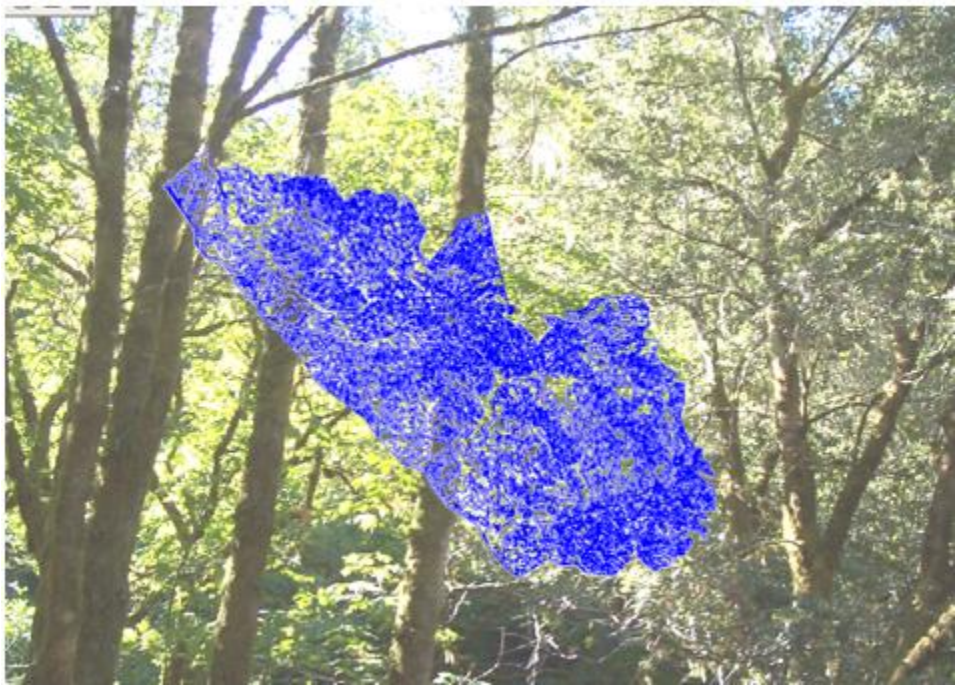
PHOTO INTERPRETATION REPORT
FOR THE MOUNT TAMALPAIS WATERSHED



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Aerial Information Systems, Inc.
112 First St., Redlands, CA 92373
PHONE 909-793-9493 FAX 909-798-4430
ais@aisgis.com

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INTRODUCTION

Aerial Information Systems, Inc. (AIS) prepared this report for Marin Municipal Water District (MMWD). The following information is contained in this report:

- A description of the mapping conventions and methodologies used to delineate and assign attributes to polygons for the terrestrial vegetation map for the Mt. Tamalpais Watershed as well as its lands surrounding Nicasio and Soulajule Reservoirs.
- A list of the MMWD mapping types description, which was based on the MMWD Vegetation Classification, jointly created by MMWD and California Native Plant Society (CNPS).
- An area report of the study area, complete with the vegetation code, polygon count, area (in square feet), acres, hectares and average polygon size (in acres).
- A list of items in the final coverage.

MARIN MUNICIPAL WATER DISTRICT VEGETATION MAPPING METHODOLOGY

In order to efficiently produce the MMWD Vegetation Map, the project occurred in several stages, which are listed below:

1. Data Inventory, Organization of Project Materials and Uploading of Digital Files
2. Preliminary Aerial Photograph/ Digital Imagery Signature Identification
3. Field Reconnaissance
4. Photo Interpretation
5. Quality Control
6. Field Check and Field Revisions
7. Final Quality Control/ Code Verification/ Edit Review
8. Final Data Processing and Documentation

STAGE 1: Data Inventory, Organization of Project Materials and Uploading of Digital Files

A detailed inventory of the project materials was performed to verify that all the materials were received. Any digital files received from MMWD were uploaded onto AIS' computer system. Any additional manipulation of the data to make it ready for the interactive photo interpretation process also occurred at this time.

STAGE 2: Preliminary Aerial Photograph/ Digital Imagery Signature Identification

In the initial stage of the project, the photo interpreters (PI) from AIS performed a preliminary photo signature identification via a heads-ups digitizing technique using the digital Vargis imagery as the base imagery. The PI reviewed the digital imagery and flagged areas that were possible repeatable vegetation mapping units, had questionable photo signatures or were otherwise deemed important to review when on the field reconnaissance trip.

STAGE 3: Field Reconnaissance

The next step was the field reconnaissance effort. Photo Interpreters from AIS were joined on the field reconnaissance trip by ecologists from MMWD and CNPS. The main purpose of the field reconnaissance trip was to correlate the digital photo signatures with the Preliminary MMWD Vegetation Classification as well as to identify plant species, preliminary vegetation alliances and the associated photo signatures and answer any other questions that evolved in the preliminary photo signature identification phase. The team visited pre-selected sites based on the preliminary digital photo signature identification in addition to sites not previously chosen. The sites that were not pre-selected were chosen as the trip progressed and the team considered them important to visit, usually for unique characteristics or the repeatability of the vegetation unit.

Classification Development

After the field reconnaissance was completed, the Preliminary MMWD Vegetation Classification (based on floristics) was jointly created by MMWD and CNPS. Field plots and plot analysis supported the floristically derived classification. The alliances in this classification were determined by the relative abundance of species present in the vegetation overstory. The association levels in this classification were based on plot data sampling, diagnostic species, and ecological factors. The Preliminary MMWD Vegetation Classification (Floristic Vegetation) was consistent with the standards set by the National Vegetation Mapping Program of floristically derived alliances and associations.

With guidance from the ecologists at MMWD and CNPS, AIS created a Preliminary MMWD Mapping Vegetation Classification (based on the floristic Preliminary MMWD Vegetation Classification). The mapping units created for this classification were defined by species dominance and what could be seen on the imagery as well as the environmental characteristics.

The Preliminary MMWD Mapping Vegetation Classification (Mapping) and Floristic Vegetation classifications cross-walked to each other, but the photo interpreter used the Preliminary MMWD Mapping Vegetation Classification to map the study area. The vegetation mapping effort began once the preliminary floristic and mapping classifications were developed.

STAGE 4: Photo Interpretation

Viewing the digital imagery on screen and using the Preliminary MMWD Mapping Vegetation Classification, the PI began the photo interpretation. There were 2 sets of digital imagery used for the mapping. The base imagery was the natural color New Marin Map imagery, by Vargis, which covered the entire study area. The resolution for the Vargis imagery averaged 1:400 (it was variable from ½ foot to 1 meter). Another set of digital imagery, DAIS Imagery by Space Imaging (DAIS), was used as ancillary data. The imagery primarily covered the western ¾ of the study area and had a resolution of 1:1200 (1-meter [3.3 ft] pixels). The DAIS imagery was set up to be viewed in both natural color and Color Infrared (CIR). The CIR imagery was valuable since the healthy vegetation appeared magenta or dark red color in the CIR imagery, while the unhealthy or dead vegetation appeared gray or white.

Ancillary Data

Prior to making any delineations or decisions regarding the vegetation type, all ancillary data was reviewed. The ancillary data used for the vegetation mapping project included the following:

- DAIS Imagery by Space Imaging- 1 meter resolution, 4-band RGB and near-IR bandwidth, flown in October 2001
- Contours- 10ft intervals; unknown originator- data obtained from MMWD
- AIS Waypoints- GPS points taken by AIS on the field reconnaissance trip.
- Quick Points- GPS points taken by MMWD prior to the field reconnaissance trip that briefly described the vegetation in the area sampled.
- Preliminary Alliance Points- GPS points taken by MMWD that were assigned preliminary alliances and also included a list of dominant species in the sampled area.
- Vegetation Map 1995- Polygons of vegetation types created for the 1995 Vegetation Management Plan.
- Broom Coverage- Polygons of broom, obtained from MMWD.
- Geology- Geology polygon feature dataset from USGS.
- Point Reyes National Seashore Vegetation Map- Polygons of vegetation types created for Point Reyes National Seashore Vegetation Map.
- Rare Plants- Polygons locating rare plant populations known to exist or have a high likelihood of still existing on the Mt. Tamalpais watershed; data provided by MMWD.
- MMWD Culverts- Points within the study area indicating culverts, obtained from MMWD.
- Streams- Lines indicating stream locations in the study area- originator unknown- obtained from MMWD.

- Roads- Lines indicating locations of primary, secondary and tertiary roads in study area. Originator unknown- obtained from MMWD.

Photo Interpretation

By starting at one edge of the study area and working methodically, the interpretation was conducted for the entire study area using heads-up digitizing techniques. The heads-up mapping procedure incorporated custom ArcEdit tools that AIS had developed for other vegetation mapping projects previously completed by AIS throughout the state of California. The minimum mapping unit (MMU) used for delineating polygons was 0.5 hectares. However, there were a few exceptions such as: areas of critical habitats, critical water sources and wetlands that were mapped smaller than the MMU.

