HERBACEOUS COVER (V_{HERBC})

Definition

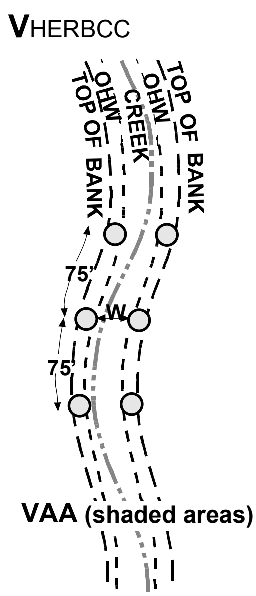
Herbaceous Cover is the percent cover of herbaceous vegetation, including graminoids, forbs, ferns, and fern allies within the VAA.

Rationale For Selection of the Variable

Cover of herbaceous vegetation typical of reference standard conditions indicates the presence and maintenance of native plant communities. Low herbaceous cover is characteristic of late succession, undisturbed reference standard conditions. High percent cover of herbs can indicate an early stage on the forested waters/wetlands of the SCSBC, but often suggests an early successional phase in fire/flood/debris flow disturbance regimes that are the hallmark of the Southern California landscapes. A high percentage of herbaceous cover can also indicate recent, intense, or frequent disturbance by human activities.

Measurement Protocol

The VAA for V_{HERB} consists of six 0.01-acre circular plots (radius = 11.8 feet) established along two vegetation transects, located on stream right and stream left. To establish the six 0.01-acre circular plots that are required to scale V_{HERB} , two vegetation transects need to be established parallel to the PAA stream reach on stream right and stream left. To establish each vegetation sampling transect, begin at the PAA cross section. Visually extend the PAA cross section to top of bank (TOB) on river right and river left. Identify the midpoints of the riparian zone between the TOB and the ordinary high water (OHW) mark on stream right and stream left. Mark these midpoints with plastic flagging. These midpoints will act as the plot center for two of the six vegetative sampling plots, and the midpoint for both vegetation transects. From both midpoints, extend the vegetative transects 75 feet upstream and downstream parallel to the PAA stream reach on stream right and stream left. Establish the four additional plot centers at the midpoints of the riparizn zone between the TOB and the OHW mark, 75 feet upstream and downstream from the PAA cross section midpoints on stream right and stream left (Figure5.11).

