USNVC Interacting with the National Vegetation Classification: A Window on the Ecological Landscape of the United States

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Using legacy datasets to analyze changes in vegetation distribution: examples and considerations

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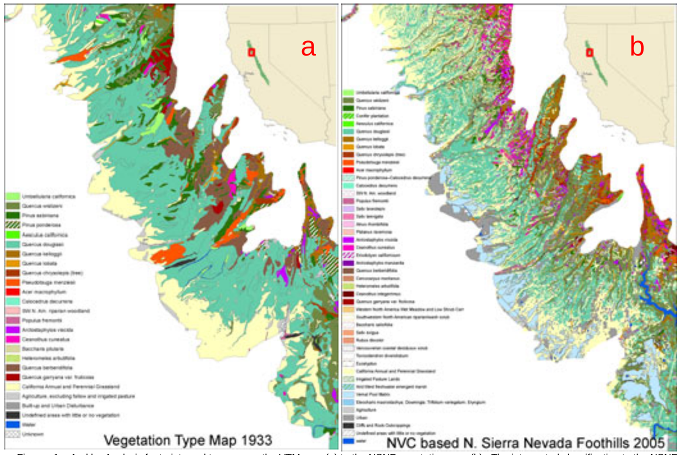


Figures 1a. And b Analysis footprint used to compare the VTM map (a) to the NSNF vegetation map (b). The interpreted classification to the NSNF of the VTM ordered list of dominants is shown for comparison.

Extensive and chronologically well-separated data sets containing quantitative information on extent and composition of vegetation or species at landscape scales are particularly appealing and potentially very valuable to ecologists and managers interested in the exploring effects of climatic or management related trends on vegetation.

The Wieslander Vegetation Type Maps (VTM) were produced in California in the 1920's and 30's. Products from this effort include plot data, photos, and vegetation maps covering over 40% of the state. Since 1998, jurisdictional and regional vegetation maps have been produced in California using a methodology which also incorporates plot data and photos using the National Vegetation Classification System as a basis. One recently mapped area is the Northern Sierra Nevada Foothills (NSNF). Here we compare the two datasets to explore ecological questions but with a focus on issues that could limit or confuse analyses; including scale, georefeferencing, and classification issues.

The Wieslander dataset was produced through a survey effort that occurred between 1927 and 1933. Topographic maps were mounted on boards and taken into the field with survey crew who took surveys and photos at points, and drew vegetation polygons from ridgetop vistas. The extent of the project includes much of California, but excludes the agricultural areas in the Central Valley and the deserts of Southern California. There were 17,860 surveys completed within this area. Strata are defined as Tree, Shrub, Herb, and Mosaic with each defined by the cover of the dominant strata being >80% and any areas that don't have this dominance being designated as mosaics. Dominant species are coded and listed in order on polygons. Economically important tree species are listed first, regardless of cover relative to other dominants. A recent effort by the UC Davis Information Center for the Environment has converted much of this effort into a GIS format, and is continuing as projects allow.

The Northern Sierra Foothills Map was produced through a combination of surveys and heads-up digitizing in a GIS using 2005 NAIP imagery as a base. Field survey consisted of 710 CNPS Relevés and 1,691 Rapid Assessments all with photos, field reconnaissance, and 594 Accuracy Assessments. These surveys went through a classification process that followed the National Vegetation Classification System (NVCS). Vegetation types are not based solely on dominance but also on adequate presence of characteristic species. Strata are defined as Tree, Shrub, and Herb. Half of the mapping was completed in October, 2009 and the other half will be completed this year.

To compare the two datasets, we reviewed the dominant species listed with the VTM data and crosswalked this to NVCS alliance definitions. Since the cover values are not explicit on the VTM maps, exact matches were not possible. A single 30 minute quadrangle of the Wieslander dataset was used for this comparison: the Chico quad. The two datasets were clipped to the boundary of the Chico quad and the extent of the ecoregion used to bound the NSNF project (figures 1a and b). Then, the acreages were summed for each NSNF mapping unit.

Our exploration is an attempt to evaluate two alternative hypotheses for a series of vegetation types shared between the two data sets, which appear to have distinctively different acreages. Hypothesis category 1 reflect a suite of potential ecological or direct management related explanations, while hypothesis category 2 reflects a more practical and thematic series of possible explanations for the apparent differences (see Table 1 for selected results). Some examples of opposing hypotheses and implications for their proper interpretation are shown in the highlighted boxes below.