Each vegetation polygon was assigned 9 attributes. These attributes included the following:

- Veg - the 4 digit numeric code from the Preliminary MMWD Mapping Vegetation Classification
- ConDensity - density of the conifer component in the polygon (ranges from 0-5)
- HwoodDensity - density of the hardwood component in the polygon (ranges from 0-5)
- ShrubDensity - density of the shrub component in the polygon (ranges from 0-5)
- Broom - broom modifier in the polygon (ranges from 0-3)
- Dead tanoak - dead vegetation (usually tanoak) disturbance modifier in the polygon (ranges from 0-3)
- Field - either 0 for no questions or 1 for field questions
- QC - either 0 for not yet QC or 1 for QC completed
- Note- text that describes field questions

Described below are the descriptions for each attribute:

Vegetation Code

The first attribute to be assigned was the vegetation type. The PI assigned a 4-digit numeric code to the polygon that represented either the best alliance, mapping unit or association from the Preliminary MMWD Mapping Vegetation Classification. When assigning a vegetation code to a polygon (veg), the photo interpreter would first review all data available that could help with the decision making process.

Density

The densities for the conifer, hardwood and shrub components were then assigned to the polygon. Cover class densities for the conifer, hardwood and shrub components were assigned the following values:

1. = Greater than 60%
2. = 40-60%
3. = 25-40%
4. = 10-25%
5. = 2-10%

9 = Not Applicable

Neither the non-vegetated surfaces nor the herbaceous component was assigned a density value. Absolute density cover was used instead of relative density cover in order to accurately depict total plant coverage from the aerial images. Absolute density refers to the sum total of the visible plant and non-vegetative cover within a given mapping unit. The total density cover for all visible over-, mid- and understory vegetated and non-vegetated surfaces must equal 100% present. Vegetation not visible on the aerial imagery was not considered as part of the total plant density.

Broom Disturbance Modifier

After the densities were assigned for the conifer, hardwood and shrub layers, the modifier for the broom disturbance was given. Within the study area, a presence of French broom, Scotch broom and Spanish broom had been noted. Several species, especially French broom, are considered aggressively invasive exotics. As an aggressive exotic plant, it created safety issues including reduced visibility along roadsides, increasing the fuel load and reducing biological diversity in natural areas. Due to these concerns, MMWD considered it a priority to map the presence of broom. The disturbance modifier for the presence of broom in a polygon was assigned the following values:

0. = Minimal or no disturbance visible
1. = Low: 1-5% of the polygon had broom visible
2. = Moderate: 5-10% of the polygon had broom visible
3. = Severe: Over 10% of the polygon had broom visible

It is important to note that the broom modifier should be considered temporal since the eradication effort was ongoing, and the imagery may differ from what was actually found on the ground. MMWD gave AIS a GIS data set (polygons) with locations of broom that had been documented by MMWD staff. AIS used this coverage to help determine if the broom was present on the imagery. The broom modifier was only used when seen on the digital imagery and was not a line former for polygons. In other words, the linework for a polygon was not based on the presence of broom.

Dead Vegetation Disturbance Modifier

Within the study area, Sudden Oak Death (SOD) was a disease that infected oak trees or close relatives to oaks (e.g. tanoak trees). The SOD disease had contributed to the death of trees, particularly tanoak (Lithocarpus densiflorus or LIDE). When the tanoak trees died, the dead trees not only created increased fuel for fire, but also would occasionally fall. The new openings in the forest would change the fire dynamics, allowing broom and Douglas-fir trees to grow where there was once sheltered grass, Since the dead tanoak trees created a dangerous fire hazard, the presence of dead tanoak was given a modifier. The disturbance modifier for the presence of dead vegetation, which was tanoak in most cases, was assigned the following values:

0. = Minimal or no mortality – (standing trees)
1. = Low: 1-5% of the polygon had canopy mortality
2. = Moderate: 5-10% of the polygon had canopy mortality
3. = Severe: Over 10% of the polygon had canopy mortality

The dead vegetation disturbance modifier was temporal so the imagery may differ from what was found on the ground. The dead vegetation disturbance modifier was not a line former for polygons, so the linework of a polygon was not based on the presence of the dead trees; however, the densities were affected by the amount of dead trees present.

Field Attribute

The field attribute was coded next. The following values were given to this field:

1. = Field Questions
2. = Answered
3. = Internal Questions
4. = Corrections to Marin Field Assessments
5. = Corrected to Jeff Kennedy Assessments

A value of 1 was assigned to a polygon when the photo interpreter or the reviewer (the person who conducted the quality control) had a question about a polygon that needed to be checked by a field crew person. Once the question was answered, the veg code was assigned based on the field crew's findings, and a value of 2 was given to the field attribute in the polygon. A value of 3 was given to polygons that required the reviewer's guidance, but was not necessarily a field question. Once

addressed by the reviewer, then the field value was changed to another pertinent code. There should not be any field attributes with a value of 3 remaining in the final coverage. They were all changed to a different code after being reviewed in the final quality control (QC) check. A value of 4 was given to polygons that were reviewed by MMWD in the Accuracy Assessment. A value of 5 was given to polygons that were reviewed by the AIS's sub-consultant, Jeff Kennedy of GeoBotany.

QC Attribute

The QC attribute has a value of either 0 for no quality control check or 1 for quality control check performed.

Note Attribute

Any information regarding the field questions from AIS was noted in this field in order to better guide the field crew person to what the specific field question was.

STAGE 5: Quality Control

Once the Photo Interpretation stage was completed, a comprehensive quality control was performed by the senior photo interpreter (also known as the reviewer) in conjunction with checking the map for any internal AIS questions (Field attribute = 3) or field questions (Field attribute = 1). Any field questions were then sent to MMWD for the field crew or the sub-consultant to answer.

In order to ensure the completeness of the interpretations, custom programs were used that indicated which polygons have been reviewed. Once a polygon was reviewed, updated, or flagged for further field, the on-screen codes for that polygon changed color. This way, the reviewer could keep track of what had been previously reviewed and/or updated. This eliminated any duplication of effort resulting from revisiting previously reviewed areas and ensured that every polygon delineated on the digital image was reviewed. In addition to the visual QC effort, automated QC programs were run on the data that checked for coding errors

STAGE 6: Field Check and Field Revisions

Field check/verification edit plots containing the vegetation delineations, vegetation codes and project imagery were generated with all problematic polygons flagged for field review. The goal of the field check visits was to ground-truth both specific polygons and general signatures on photos for which initial interpretation was complete. Both the MMWD Preliminary Mapping Vegetation Classification and photo interpretation efforts were assessed for changes necessary to accurately finish the vegetation map.

The field personnel from MMWD answered field questions for AIS photo interpreters and performed an accuracy assessment on the interim product. The findings were sent to AIS in a spreadsheet, and then changes were made to the coverage. In addition, Jeff Kennedy (sub-consultant to AIS), also answered field questions and performed an accuracy assessment on the interim product and made all necessary revisions and/or corrections directly onto the field plots. Once AIS received all of this data, it was incorporated into the database and revised where necessary.

STAGE 7: Final Quality Control/ Code Verification/ Edit Review

As a final QC of the final vegetation database, AIS produced a set of edit-plots to verify accuracy of data capture and any revisions made to the database due to the field check effort.

STAGE 8: Final Data Processing and Documentation

The coverages were then mapjoined together to create a single coverage of the entire study area. A series of automated quality assurance (QA) checks were run on the final coverage to identify label errors and other problems arising from the mapjoin step. When all of the errors were corrected, another automated QA check was conducted to identify edgematch discrepancies along the module boundaries. Problems identified during this process were resolved on-screen and the coverage went through another series of QA checks. The automated QA review was repeated until the coverage was error free.

Upon completion of the automated QA steps, the edgematched coverages were converted into an ArcGIS shapefile. The shapefile coordinates were in State Plane CA, feet, zone III FIPS 0403, NAD83. A metadata file was generated that met the standards found in attachment G of the RFP.

AIS provided MMWD with a Photo Interpretation Summary Report. The report contained a description of the methodologies used to delineate and attribute polygons, a link between each mapped vegetation type and the U.S. National Vegetation Classification Alliance code. Also, an area report was generated which summarized each mapped Alliance or vegetation type by listing the total number of polygons, total hectares, total acres, and average polygon size.

DESCRIPTIONS OF MARIN MUNICIPAL WATER DISTRICT VEGETATION MAPPING TYPES

1101 – Coast Live Oak - Madrone Lower elevation Mixed Broadleaf Woodland

Distribution:

Common but regional – located primarily north of Alpine and Bon Tempe Lakes and west of Phoenix Lake.

Environmental Characteristics:

Trending in xeric settings in areas of deep soil; primarily on southeast or westerly slopes.

Description:

Stands are quite extensive in size; Coast live oak or madrone generally dominates or co-dominates. At least two hardwood species are present as a dominant or co-dominant. Black oak and madrone occasionally co-dominate but more often coast live oak and madrone.

Photo Interpretation Signature:

Coast live oak tends to yield a dark green signature with madrone giving of a light gray to green signature (highly variable) and sometimes not distinguishable from other hardwoods. Black oak is generally lighter green.

1102 – Tanoak – California Bay – Canyon Oak Higher elevation Mixed Forest

Distribution:

Common south of Phoenix Lake adjacent to mixed conifer and redwood forest and near Kent Lake

Environmental Characteristics:

Common at higher elevations generally in sub mesic to mesic settings

Description:

Tanoak or California bay dominate or co-dominate the stand generally in a forest setting. Canyon oak may be a subordinate or rarely co-dominate at higher elevations in dryer settings.

Photo Interpretation Signature:

Intensities of tanoak death provide openings to the crown yielding a dark shadowy signature with variable gray shades mixing with the lighter green of the bay.

