foothills Area has GAP Status 3, and very little land in the Foothills Area has GAP Status 1. The location of protected lands is displayed by Large Land Holdings Maps LH-1 through LH-5.