NSNF map unit	NSNF acres	VTM acres	Ecological hypothesis for disparity	Practical methodological or translation hypothesis
Pinus ponderosa–Calocedrus decurrens	44.8		fire regime change reduction of frequent ground fires	classification difference
Heteromeles arbutifolia	2.2	59.0	drying and heating trends, reducing mesic chaparral	classification difference
Pinus sabiniana	2905.4	11168.7	increased fire frequency/intensity, clearing of conifers	classification (emphasis of conifer cover vs hardwood cover)
Quercus kelloggii	10130.9	5527.3	altered fire regime fostering regen (asexual, sexual)	classification (emphasis of conifer cover vs hardwood cover)
Quercus chrysolepis (tree)	5118.8	1986.9	reduction of conifer veg being replaced by canyon oak	classification (emphasis of conifer cover vs hardwood cover)
Pseudotsuga menziesii	1015.5	6075.6	drying and heating trends, logging of valuable douglas fir	classification (emphasis of conifer cover vs hardwood cover), or miss-coding
Pinus ponderosa		4161.8	logging, warming and drying trends	classification (emphasis of conifer cover vs hardwood cover)
Irrigated Pasture Lands	68.5		more irrigation	classification difference
Western North America Wet Meadow and Low Shrub Carr	320.0		more irrigation	classification difference
Baccharis pilularis		55.7	less moist early seral vegetation	miss-coding
Umbellularia californica	257.0	2162.1	reduction in rainfall or increase in summer heat	mmu and lumping of adjacent stands
Quercus wislizeni	41282.4	16945.3	reduction of conifer veg being replaced by interior live oak, or change in fire regime, fostering resprouting and spread of quwi	mmu and lumping of adjacent stands
Quercus douglasii	49078.9	98202.1	hardwood cutting, drying conditions fostering senescence and reduced regen due to increased livestock and other seedling/seed consumers	mmu and lumping of adjacent stands
Quercus lobata	1976.2	720.7	no obvious explanation	mmu and lumping of adjacent stands
Calocedrus decurrens	120.4		fire regime change reduction of frequent ground fires	mmu and lumping of adjacent stands
Arctostaphylos viscida	3653.2	1827.0	more clearing and early seral vegetation replacing old conifer and mixed hardwood	mmu and lumping of adjacent stands
Ceanothus cuneatus	4687.0	1074.9	higher fire frequencies supporting early seral veg	mmu and lumping of adjacent stands
Quercus garryana var. *fruticosa*	631.0	2967.5	drying and heating trends, reducing mesic chaparral	mmu and lumping of adjacent stands
Rubus discolor	39.0		more invasive exotics, more managed wetlands (stock ponds, etc.)	mmu and lumping of adjacent stands
Toxicodendron diversilobum	248.3		clearing of oak overstory	mmu and lumping of adjacent stands
California Annual and Perennial Grassland	53847.4	39092.2	grazing and clearing combining with drying and heating trends promoting grasses over hardwood woodlands	mmu and lumping of adjacent stands
Arid West freshwater emergent marsh	52.7		more irrigation	mmu and lumping of adjacent stands
Vernal Pool Matrix	16544.3		no obvious explanation	survey timing, classification difference
Eleocharis macrostachya; Downingia; Trifolium variegatum; Eryngium sp.	13.1		no obvious explanation	survey timing, mmu, classification difference
Agriculture, excluding fallow and irrigated pasture	1021.0	3509.4	less agriculture in foothills now	mmu and lumping of adjacent stands, classification difference
Built-up and Urban Disturbance	10661.7	26.9	more development	mmu and lumping of adjacent stands, classification difference
Ceanothus integerrimus	630.4		higher fire frequencies supporting early seral veg	mmu and lumping of adjacent stands, or emphasis on conifer
Southwestern North American riparian evergreen and deciduous woodland	403.4	110.3	more dams and less flooding supporting growth of riparian trees	mmu, perspective, and mapping rules that limit riparian mapping due to mmu & perspective
Populus fremontii	691.1	127.2	more dams and less flooding supporting growth of riparian trees	mmu, perspective, mapping rules that limit riparian mapping due to mmu & perspective
Platanus racemosa	508.5		no obvious explanation	mapping rules that limit riparian mapping due to mmu & perspective
Quercus berberidifolia	869.7	14687.3	drying and heating trends, reducing mesic chaparral	taxonomic confusion with shrubby Q. wislizeni?, also mmu and lumping of adjacent stands

Table 1: selected map units and the number of acres there are in the study area in the NSNF dataset and interpreted from the VTM dataset. Potential ecological and methodological explanations are included. Map units in pink have more acreage in the VTM as crosswalked here; ones in blue had more acreage in the NSNF map.

Box 1: Exploring classification differences and georeferencing: Did the *Pinus ponderosa* alliance formerly occur in the area?