1103 – California Bay – Alder – Bigleaf Maple – Mixed Willow Riparian Forest

Distribution:

Uncommon but widespread in narrow riparian settings

Environmental Characteristics:

Found in perennial watersheds very close to the water's edge.

Description:

California bay is nearly always present as a dominant, co-dominate or subordinate to any of the riparian trees including maple, alder and willow.

Photo Interpretation Signature:

Bigleaf maple gives off a green to blue-green signature and is distinct as a narrow band adjacent to upland hardwoods.

1104 – Madrone – California Bay – Tanoak Forest

Distribution:

Common – distributed in regionally similar areas to type 1101.

Environmental Characteristics:

Often adjacent to type 1101 on more protected slopes trending northwest to easterly.

Description:

Madrone is co-dominate or subordinate to tanoak or California bay. Black oak may be a minor component to the canopy.

Photo Interpretation Signature:

Madrone gives of a generally light gray but highly variable signature and when it shares the canopy with tanoak or black oak the overall signature is lacking in green. Photo interpreters have trouble detecting madrone in dense hardwood canopy when the madrone cover is below ~10%.

1110 – California Bay Alliance

(Generally mapped below alliance level.)

1111 – California Bay Pure Stands

Distribution:

Fairly common as small polygons generally around Kent and the western portions of Alpine Lake.

Environmental Characteristics:

Pure stands found in concave or riparian settings

Description:

Dense stands of California bay strongly dominate the tree canopy with at least 90% relative cover.

Photo Interpretation Signature:

Generally narrow crowns close together light to medium green.

1112 – California Bay – Buckeye

Distribution:

Rare – primarily in the eastern portion of the study near Phoenix Lake

Environmental Characteristics:

Found primarily in steep narrow draws

Description:

California bay is often a component in steep riparian settings, on lower side slopes of the canyon. California bay dominates the stand with buckeye an important subordinate locally dominant in places.

Photo Interpretation Signature:

Buckeye gives off a light green signature and is not under stress conditions in the early season photography. Highly rounded crown often in rocky settings.

1113 – California Bay – Interior Oak

Distribution:

Abundant but regionally localized in the southeastern portion and to a lesser extent the north central portions of the watershed. Polygons are generally small in size.

Environmental Characteristics:

Transitions between the mixed hardwood and chaparral stands – often adjacent to both.

Description:

Both species are either co-dominant or an important subordinate to the other; California bay is a slight emergent to the shrubby interior oak.

Photo Interpretation Signature:

Light gray-green to green. Mottled texture depending on the composition of trees to shrubs.

1114 – California Bay – Canyon Oak

Distribution:

Uncommon in the higher elevations near Pine Mountain

Environmental Characteristics:

Steeper protected upper slopes trending neutral to concave

Description:

Both hardwoods co-dominate or are an important subordinate species

Photo Interpretation Signature:

Rounded crowns of the canyon oak contrast to the narrow crowns of the California bay in this setting.

1115 – California Bay – Coast Live Oak

Distribution:

Limited to the far eastern edge of the study in the vicinity of Phoenix Lake, Bald and Wright Hill

Environmental Characteristics:

Low elevations in minor watersheds and concavities

Description:

Both species co-dominate or are an important subordinate species; generally more mesic riparian settings favor California bay.

Photo Interpretation Signature:

Narrow crowns of the California bay and broad crowns of the coast live oak contrast well; generally coast live oak giving off a darker green signature.

1116 – California Bay – Tanoak

Distribution:

Primarily in the western portions of the watershed on the Bolinas Ridge to just east of Kent Lake.

Environmental Characteristics:

Located on steep slopes generally trending northeast often adjacent to redwood forest. Tanoak death is severe especially on the Bolinas ridge.

Description:

Both species co-dominate or are important subordinate species often with a sparse redwood emergent canopy of less than 10%. Stand densities can be spares because of tanoak death.

Photo Interpretation Signature:

Narrow crowns of both species with tanoak generally the lighter green. Open canopy from tanoak deaths reveal sparse herbaceous understory on less steep slopes.

1140 – Tanoak Alliance

Distribution:

Generally not noted as mappable pure stands except where plot data substantiates locations.

Environmental Characteristics:

Not enough samples to reliably correlate to a repeating environmental setting

Description:

Stands of tanoak strongly dominant

Photo Interpretation Signature:

Narrow crowns of tanoak visible in few examples

1160 – Madrone Alliance

Distribution:

Uncommon in pure mappable stands generally along the eastern fringe of the study.

Environmental Characteristics:

Not enough samples to extrapolate a reliable environmental setting but probably in more xeric settings than California bay or tanoak.

Description:

Madrone makes up the sole dominant in the canopy, generally over 90% relative cover in dense stands.

Photo Interpretation Signature:

Light gray color of the madrone stands out when the trees are in the visible canopy layer; photo interpreters generally have difficulty in pulling out madrone when the canopy component falls below 10%.

1170 – Canyon Oak Alliance

Distribution:

Uncommon in small stands throughout the watershed at the higher elevations; in forest settings along the Pine Mountain Ridge and Bolinas Ridge and in concavities adjacent to higher elevation chaparral on Mt. Tamalpais.

Environmental Characteristics:

Located at higher elevations, generally on steeper north slopes and upper concavities.

Description:

Canyon oak is dominant in the canopy with other hardwoods often a significant component; especially California bay or tanoak.

Photo Interpretation Signature:

Large rounded crown of the canyon oak is typical in more open settings and is not as dark green as the coast live oak. Sometimes there is confusion with multiple crowning or younger trees with chinquapin stands in similar settings. Canyon oak is extremely difficult to distinguish in mixed hardwood stands.

1171 – Canyon Oak – Interior Oak

Distribution:

Uncommon, almost exclusively limited to the Pine Mountain Ridge as mappable stands.

Environmental Characteristics:

Found in settings similar to that of interior oak and bay except at higher elevations.

Description:

Canyon oak dominates the canopy as a sparse to moderately dense emergent to a dense shrubby interior oak understory.

Photo Interpretation Signature:

Rounded crown of canyon oak in a dense chaparral setting distinguishes this pattern from other types with interior oak.

1180 – Giant Chinquapin Alliance

Distribution:

Uncommon, limited mainly to higher slopes of Mt. Tamalpais and the Bolinas Ridge in very small stands.

Environmental Characteristics:

Upper slopes in neutral settings

Description:

Generally in pure stands or mixing with Manzanita chaparral.

Photo Interpretation Signature:

Confusing signature in that chinquapin takes on a number of different growth forms; in chaparral settings it is extremely difficult to distinguish from other species; in tree settings, crowns are extremely narrow but is often difficult to distinguish as individual crowns; photo interpreters may mistake the entire clone as a single crown which occasionally confuses it with canyon oak.

1201 – Planted Stands of Pine

Distribution:
Isolated areas around Mt. Tamalpais

Environmental Characteristics:
None extrapolated by PI's

Description:
Generally including bishop pine or Monterey pine.

Photo Interpretation Signature:
Generally dark green; difficult to distinguish from adjacent Douglas-fir.

1210 – Redwood Alliance

(Generally mapped below alliance level.)

1211 – Redwood / Tanoak

Distribution:
Rare as mappable stands; generally, redwood is mapped in mixed hardwood settings with tanoak.

Environmental Characteristics:
Protected slopes generally trending north and east

Description:
Redwood and tanoak co-dominate, with redwood a tall emergent to tanoak; crown canopy may be open due to tanoak death.

Photo Interpretation Signature:
Difficult to distinguish from the more general redwood – mixed hardwoods mapping unit so actual association of redwood – tanoak is mapped sparingly.

1212 – Redwood – Douglas-fir

Distribution:
Common throughout the Bolinas Ridge

Environmental Characteristics:
Mapped in settings slightly more xeric than pure stands of redwood; generally upslope and out of immediate drainages from pure redwood.

Description:
Both conifer species co-dominate or either is an important subordinate to the other with at least 20-30% relative cover. Hardwoods are generally present up to 30-40% relative cover to conifers.

Photo Interpretation Signature:
Dark blue-green signature of the Douglas-fir contrasts with lighter greens of the coast redwood; older stands are more difficult to separate out the two species. Canopies of younger trees are distinct, with Douglas-fir generally spreading branches out at a earlier age.

1213 – Redwood / Chinquapin

Distribution:

Mapped in only two incidences in the watershed.

Environmental Characteristics:

Description:

Photo Interpretation Signature:

1214 – Redwood /California Bay

Distribution:

Fairly common as small to medium sized polygons generally in the southeastern portion of the watershed on the eastern slopes of Mt. Tamalpais

Environmental Characteristics:

Upper riparian settings and small coves

Description:

Redwood is an emergent to an understory of California bay with at least 10% conifer cover. In most cases, redwood has a dense canopy with bay an understory component. Big leaf maple or other true riparian trees can be a minor component to the understory.

Photo Interpretation Signature:

Typical redwood signature, however conifers are usually young and close together, therefore, photo interpreters often infer the presence of California bay based on environmental setting.

1215 – Redwood – Pure Stands

Distribution:

Common as small stands especially on the eastern slopes of Mt. Tamalpais

Environmental Characteristics:

Generally in riparian settings; occasionally in upper coves above drainages in protected settings.

Description:

Redwood strong dominant generally over 90% relative cover in dense very young stands; often adjacent to California bay and interior oak.

Photo Interpretation Signature:

Young narrow crowns very close together with very definitive ‘clonal’ edges.

1216 – Redwood – Upland Mixed Hardwoods

Distribution:

Common; widely variable stands throughout the Bolinas Ridge, and the Mt. Tamalpais region and to a lesser extent in the Phoenix Creek drainage.

Environmental Characteristics:

On northerly slopes well away from drainages; restricted to lower protected slopes and close to riparian zones when trending south.

Description:

Highly variable with coast redwood at least 10% emergent cover to mixed hardwoods; often a dominant overstory with hardwoods making a second understory tree layer. Mapped where hardwood component is not distinguishable to finer species level or where at least two hardwoods co-dominate in the understory.

Photo Interpretation Signature:

Redwoods often hide the understory hardwood cover; however when hardwoods are visible they are often broader crowned. Openings in the canopy are often the result of tanoak death.

1217 – Redwood – Riparian

Distribution:

Uncommon and scattered throughout the range where redwoods occur in the watershed.

Environmental Characteristics:

Generally mapped in major perennial watersheds adjacent to redwood mixed hardwood stands.

Description:

Redwoods are emergent to understory riparian hardwoods; often with a tanoak or bay component to the hardwood layer. Generally big-leaf maple is the most common riparian component.

Photo Interpretation Signature:

Riparian element inferred in redwood settings along major drainages, however, maple is often visible with a dark blue-green crown.

1220 – Douglas-fir Alliance

(Generally mapped below alliance level.)

1221 – Douglas-fir – Mixed Hardwoods in Drier Woodland Settings

Distribution:

Local in the region north of Alpine and Bon Tempe Lakes in small to medium stands.

Environmental Characteristics:

The lowest elevation and most xeric conifer-mixed hardwoods type; generally located adjacent to oak woodlands and savannas in slightly more mesic settings.

Description:

Douglas-fir is a sparse to moderate emergent over a dry hardwood woodland generally composed of coast live oak with some bay, madrone and black oak.

Photo Interpretation Signature:

Douglas-fir easily separable from adjacent hardwoods even as a sparse emergent with its dark blue conical crown. Dry annual grasses often visible towards the edges or immediately adjacent to the stand.

1222 – Douglas-fir – Mixed Hardwoods in Upland Forest Settings

Distribution:

Very common in all but the lowest elevations of the watershed.

Environmental Characteristics:

This type is best suited to slopes trending north over extensive areas such as the Rocky and Bolinas ridge.

Description:

Douglas-fir is a sparse (at least 10%) to dense emergent conifer over a mixed hardwood component typical of higher or more mesic settings. Hardwoods that make up the understory include canyon oak and/or tanoak with California bay and madrone often an important component. Distinguished from type 1221 by the absence of coast live oak and presence of tanoak or canyon oak.

Photo Interpretation Signature:

Difficult to distinguish from type 1221; photo interpreters infer this type by the absence of coast live oak, elevation and adjacent vegetation. Presence of tanoak or canopy openings where tanoak has died back help in classifying to this type.

1223 – Douglas-fir – California Bay Mapping Unit

Distribution:

Difficult to distinguish from type 1222 so reliable distribution may not exist; most mapped polygons are in the vicinity of Alpine Lake.

Environmental Characteristics:

In slightly more mesic settings than type 1222; generally in concavities and near riparian situations.

Description:

Emergent Douglas-fir of varying densities over a generally dense canopy of hardwoods, strongly dominated by California bay.

Photo Interpretation Signature:

Similar to type 1222 – however narrow crowns of the bay may aid in separating out this finer level type. Generally in smaller stands than type 1222.

1224 – Douglas-fir – Tanoak

Distribution:

Not separable from type 1222 – one polygon noted on the upper slopes of the Bolinas Ridge based on field data information only.

Environmental Characteristics:

Description:

Photo Interpretation Signature:

1225 – Douglas-fir – Riparian

Distribution:

Only two examples – generally riparian conifer stands contain coast redwood instead of Douglas-fir.

Environmental Characteristics:

Description:

Photo Interpretation Signature:

1226 – Douglas-fir Pure Stands

Distribution:

Uncommon, regenerative stands located mostly along the Bolinas Ridge upslope from Cataract Creek.

Environmental Characteristics:

Upper slopes adjacent to grasslands

Description:

Primarily young sparse trees in grassland settings. Some dense stands also noted in possibly post fire or logging disturbance.

Photo Interpretation Signature:

Dark blue-green signature noted; crown development minimal since most trees are less than 10 years old.

1227 – Douglas-fir – California Bay / Interior Oak

Distribution:

Three major clusters; one in the far north above Mountain Truck Road, another in the central portion of the watershed northwest of Alpine Lake and the southern most located on the western slopes of Mt. Tamalpais.

Environmental Characteristics:

Located in rather xeric settings between Douglas-fir – mixed hardwood communities and stands of chaparral.

Description:

Douglas-fir is generally a sparse emergent to a mix of California bay and dense interior oak chaparral. Stands may contain little bay but usually have a lot of shrubby interior oak.

Photo Interpretation Signature:

Three main life form components (tall emergent conifer, hardwoods and chaparral) make this type unique as a composite of several signatures for one type.

1230 – Bishop Pine Alliance

(Mapped in settings that don't contain Manzanita and are not pure pine.)

1231 – Bishop Pine / Eastwood Manzanita

Distribution:

Uncommon in the Mt. Tamalpais Watershed.

Environmental Characteristics:

Description:

Photo Interpretation Signature:

1232 – Bishop Pine Pure Stands

Distribution:

Several stands above the western arm of Kent Lake and in the Mt. Tamalpais region.

Environmental Characteristics:

Dry upper slopes

Description:

Bishop pine a sparse to moderately dense emergent to dense patches of Eastwood manzanita (type 1231); pure stands usually occur in fairly dense small patches at or below the minimum mapping unit.

Photo Interpretation Signature:

Bishop pine is rare in the watershed; stands are small in size so it is extremely difficult to extrapolate a reliable signature; plot data was heavily used and extrapolation at a minimum.

1240 – Sargent Cypress Alliance
(Most stands mapped below alliance level.)

1241 – Sargent Cypress / Mt. Tamalpais Manzanita

Distribution:
Common in two regions; the most extensive stands are located above Mountain Truck Road and sever smaller stands are noted west of Mt. Tamalpais.

Environmental Characteristics:
On serpentine derived ultramafic soils in less xeric settings than pure chaparral

Description:
Sargent Cypress is a sparse to rather dense conifer overstory to sparse to moderately dense manzanita.

Photo Interpretation Signature:
Sargent cypress gives off a very light gray-green signature; crowns are highly variable and irregularly shaped; understory manzanita yields a dark gray signature. Very little greenness in the signature overall.

1242 – Sargent Cypress Pure Stands

Distribution:
Much less common in pure stands; located in similar regions to type 1241.

Environmental Characteristics:
On serpentine derived ultramafic soils in relatively mesic settings for serpentine types.

Description:
Sargent cypress is sole conifer dominant; California bay may be a minor hardwood component; understory shrub and herb layer sparse.

Photo Interpretation Signature:
Similar to type 1241 without the understory manzanita signature.

1310 – Mixed Willow Mapping Unit

Distribution:
Uncommon in the Mt. Tamalpais Watershed; numerous small examples are noted adjacent to the Nicasio and Soulajule Reservoirs with arroyo willow making up the dominant species in the stand.

Environmental Characteristics:
Seasonally flooded riparian settings along drainages into the two reservoirs.

Description:
Arroyo willow usually the dominant species in the stand; other tree or shrub willow species may be a component.

Photo Interpretation Signature:
Generally light green; edges of stand are distinct and abrupt.

1321 – White Alder – California Bay
(Rare as mappable stands; generally a small component in riparian types of not more than a few individuals)

1410 – Black Oak Alliance

Distribution:

Uncommon in the study area, only occurring on slopes near the Meadow Club Golf Course.

Environmental Characteristics:

Upper slopes and ridgelines in areas of well developed soil.

Description:

Black oak dominates the stand often with a component of coast live oak and madrone.

Photo Interpretation Signature:

Adjacent to coast live oak; black oak has a lighter green signature

2110 – Coast Live Oak Alliance

Distribution:

Common in the study area, occurring predominantly around the Soulajule Reservoir and along the eastern edge of the Mt. Tamalpais Watershed, with some polygons near the eastern edge of Bon Tempe Lake.

Environmental Characteristics:

Coast live oak can be found in the lower elevations on gentle or moderate slopes in drier environments, often in an open woodland or grassy setting.

Description:

Coast live oak is usually the dominant species in large, dense stands.

Photo Interpretation Signature:

Coast live oak trees appear to be a dark green color, with broad crowns in a uniform canopy.

2111 – Coast Live Oak / (Grass-Poison Oak)

Distribution:

Found around the Soulajule Reservoir. Also commonly occurs along the eastern edge of the Mt. Tamalpais Watershed from the White Hill area down along the eastern and northern edges of Bon Tempe Lake to Lake Lagunitas, with a concentration west and south of Sky Oaks Headquarters.

Environmental Characteristics:

Coast live oak can be found in the lower elevations on gentle or moderate slopes in drier environments, often in an open woodland or grassy setting.

Description:

Coast live oak is usually the dominant species with small to large open areas of grass and occasionally poison oak in rocky outcroppings.

Photo Interpretation Signature:

Coast live oak trees appear to be a dark green color, with broad crowns in a uniform canopy over open areas of tan or brown colored shrubs and/or grass.