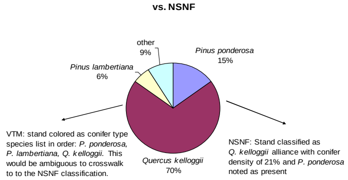
The VTM dataset in our study area contains approximately 4162 acres which we assigned to the *Pinus ponderosa* alliance based on the ordered list of dominant species. The NSNF dataset for that region contains no polygons in that alliance. Does this mean that logging, global warming and associated drying have resulted in that alliance having shifted its range upslope?

One issue that may explain some of the difference is the georeferencing. Most of the polygons in the *Pinus ponderosa* alliance are near the eastern boundary. Because the vegetation was drawn onto older topographic maps with less horizontal and vertical accuracy, the georeferencing process was not perfect. Shifts up to 307 m were observed by comparing locations on the 2005 NAIP imagery to ones shown on the VTM maps (see figure 2), and other efforts to estimate the horizontal error in the topographic maps used in Wieslander's survey have put the error at between 200-300 m[4,5]. In the data reviewed here, of 69 polygons that had been assigned to the *Pinus ponderosa* alliance, only 17 of them were close enough to the boundary of the NSNF footprint that a 300 m error could explain the difference.

Another issue is classification differences. In order to have *P. ponderosa* listed as the first dominant species in the VTM dataset, it would need to cover only 20 percent of the vegetated area in the stand, or have more cover than another conifer and the combined coverage total more than 20%. Conifer cover is prioritized over hardwood cover and even if *Quercus kelloggii* cover was 70%, it would be listed second. In the NVCS system, this same stand would be placed in the *Q. kelloggii* (black oak) alliance (see figure 3). In fact, a stand with as little as 31% relative cover of *Q. kelloggii* could be classified to the *Q. kelloggii* alliance. There are 25 stands of oaks within 300 m of the VTM *P. ponderosa* stands that have *P. ponderosa* present and conifer cover > 20%. However, in this case for most of the *P. ponderosa* stands in the VTM dataset, no other dominant is listed. Therefore we conclude that an upslope shift of as much as 4.8 km may have occurred. It is of interest that oak stands in the NSNF dataset that would have been ambiguous with respect to classification are in proximity to most of the *P. ponderosa* stands in the VTM data (figure 4).

Figure 2: a displacement of 307 meters is seen between the topographic map base for the VTM dataset (a) and the 2005 NAIP imagery used by the NSNF project (b). The displacement measured is between the crossing of Butte Creek by Centerville Road.

Figure 3. Hypothetcial stand cover and interpretation in VTM vs. NSNF



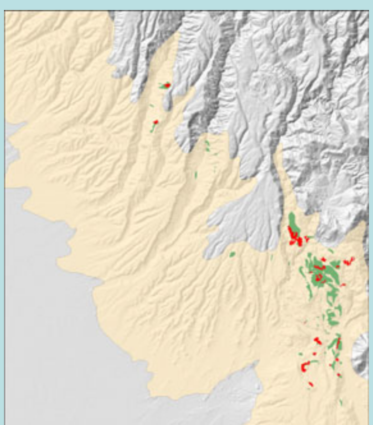


Figure 4: Pinus ponderosa alliance apparent shift in distribution

Box 2: Exploring minimum mapping units: Has Blue Oak been replaced by grassland?

The VTM dataset in our study area contains approximately 98,202 acres which we assigned to the blue oak alliance (Q. douglasii) based on the ordered list of dominant species. The NSNF dataset for that region contains only 49,079 acres in that alliance. There have been many efforts to document loss of oak woodlands in California due to woodcutting, and senescence without recruitment of new individuals[4]; but in comparing these two datasets, it is evident that differences in mapping rules account at least some, if not most, of the acreage difference.

The minimum mapping unit for the VTM was 40 acres generally, with an exception for timber types to be mapped down to 10 acres. The minimum mapping unit for the NSNF project is 2 acres generally, with an exception for a number of special mapping types like vernal pools and riparian vegetation of 1 acre. This has serious implications for comparing acreage between the two maps.