2112 – Coast Live Oak – Riparian

Distribution:

Generally not a riparian species in the study area - only found along Bon Tempe Creek and a small area west of Soulajule Reservoir.

Environmental Characteristics:

Description:

Photo Interpretation Signature:

2113 – Coast Live Oak – Douglas-fir

Distribution:

Rare - only found in small stands around Alpine Lake.

Environmental Characteristics:

Lower elevations in somewhat protected settings

Description:

Douglas-fir is generally a sparse emergent (usually below 15%) to dense stands of coast live oak.

Photo Interpretation Signature:

Emergent Douglas-fir shows with a conical to star-shaped crown to the dark green rounded crowns of the coast live oak.

2210 – Oregon Oak Alliance

Distribution:

Rare- only found in a few small stands in the eastern edge of the central part of the Mt. Tamalpais Watershed.

Environmental Characteristics:

Description:

Oregon oak dominates the stand with important associates including coast live oak and black oak.

Photo Interpretation Signature:

Similar to black oak in color; crown is more rounded and well defined – similar to the coast live oak.

2220 – California Buckeye Alliance

Distribution:

Rare as pure stands - found primarily in small stands south of Phoenix Lake.

Environmental Characteristics: -

Steep rocky side-slopes

Description

California buckeye dominates the stand in sparse settings often with a sparse understory of shrubs and grasses.

Photo Interpretation Signature:

Buckeye appears light green on the imagery – too early in the season for signs of drought stress.

2231 – Valley Oak Riparian Mapping Unit

Distribution:

Extremely rare- found only in drainages north of Alpine Lake and Phoenix Lake.

Environmental Characteristics:

Riparian settings in the study area

Description:

Photo Interpretation Signature:

2321 – Big-Leaf Maple – California Bay Mapping Unit

Distribution:

Maple generally mapped to a more general mapping unit (1103) where it is a component to a riparian woodland along with bay, willow and alder.

Environmental Characteristics:

Description:

Photo Interpretation Signature:

3100 – Temperate Broadleaf Sclerophyll Evergreen Shrublands
(Generally mapped below formation level.)

3110 – Chamise Alliance
(Generally mapped below alliance level.)

3112 - Chamise - Serpentine Chaparral

Distribution:

Uncommon, found only in the Mt. Tamalpais Watershed. Some of the larger stands are located on slopes near Pine Mountain, north of Alpine Lake and on the south-facing slope between Mt. Tamalpais and Panoramic Highway.

Environmental Characteristics:

Occurs in drier serpentine settings.

Description:

Chamise strongly dominates the stand in sparse to moderately dense settings; other serpentine species are minor subordinates.

Photo Interpretation Signature:

Chamise looks like short, small, round brown shrubs, usually over rocky and gravelly soils.

3114 – Chamise – mixed chaparral

Distribution:

Common in the study area. Spread throughout the Mt. Tamalpais Watershed, but occurs primarily adjacent to grasslands.

Environmental Characteristics:

Found on moderate to steep slopes, usually near a grassland.

Description:

Generally an open stand of chamise mixed with other shrubs, usually sticky monkey flower wedgeleaf Ceanothus, California sagebrush or coyote brush.

Photo Interpretation Signature:

Usually an open stand of short, small brown colored shrubs mixed with a few other more textured shrubs. Usually occurs near grasslands.

3115 – Chamise (pure)

Distribution:

Commonly found throughout the Mt. Tamalpais Watershed, and one additional small stand north of the Soulajule Reservoir.

Environmental Characteristics:

Found on ridgetops or on steep upper slopes.

Description:

Dense stands of pure chamise located on non-serpentine soils. Several stands noted which are significantly shorter (wind sheared?) on higher unprotected ridges.

Photo Interpretation Signature:

Usually short, dense, small brown shrubs. Shorter stands have less decadent growth and appear much greener on the imagery.

3120 – Mt. Tamalpais Manzanita Alliance

(Generally mapped below alliance level.)

3121 - Mt. Tamalpais Manzanita - Chamise - (Garraya - Leather Oak – Jepson Ceanothus) – Serpentine Chaparral)

Distribution:

Very common. Found along the ridgetops and steep upper slopes on the serpentine strip that runs north to south through the Mt. Tamalpais Watershed, and one small stand near the Nicasio Reservoir.

Environmental Characteristics:

Found along ridgetops and steep upper slopes on serpentine soil.

Description:

Generally small, dense stands of Mt. Tamalpais manzanita mixed with serpentine obligate or serpentine facultative shrubs, sometimes with serpentine outcrops. Mt. Tamalpais manzanita dominates the shrub layer with chamise an important co-dominant or subordinate. Jepson Ceanothus, garraya and leather oak are often minor components to the shrub layer. Emergent California bay is often seen in small draws.

Photo Interpretation Signature:

The Mt. Tamalpais manzanita signature looks smooth and brown mixed with taller green shrubs.

3122 – Mt. Tamalpais Manzanita - / sparse emergent Douglas-fir

Distribution:

Uncommon, found throughout the Mt. Tamalpais Watershed

Environmental Characteristics:

Located on moderate slopes in more mesic less severe serpentine settings.

Description:

Sparse emergent of Douglas-fir, generally less than 5 meters tall over moderately dense stands of Manzanita.

Photo Interpretation Signature:

The Mt. Tamalpais manzanita looks smooth and brown on the Vargis imagery; however, it has a smooth blue signature in the ancillary DAIS imagery. Since the signature can be confused with other manzanitas, sometimes it was necessary to use the DAIS imagery to make a decision. The Douglas-fir signature is dark blue-green and is emergent above the manzanita, where the Douglas-fir crown development is variable.

3130 – Sensitive Manzanita Alliance

Distribution:

Uncommon- found in the Mt. Tamalpais Watershed. There are small clusters of polygons west of Bolinas Ridge, east of Kent Lake and north of Panoramic Highway in the southern part of the study area..

Environmental Characteristics:

Found on steep slopes and ridgetops.

Description:

Generally dense stands dominated by sensitive manzanita.

Photo Interpretation Signature:

Signature is green with little texture, (generally darker green than Eastwood) and easily confused with other manzanitas in the study area. Photo interpreter relied on the rare plants coverage to help discern where the sensitive manzanita was located.

3132 – Jepson's Ceanothus (stand noted at Nicasio Reservoir)

Distribution:

Only one mappable stand located within study area at Nicasio Reservoir based on information from field crew.

Environmental Characteristics:

Description:

Generally a minor component in mixed serpentine chaparral

Photo Interpretation Signature:

3140 – Silver Leaf Manzanita Alliance

Distribution:

Extremely rare- only two stands found in the southern part of the Mt. Tamalpais Watershed near Panoramic Highway.

Environmental Characteristics:

Description:

Photo Interpretation Signature:

3150 – Eastwood Manzanita Alliance

Distribution:

Uncommon in pure stands, but found sporadically throughout the Mt. Tamalpais Watershed and one small stand north of the Soulajule Reservoir.

Environmental Characteristics:

Occurs on moderate to steep slopes or ridgetops.

Description:

Dense stands dominated by Eastwood manzanita, with occasional sparse emergent Douglas-fir.

Photo Interpretation Signature:

Eastwood manzanita appears as a smooth, dense cover of green or dark brown shrubs, sometimes with sparse emergent Douglas-fir.

3160 – Interior Live Oak Alliance

(Generally mapped below alliance level.)

3161 – Interior Live Oak- Eastwood Manzanita

Distribution:

Very common in the Mt. Tamalpais Watershed, but none found around the Soulajule and Nicasio Reservoirs. There is a large concentration of small stands in the lower 1/3 of the study area south of Bon Tempe Lake.

Environmental Characteristics:

Xeric trending, generally found on convex slopes adjacent to chamise-Eastwood manzanita vegetation or California bay-interior live oak vegetation.

Description:

Mixture of interior live oak with Eastwood manzanita

Photo Interpretation Signature:

Generally dense stands of the smooth, brown Eastwood manzanita under the taller light green interior live oak shrub with a round, even textured crown structure.

3170 – Blue Blossom Alliance

Distribution:

Very rare in the study area as mappable stands

Environmental Characteristics:

Description:

Photo Interpretation Signature:

3180 – Leather Oak – Chamise – Mt. Tamalpais Manzanita Serpentine Chaparral

Distribution:
Located throughout the Mt. Tamalpais Watershed.

Environmental Characteristics:
Occurs only on steep, convex serpentine slopes.

Description:
Sparse to dense mixture of leather oak, chamise and Mt. Tamalpais manzanita.

Photo Interpretation Signature:
On the Vargis imagery, the Mt. Tamalpais manzanita and chamise are relatively smooth while the tan colored leather oak is slightly taller and has a bit more texture. On the DAIS imagery, the leather oak has a yellow color and the Mt. Tamalpais manzanita has a blue tint to it.

3190 –Chamise – Eastwood Manzanita

Distribution:
Very common, especially in the Mt. Tamalpais Watershed

Environmental Characteristics:
Xeric type- occurs on non-serpentine ridgetops and convex mid to upper slopes – but in less severe settings than pure chamise.

Description:
Usually very dense mixture of chamise and Eastwood manzanita.

Photo Interpretation Signature:
Smooth dark brown or green signature of Eastwood manzanita mixed with the taller, brown, slightly textured signature of chamise.

3210 – (French) Broom Alliance

Distribution:
Uncommon as mappable pure stands, limited mainly to the eastern part of the Mt. Tamalpais Watershed north of Phoenix Lake and Bon Tempe Lake.

Environmental Characteristics:
Frequently found in areas of post disturbance, especially along road cuts.

Description:
Sparse to dense coverage in a disturbed environment, occasionally found mixed with coyote brush.

Photo Interpretation Signature:
Broom has a yellow (in flower) or light green stippled appearance in the imagery.

3220 – Coyote Brush Alliance

(Generally mapped below alliance level.)

3221 – Coyote Brush – California Sagebrush – Sticky Monkey Flower

Distribution:

Uncommon, but few isolated stands in the Soulajule Reservoir area and in the eastern part of the Mt. Tamalpais Watershed near Bald Hill.

Environmental Characteristics:

Generally on steep, xeric slopes

Description:

Ranges from sparse to dense coyote brush mixed with California Sagebrush and sticky monkey flower.

Photo Interpretation Signature:

The coyote brush is smooth and green with round crowns and an even texture, while the California sagebrush is browner with a bit more texture to it. The sticky monkey flower is not really discernable, and its presence is inferred.

3222 – Coyote Brush / Annual or Perennial Grasslands (open stands)

Distribution:

Common, with most of the stands occurring around the Soulajule and Nicasio Reservoirs, although there are also stands located in the Mt. Tamalpais Watershed.

Environmental Characteristics:

Found on gentle slopes, usually around disturbed areas.

Description:

Coyote brush is usually found in sparse small clumps or in small open stands over annual or perennial grasslands.

Photo Interpretation Signature:

Coyote brush has as small, round, green crowns and the grasslands have a smooth green texture.

3223 – Coyote Brush – Mixed Shrub / Grass

Distribution:

Common, with most of the stands occurring around the Soulajule and Nicasio Reservoirs, although there are also a few stands located in the Mt. Tamalpais Watershed.

Environmental Characteristics:

Generally located on steep mid to upper slopes.

Description:

Ranges from dense to dispersed shrub cover, including coyote brush, and sometimes California sagebrush, sticky monkey flower, poison oak and California blackberry over a sparse or dense grass understory.

Photo Interpretation Signature:

The coyote brush is smooth and green with round crowns and an even texture, while the California sagebrush is brown with a bit more texture to it. The poison oak signature has a very smooth light green texture, which can sometimes be confused with coyote brush in a more mesic setting. Neither the sticky monkey flower nor the California blackberry are discernable, and their presence is inferred. The understory of the green grasslands has a smooth texture, and can range from being sparse to quite dense.

3310 - California Sagebrush Alliance

Distribution:

Extremely rare- a stand is located south of the Soulajule Reservoir and a few stands are in the eastern part of the Mt. Tamalpais Watershed near Bald Hill.

Environmental Characteristics:

Steep slopes.

Description:

Sparse California sagebrush on rocky soils

Photo Interpretation Signature:

Due to low number of polygons, photo signature was not established but extrapolated

3311 – California Sagebrush – Sticky Monkey Flower

Distribution:

Rare in the study area - only one stand found around the Nicasio Reservoir and a few stands located in the Mt. Tamalpais Watershed.

Environmental Characteristics:

Steep slopes

Description:

Sparse California sagebrush and sticky monkey flower on rocky soils

Photo Interpretation Signature:

Photo signature was not established, but extrapolated due to low number of polygons.

3410 – Poison Oak Alliance

Distribution:
Rare as mappable stands in the study area.

Environmental Characteristics:
Variable - ranges from steep to moderate slopes to adjacent to drainages.

Description:
Generally dense poison oak, sometimes mixing with other sparse shrubs.

Photo Interpretation Signature:
Photo signature was not established, but extrapolated based on plot data.

4101 – Undifferentiated Marsh (cattail, bulrush, other scirpus spp.)

Distribution:
Uncommon in the study area, but a few stands found primarily around the Soulajule and Nicasio Reservoirs.

Environmental Characteristics:
Found in seasonally to permanently flooded settings, generally surrounding lakes, ponds and reservoirs.

Description:
Variable due to mixture of below MMU cattail, bulrush or other scirpus species.

Photo Interpretation Signature:
Highly variable, but ranges from nearly black to a smooth dark green to lighter green and tan.

4110 – Cattail Alliance

Distribution:
Rare, but a few stands located near Phoenix Lake and Lake Lagunitas.

Environmental Characteristics:
Found in seasonally to permanently flooded settings, generally surrounding lakes and reservoirs.

Description:
Cattails generally dominate.

Photo Interpretation Signature:
Signature is usually smooth or uniform and light brown or tan stipple texture.

4120 – Bulrush Alliance

Distribution:
Only one stand found along Phoenix Lake

Environmental Characteristics:
Found in seasonally to permanently flooded settings surrounding lakes and reservoirs.

Description:
Bulrush dominates.

Photo Interpretation Signature:
Signature is dark brown.

4210 –Sedge – Rush – Wet Graminoids Meadow

Distribution:
Uncommon, but mainly occurs around Nicasio Reservoir.

Environmental Characteristics:
Found in temporarily to seasonally flooded settings generally drying up early in the growing season

Description:
Mixture of sedge, rush and wet graminoids, which may include *juncus, carex, hordeum brachyantherum and* meadow barley.

Photo Interpretation Signature:
Variable, but is usually a mosaic of smooth dark green and brown or gray signature.

4211- Temporarily flooded or saturated Meadow Edge

Distribution:
Uncommon.

Environmental Characteristics:
Found in intermittent or temporarily flooded settings generally drying soon after storms.

Description:
Mixture of sedge, rush, wet graminoids, and upland annual grasses

Photo Interpretation Signature:
Variable, depending on the component of wetland grasses and upland annuals.

4300 – Tall Temperate Annual Graminoids
(Generally mapped below formation level.)

4310 – California Annual Grasslands Alliance (Native Component Variable)
(Mapped in two settings – see below.)

4311 – Grasslands on well-developed soils

Distribution:
Commonly found in the study area.

Environmental Characteristics:
Primarily occurs on non-serpentine slopes with well developed soils.

Description:
Annual grasslands dominate (*hordeum, bromus, lolium, avena)* with varying amounts of forbs in the herbaceous layer.

Photo Interpretation Signature:
Smooth, even light green signature.

4312 – Grasslands on poorly developed soils

Distribution:
Uncommon in the study area

Environmental Characteristics:
Primarily occurs on non-serpentine slopes with rockiness and poorly developed soils.

Description:
Generally open annual grasses dominate – bromes probably dominate over avena or lolium grasses – native component can be relatively high (primarily nasilla grasses).

Photo Interpretation Signature:
Sparse green grass, generally in a poorly developed soil or rocky environment.

4313 – Grasslands with a fern or sub-shrub (golden banner) component

Distribution:
Uncommon, but limited to the Mt. Tamalpais Watershed. None found around either the Soulajule or Nicasio Reservoirs.

Environmental Characteristics:
May be related to grazing or fire?

Description:
Generally dense annual grasses with a sparse to moderately dense layer of bracken fern or golden banner. Temporal in nature and may not reflect the current conditions of the imagery.

Photo Interpretation Signature:
Bracken fern appears green to brownish on the imagery over a typical signature of annual grasses.

4400 – Tall Temperate Perennial Herbaceous
(Generally mapped below formation level.)

4410 – Harding Grass Alliance

Distribution:
Possibly occurring around Nicasio Reservoir

Environmental Characteristics:

Description:

Photo Interpretation Signature:

4500 – Native Temperate Perennial Grasslands
(Generally mapped below formation level.)

4510 – California or Idaho Fescue Grasses

Distribution:
Sporadic – most patches well below MMU

Environmental Characteristics:

Description:

Photo Interpretation Signature:
Not defined – often not visible on imagery

4520 – Purple Needlegrass

Distribution:
Not noted in pure mappable stands

Environmental Characteristics:

Description:

Photo Interpretation Signature:

4610 – Upland Serpentine Grassland

Distribution:
Commonly found in the Mt. Tamalpais Watershed near serpentine. Not found near Soulajule or Nicasio Reservoirs.

Environmental Characteristics:
Upland slopes on serpentine or near areas that receive drainage from serpentine settings.

Description:
Rather sparse to dense grasslands that are on somewhat rocky serpentine soil including species such as purple needlegrass, Torrey's melic, dwarf plantain, small fescue, and sticky western rosinweed

Photo Interpretation Signature:
Variable, but generally has a smooth gray or green signature. Nearly impossible to distinguish from other grasslands, so photo interpreters primarily used the geology coverage to help determine where this type was mapped based on the location of serpentine areas.

4620 – Wetland Serpentine Grassland

Distribution:

Extremely rare

Environmental Characteristics:

Found in wet seeps on serpentine.

Description:

May include perennial and annual species at varying cover such as meadow barley, rosinweed, goldfields.

Photo Interpretation Signature:

Variable, but generally smooth green or gray signature. Nearly impossible to distinguish from other grasslands, so photo interpreters primarily used the geology coverage to help determine where this type was mapped based on the location of serpentine areas.