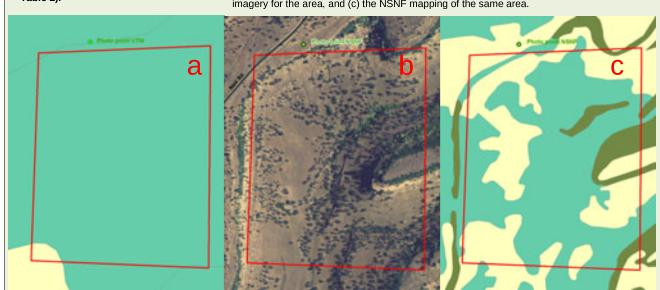
We located a photo point from the Wieslander VTM survey along Neal Rd (see Figures 5a and b). The area covered by the photo point, when compared with recent imagery in a terrain model, hasn't changed significantly since the time of the survey. When the NSNF and VTM maps are compared for the same area (interpreted from the topo for the VTM), the difference the mapping units make becomes clear. In the NSNF dataset, much smaller polygons are pulled out based on changes in cover and vegetation signature; and this results in more of the area being mapped as grassland (see Figures 6a, b and c and Table 2).

Figures 5 a and b: A photograph from the Wieslander survey[3] showing a landscape view from Neal Rd. in Butte Co. which was mapped with Q. douglasii as the dominant (a); and the same area as shown using NAIP imagery in Google Earth (b). The overall density of oaks has not changed much since 1933.

Table 2: summed acreage of each NSNF type for the AOI used in Figures 6 a,b, and c. Because of the smaller mmu in the NSNF project, more grassland was separated from Q. douglasii, and small polygons of Q. wislizeni were delineated

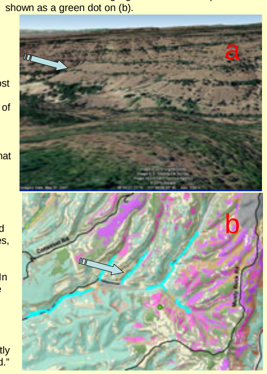
MapUnit	Acres in NSNF	Acres in VTM
Quercus wislizeni	8	
Quercus douglasii	64	111
California Annual and Perennial Grassland	41	2

Figures 6 a,b and c: maps showing (a) the VTM map near the photo point shown in Fig. 5, (b) the NAIP imagery for the area, and (c) the NSNF mapping of the same area.



Box 3: What is behind the omission of *Platanus racemosa* and other riparian types in the VTM data used here?

Figures 7 a and b: visualization of a theoretical viewpoint for field mapping. The blue arrows point to a stand of *P. racemosa* that can't be seen from the viewpoint. P. racemosa stands are highlighted and the viewpoint is shown as a green dot on (b).



The NSNF project contains approx. 509 acres in the *P. racemosa* (western sycamore) alliance in the project area, but the VTM dataset has none. Most of this has to do with the minimum mapping unit—only 2 of the 30 stands mapped in the NSNF are over 40 acres; however in this case it is systematic. The field manual that directed the VTM survey specifically says about the woodland mapping type: "This designation also embraces the WOODLAND that occurs in narrow strips along streams and ravine bottoms. These subtypes, unless of unusual width, are mapped only where they are surrounded by treeless types. In such localities they are of some importance. Where these subtypes are surrounded by other TREE types, they are so frequently obscured that they cannot be delineated consistently and therefore should be omitted."

This means that riparian woodland types are generally not separated in the VTM effort, because they cannot be mapped consistently. They are small, narrow, and hard to see completely. Even using modern mapping methods, mapping riparian types can be a challenge. When you add having a viewpoint that is not "birds-eye", this challenge becomes almost impossible. Figures 7 a and b illustrate the issue.

Conclusions and recommendations:

1. **Minimum mapping unit differences between maps seriously impact the ability to analyze change in distribution of vegetation types over time. Acreages, extents, presence and absence can all be affected. The compatibility of the datasets should be checked before performing analyses, and discussed as a factor in any conclusions drawn.**
2. **Classification and mapping rules must be carefully understood and addressed in analysis. Each mapping class should be considered separately and hypotheses-tested with multiple crosswalks if classification crosswalks are ambiguous. Crosswalk ambiguity should be discussed as a factor in any conclusions drawn.**
3. **Plot data and photographs can be used to test assumptions about classifications and mapping rules when comparing vegetation maps. They also can be used by themselves in temporal analysis.**
4. **Users and producers of vegetation data in temporal analysis should have an eye on these issues. Although important differences may exist, they may not become clear without careful scrutiny and appropriate adjustment.**

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3. Images from the Wieslander Vegetation Type Mapping Collection are courtesy of the Marian Koshland Bioscience and Natural Resources Library, University of California, Berkeley, www.lib.berkeley.edu/BIOS/vtm/
4. Thorne et al, 2008. Vegetation Change Over Sixty Years in the central Sierra Nevada. Madrono Vol 55 #3, pp 223-237
5. Kelly et al , 2005. Digitization of a Historic Dataset: the Wieslander California Vegetation Type Mapping Project. Madrono Vol 52 #3, pp 191-201