APPENDIX A

Mount Tamalpais Watershed Mapping Classification (Mapping Short Form)

Revised June 22, 2006

CLASS

Formation

Alliances (Series)

Mapping units or Potential Associations yet to be defined

1000 – 2000 – FORESTS & WOODLANDS

1100 – Temperate Broadleaf Sclerophyll Evergreen Forests & Woodlands (Mixed Hardwoods)

1101 – Lower Elevation Mixed Broadleaf Mapping Unit (Trending Xeric) – Coast Live Oak, Madrone or Black Oak dominant ***(At least two species co-dominate, may include Madrone – Coast Live Oak, Black Oak – Coast Live Oak, or Black Oak – Madrone.)***

1102 – Tanoak – California Bay – Canyon Oak Mixed Forest ***(Either Tanoak or California Bay dominate but the other either co-dominates or is present. Canyon Oak may or may not be present but generally does not co-dominate.)***

1103 – California Bay – Alder – Big Leaf Maple – Willow spp. Riparian Forest ***(California Bay is always present in association with any or all three riparian species.)***

1104 – Madrone – California Bay – Tanoak ***(Madrone co-dominates with either Tanoak or California Bay including Madrone – Tanoak, Madrone – California Bay, and California Bay – Black Oak – Madrone.)***

1110 – California Bay Alliance

1111 – California Bay (pure)

1112 – California Bay – Buckeye

1113 – California Bay – Interior Live Oak

1114 – California Bay – Canyon Oak

1115 – California Bay – Coast Live Oak

1116 – California Bay – Tanoak

1140 – Tanoak Alliance

1160 – Madrone Alliance

1170 – Canyon Oak Alliance ***(Includes Canyon Live Oak with lower cover of Tanoak.)***

1171 – Canyon Oak – Interior Live Oak

1180 – Giant Chinquapin Alliance ***(Includes a possibility of 3 associations that include Eastwood Manzanita, and stands are sometimes shrub-like in nature.)***

1200 – Temperate Needleleaf Evergreen Forests & Woodlands

1201 – Planted Stands of Pine (Monterey Pine – Bishop Pine – Monterey Cypress and other spp

1210 – Redwood Alliance

1211 – Redwood / Tanoak ***(Includes a possibility of at least 2 associations.)***

1212 – Redwood – Douglas-fir – (Mixed Hardwoods)

1213 – Redwood / Chinquapin

1214 – Redwood / California Bay

1215 – Redwood (pure) ***(often young dense stands)***

1216 – Redwood - Upland Mixed Hardwoods ***(Generally California bay, Tanoak, occur as co-dominant or subordinate species in upland settings.)***

1217 – Redwood – Riparian ***(Redwoods in riparian settings with maple, California bay, Tanoak, and/or White alder in the secondary canopy.)***

1218 – Redwood – Madrone ***(Surveys suggest this type with Vaccinium ovatum in the understory)***

1220 – Douglas-fir Alliance
1221 – Douglas-fir - Mixed Hardwoods in upland drier settings (Coast Live Oak, Madrone) ***(Generally in smaller stands often adjacent to grasslands or shrublands.)***
1222 – Douglas-fir Mixed Hardwoods in upland forest settings (California Bay, Canyon Oak, Tanoak – Madrone) ***(Canyon Oak often occurring in larger stands adjacent to other conifer forests.)***
1223 – Douglas-fir – California Bay Mapping Unit ***(May include Coast Live Oak as an associate.)***
1224 – Douglas-fir – Tanoak
1225 – Douglas-fir – Riparian ***(Douglas-fir in riparian settings with White Alder, Blackberry, etc, in understory.)***
1226 – Douglas-fir (pure) ***(Little understory development other than Douglas-fir regenerating)***
1227 – Douglas-fir – California Bay / Interior Live Oak
1230 – Bishop Pine Alliance
1231 – Bishop Pine / Eastwood Manzanita
1232 – Bishop Pine (pure)
1240 – Sargent Cypress Alliance
1241 – Sargent Cypress / Mt. Tamalpais Manzanita
1242 – Sargent Cypress (pure)
1243 – Sargent Cypress – Riparian ***(May be very rare.)***

1300 – Temporarily Flooded Cold Season Deciduous Forests & Woodlands

1310 – Mixed Willow Mapping Unit (Arroyo Willow, Red Willow, and Yellow Willow Alliances)
1320 – White Alder Alliance
1321 – White Alder – California Bay
1330 – Red Alder Alliance

1400 – Cold Season Deciduous Forests

1410 – Black Oak Alliance

2000 – WOODLANDS

2100 – Xeric Sclerophyll Evergreen Forests & Woodlands

2110 – Coast Live Oak Alliance
2111 – Coast Live Oak / (Grass-Poison Oak)
2112 – Coast Live Oak – Riparian
2113 – Coast Live Oak – Douglas-fir ***(A small component of conifer cover (< or = 5%), as compared to 1221)***

2200 – Cold Season Deciduous Woodlands

2210 – Oregon Oak Alliance (small stands) ***(Includes Oregon Oak mixed with lower to equal Coast Live Oak or California bay cover)***
2220 – California Buckeye Alliance ***(Includes California Buckeye mixed with lower Coast Live Oak)***
[mapped based on plot data and some local extrapolation]
2230 – Valley Oak Alliance
2231 – Valley Oak Riparian Mapping Unit ***(California Bay and/or Big Leaf Maple- Alder are a co-dominant in a riparian setting.)***

2300 – Temporarily Flooded Cold Season Deciduous Woodlands

2320 – Big-leaf Maple Alliance
2321 – Big-Leaf Maple – California Bay Mapping Unit ***(Maybe co-dominant or one slightly higher in cover than the other.)***

3000 – SHRUBLANDS

3100 – Temperate Broadleaf Sclerophyll Evergreen Shrublands

3110 – Chamise Alliance
3112 - Chamise - Serpentine Chaparral ***(Relatively purea chamise on ultramafic soils.)***
3114 – Chamise ***(Stands with a co-dominance of chamise with other shrub species such as Sticky Monkey-flower or Wedgeleaf Ceanothus.)***
3115 – Chamise (pure)
3120 – Mt. Tamalpais Manzanita Alliance ***(Includes possibly 3 associations with Eastwood Manzanita, Chamise, or Jepson's Ceanothus as associates.)***
3121 - Mt. Tamalpais Manzanita - Chamise - (Garraya - Leather Oak – Jepson ceanothus) – Serpentine Chaparral)
3122 – Mt. Tamalpais Manzanita - \ with Sparse Douglas-fir emergent (5 - 25%)
3130 – Sensitive Manzanita Alliance ***(Small stands that may include Eastwood Manzanita or Huckleberry.)***
3132 – Jepson's Ceanothus (stand noted at Nicasio Reservoir)
3140 – Silver Leaf Manzanita Alliance ***(Small stands that may include Eastwood Manzanita and Chamise.)***
3150 – Eastwood Manzanita Alliance ***(May have up to 10-15% Douglas-fir emergent.)***
3160 – Interior Live Oak Alliance
3161 – Interior Live Oak- Eastwood Manzanita ***(QUWI and ARGL co-dominate)***
3170 – Blue Blossom Alliance ***(Small stands, and may include at least 2 associations with Coyote Brush – Poison Oak and with Shrub Interior Live Oak.)***
3180 – Leather Oak – Chamise – Mt. Tamalpais Manzanita Serpentine Chaparral
3190 – Chamise – Eastwood Manzanita

3200– Temperate Microphyllous Evergreen Shrubland

3210 – (French) Broom Alliance ***(May include low cover of Coyote Brush.)***
3220 – Coyote Brush Alliance
3221 – Coyote Brush – California Sagebrush – Sticky Monkey Flower
3222 – Coyote Brush / Annual or Perennial Grasslands (open stands)
3223 – Coyote Brush – Mixed Shrub / Grass ***(May include Poison Oak or California Blackberry with mixture of grass species.)***

3300 – Temperate Xeric Mixed Drought-Deciduous Evergreen Shrubland

3310 - California Sagebrush Alliance
3311 – California Sagebrush – Sticky Monkey Flower

3400 – Temperate Broadleaf Cold Season Deciduous Shrubland

3410 – Poison Oak Alliance ***(Small stands found in Coyote Brush patches.)***
3420 – Riparian Deciduous Shrubland ***(Includes Western Azalea.)***

4000 – HERBACEOUS

4100 – Saturated Temperate Perennial Graminoids

4101 – Undifferentiated Marsh (cattail, bulrush, other scirpus spp.)
4110 – Cattail Alliance
4120 – Bulrush Alliance

4200 – Seasonally or Temporarily Flooded Graminoids

4210 –Sedge – Rush – Wet Graminoids Meadow (Including Juncus, Carex, and Hordeum brachyantherum – Meadow barley)
4211- Temporarily flooded or saturated Meadow Edge

4300 – Tall Temperate Annual Graminoids

4310 – California Annual Grasslands Alliance (Native Component Variable)
4311 – Grasslands on well-developed soils ***(generally dense bio-mass)***
4312 – Grasslands on poorly developed soils ***(generally sparse bio-mass)***
4313 – Grasslands with a fern or sub-shrub component (either Thermopsis or fern)

4400 – Tall Temperate Perennial Herbaceous
4410 – Harding Grass Alliance
4420 – Teasal Alliance (Dipsacus sativa)
4430 – Reed Canary Grass Alliance (Festuca arundinacea)

4500 – Native Temperate Perennial Grasslands

4510 – California or Idaho Fescue Grasses ***(Small patches in grassland settings.)***
4520 – Purple Needlegrass ***(Small patches with annual grasses and sometimes other native grasses such as California Melic.)***

4600 – Serpentine Grassland
4610 – Upland Serpentine Grassland ***(May include perennial and annual species at varying cover seasonally and annually, such as Purple Needlegrass, Torrey's Melic, Dwarf Plantain, Small Fescue, Sticky Western Rosinweed.)***
4620 – Wetland Serpentine Grassland ***(May include perennial and annual species at varying cover seasonally and annually, such as Meadow barley, Rosinweed, Goldfields, etc.)***

9000 – LAND USE / UNVEGETATED
9800 – WATER

9100 – Urban Developed – Built Up
9302 – Quarry
9400 – Sparsely Vegetated or Unvegetated Areas
9401 Serpentine Balds ***(Including rare species such as Tamalpais Jewelflower)***
9410 – Landslides
9420 – Cliffs – Rock Outcrops
9810 – Reservoirs
9820 – Small Asian Elephant Ponds

9999 – Field questions

Density

(3 fields – conifer, hardwoods & shrubs)

1 = Greater than 60%
2 = 40-60%
3 = 25-40%
4 = 10-25%
5 = 2-10%

Disturbance

Broom Modifier

0 = Minimal or no disturbance visible
1 = Low: 1-5% of the polygon has broom visible
2 = Moderate: 5-10% of the polygon has broom visible
3 = Severe: Over 10% of the polygon has broom visible

Dead Vegetation Modifier (Usually for Tanoak)

0 = Minimal or no mortality – (standing trees)
1 = Low: 1-5% of the polygon has canopy mortality
2 = Moderate: 5-10% of the polygon has canopy mortality
3 = Severe: Over 10% of the polygon has canopy mortality

Field Codes

1 = Field Questions
2 = Answered
3 = Internal Questions
4 = Corrections to Marin Field Assessments
5 = Corrected to Jeff Kennedy Assessments

APPENDIX B

AREA REPORT FOR MMWD VEGETATION MAP

Vegetation Code	Polygon Count	Area (Square feet)	Acres	Hectares	Average Polygon Size (Acres)
1100	9	357,487.7	8.2	3.3	0.9
1101	100	25,824,061.2	592.8	239.9	5.9
1102	83	30,692,955.4	704.6	285.1	8.5
1103	37	4,552,388.4	104.5	42.3	2.8
1104	118	51,571,296.8	1,183.9	479.1	10.0
1110	43	5,902,414.5	135.5	54.8	3.2
1111	83	10,972,309.0	251.9	101.9	3.0
1112	11	986,155.7	22.6	9.2	2.1
1113	249	22,044,041.7	506.1	204.8	2.0
1114	105	20,775,299.0	476.9	193.0	4.5
1115	122	16,934,271.1	388.8	157.3	3.2
1116	118	40,834,866.5	937.4	379.4	7.9
1140	6	2,328,603.4	53.5	21.6	8.9
1160	18	1,007,716.9	23.1	9.4	1.3
1161	1	16,279.9	0.4	0.2	0.4
1170	37	3,475,870.5	79.8	32.3	2.2
1171	29	3,034,842.3	69.7	28.2	2.4
1180	44	2,117,146.6	48.6	19.7	1.1
1201	7	341,056.2	7.8	3.2	1.1
1210	6	137,472.6	3.2	1.3	0.5
1211	7	6,634,494.7	152.3	61.6	21.8
1212	82	65,955,249.1	1,514.1	612.7	18.5
1213	2	74,327.7	1.7	0.7	0.9
1214	45	3,971,982.5	91.2	36.9	2.0
1215	62	5,277,184.4	121.1	49.0	2.0
1216	111	66,105,801.9	1,517.6	614.1	13.7
1217	32	16,038,660.3	368.2	149.0	11.5
1220	15	1,398,957.9	32.1	13.0	2.1
1221	51	10,224,582.5	234.7	95.0	4.6
1222	207	134,831,696.6	3,095.3	1,252.6	15.0
1223	33	4,059,034.4	93.2	37.7	2.8
1224	1	2,051,759.1	47.1	19.1	47.1
1225	2	128,476.0	2.9	1.2	1.5
1226	26	1,145,523.8	26.3	10.6	1.0
1227	50	5,105,326.3	117.2	47.4	2.3
1230	8	407,572.9	9.4	3.8	1.2
1231	11	581,521.9	13.3	5.4	1.2
1232	6	328,207.4	7.5	3.0	1.3
1240	6	637,779.2	14.6	5.9	2.4
1241	78	12,632,805.5	290.0	117.4	3.7
1242	24	1,470,383.2	33.8	13.7	1.4
1310	72	3,633,889.5	83.4	33.8	1.2
1321	2	76,679.6	1.8	0.7	0.9
1410	4	246,209.2	5.7	2.3	1.4
2110	75	6,838,653.0	157.0	63.5	2.1
2111	139	10,196,038.7	234.1	94.7	1.7
2112	3	129,423.8	3.0	1.2	1.0

Vegetation Code	Polygon Count	Area (Square feet)	Acres	Hectares	Average Polygon Size (Acres)
2113	8	744,091.8	17.1	6.9	2.1
2210	5	267,921.5	6.2	2.5	1.2
2220	16	518,532.6	11.9	4.8	0.7
2231	2	434,574.4	10.0	4.0	5.0
2321	2	211,288.8	4.9	2.0	2.4
3000	1	12,901.1	0.3	0.1	0.3
3100	3	102,427.9	2.4	1.0	0.8
3110	8	191,020.8	4.4	1.8	0.5
3112	65	2,174,183.3	49.9	20.2	0.8
3114	154	5,226,688.4	120.0	48.6	0.8
3115	151	7,629,097.8	175.1	70.9	1.2
3120	83	3,043,374.3	69.9	28.3	0.8
3121	325	22,523,217.7	517.1	209.2	1.6
3122	47	4,526,994.0	103.9	42.1	2.2
3130	37	3,791,111.4	87.0	35.2	2.4
3132	1	78,989.7	1.8	0.7	1.8
3140	2	8,060.4	0.2	0.1	0.1
3150	61	4,051,947.4	93.0	37.6	1.5
3160	33	1,268,139.1	29.1	11.8	0.9
3161	355	33,145,557.9	760.9	307.9	2.1
3170	5	148,873.1	3.4	1.4	0.7
3180	76	3,641,433.2	83.6	33.8	1.1
3190	415	46,095,913.4	1,058.2	428.2	2.5
3200	1	30,417.1	0.7	0.3	0.7
3210	43	1,305,673.3	30.0	12.1	0.7
3220	8	246,356.8	5.7	2.3	0.7
3221	42	2,168,317.9	49.8	20.1	1.2
3222	212	12,520,005.2	287.4	116.3	1.4
3223	143	5,743,193.7	131.8	53.4	0.9
3310	5	318,446.4	7.3	3.0	1.5
3311	12	327,805.8	7.5	3.0	0.6
3410	7	122,007.0	2.8	1.1	0.4
4000	2	38,583.8	0.9	0.4	0.4
4101	13	278,327.6	6.4	2.6	0.5
4110	7	127,593.9	2.9	1.2	0.4
4120	1	10,619.0	0.2	0.1	0.2
4210	34	612,672.0	14.1	5.7	0.4
4211	20	675,769.3	15.5	6.3	0.8
4300	2	47,144.4	1.1	0.4	0.5
4310	4	50,536.1	1.2	0.5	0.3
4311	467	67,755,413.9	1,555.5	629.5	3.3
4312	52	4,852,281.4	111.4	45.1	2.1
4313	45	1,972,285.3	45.3	18.3	1.0
4400	1	17,006.7	0.4	0.2	0.4
4410	3	223,656.5	5.1	2.1	1.7
4500	6	990,601.7	22.7	9.2	3.8
4510	11	893,396.4	20.5	8.3	1.9
4520	1	33,386.4	0.8	0.3	0.8
4610	153	5,831,501.4	133.9	54.2	0.9
4620	8	79,297.9	1.8	0.7	0.2
9000	1	637,559.8	14.6	5.9	14.6
9100	59	3,562,921.4	81.8	33.1	1.4
9302	2	206,056.2	4.7	1.9	2.4

Vegetation Code	Polygon Count	Area (Square feet)	Acres	Hectares	Average Polygon Size (Acres)
9400	32	703,588.8	16.2	6.5	0.5
9401	96	1,318,509.9	30.3	12.2	0.3
9410	3	16,560.5	0.4	0.2	0.1
9420	86	767,224.7	17.6	7.1	0.2
9800	3	47,038.2	1.1	0.4	0.4
9810	14	85,477,880.0	1,962.3	794.1	140.2
9820	5	20,306.0	0.5	0.2	0.1
9999	22	679,085.1	15.6	6.3	0.7
Total	5,861	944,634,124.4	21,685.8	8,775.9	3.7

APPENDIX C

ITEMS IN THE FINAL COVERAGE

COLUMN	*ITEM NAME*	*WIDTH*	*OUTPUT*	*TYPE N*	*DEC*	*ALTERNATE NAME*	*INDEXED?*
1	AREA	8	18	F	5		-
9	PERIMETER	8	18	F	5		-
17	MARINVEG#	4	5	B	-		-
21	MARINVEG-ID	4	5	B	-		-
25	FIELD	1	1	I	-		-
26	VEG	4	4	I	-		-
30	CONDENSITY	1	1	I	-		-
31	HWOODDENSITY	1	1	I	-		-
32	SHRUBDENSITY	1	1	I	-		-
33	BROOM	1	1	I	-		-
34	DEADLIDE	1	1	I	-		-
35	NOTE	200	200	C	-		-