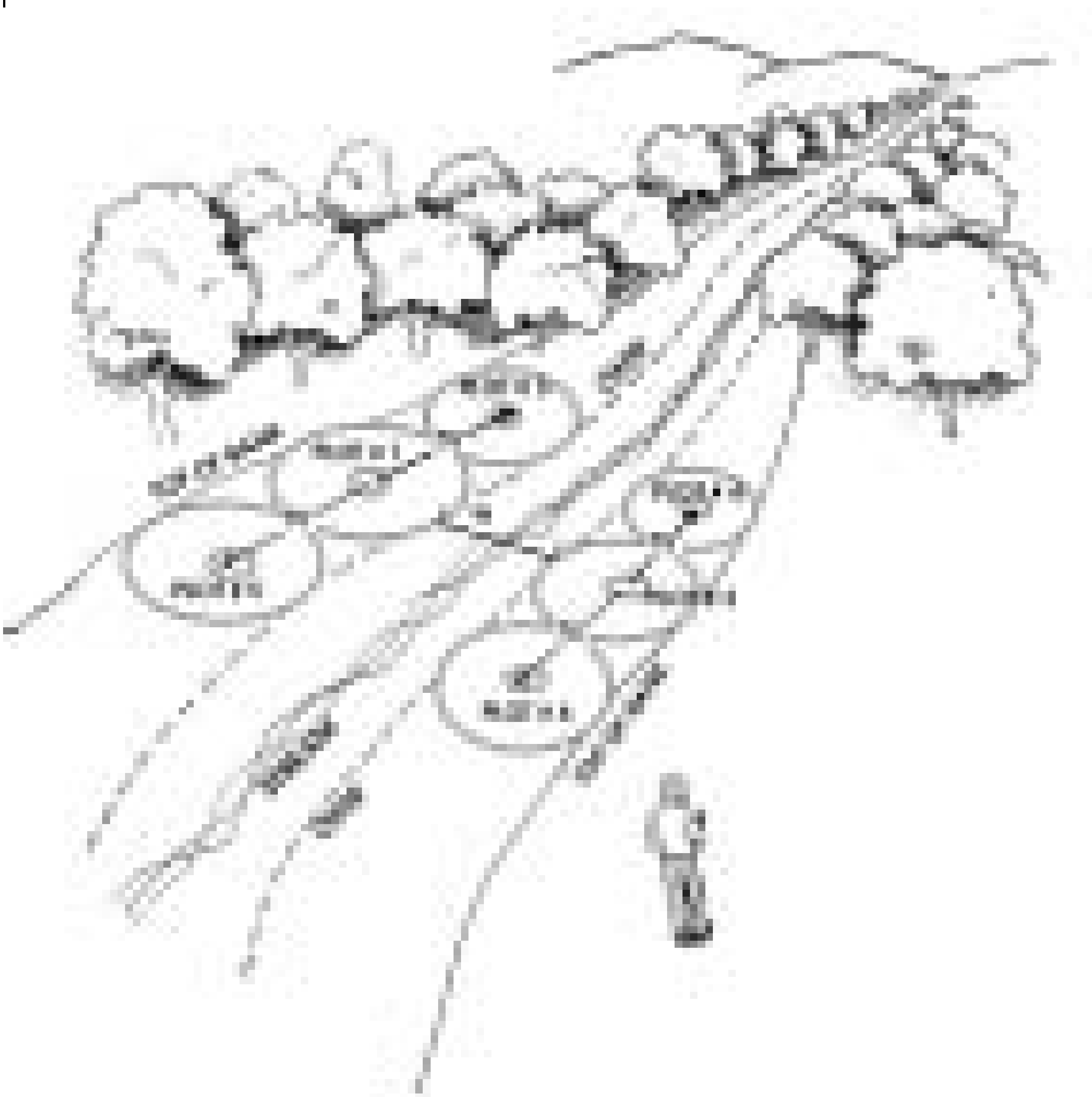


If the vegetation transects cannot be established according to the articulated HGM protocol because of extremely steep terrain, a narrow riparian zone, or extensive poison oak, then locate the six vegetation in accessible, but representative portions of the riparian zone. If the establishment of six plots is not possible at all, given hazardous or unsafe conditions, then the data required for the vegetation variables should be estimated from a remote location (*e.g.*, from the creek bed).

At each of the six plot centers, define a 0.01-acre (radius=11.8) feet) circular plot. This is best accomplished by stretching a tape from the plot center to the targeted radius, and walking slowly in a circle around the plot center. Within each of the six circular plots, make ocular estimates of the percent canopy

Variable: HERBACEOUS COVER (V_{HERBC})

Figure 5.10 Location of vegetation variable measurements along vegetation transects



Variable: HERBACEOUS COVER (V_{HERBC})

cover for the herbaceous stratum (graminoids, forbs, ferns, and fern allies) using mid-points of standard canopy-cover classes (see Appendix E.6). Record your results on the Minimum Submittal Worksheet provided in Chapter 7. Average the six measurements of canopy cover to calculate the final estimate of herbaceous cover for the VAA.

After determining the average cover class value for all herbaceous cover, determine the single most dominant herbaceous species within the VAA. This can be determined logically through observations from the first set of measurements, or you may have to take an additional walk through the VAA. Another alternative is to collect the necessay data to scale V_{RATIO}, and then use these data to determine the dominant herbaceous species. Record the percent cover for the dominant herb species using midpoints of standard canopy cover classes (Appendix E.6) on the Minimal Submittal Worksheets provided in Chapter 7.

Data Located in Appendix B-33 through B-60.

Scaling Rationale The Authors scaled V_{HERBCC} using reference data, field observations, and best scientific judgment. Specifically, reference data were analyzed to determine (a) average herbaceous cover (by cover class midpoint) for each plot, and (b) cover class midpoint for the dominant herb within each plot. Reference standard sites should support lower average herbaceous cover class values because undisturbed, late successional stands of riparian forested ecosystems along the central coast of California typically exhibit low light levels in the understory due to a closed tree canopy. Lower light levels in turn limit the diversity and abundance of herbaceous vegetation. The exception is where light gaps may occur between the stream right and stream left bank vegetation and herbaceous taxa establish within a corridor of flowing water. However, some herbs, both native and exotic (*e.g., Piptatherum miliaceum* [Smilo grass], *Artemisia douglasiana* [Mugwort], *Venegazia carpesioides* [Canyon sunflower]) and *Ageratina adenophora* [Sticky eupatorium]), were nearly ubiqitous and in relatively high abundance within the reference domain (Figure 4.25). As a consequence, cover class values converge for all three subclasses. Nonetheless, cover values were used along with best scientific judgment to scale V_{HERBCC}.

Variable: HERBACEOUS COVER (V_{HERBC})

Figure 5.11 Measurement protocol for the vegetation canopy cover variables (V_{HERBCC}, V_{REGEN}, $V_{SHRUBCC}$, V_{TREECC}, V_{VINECC})

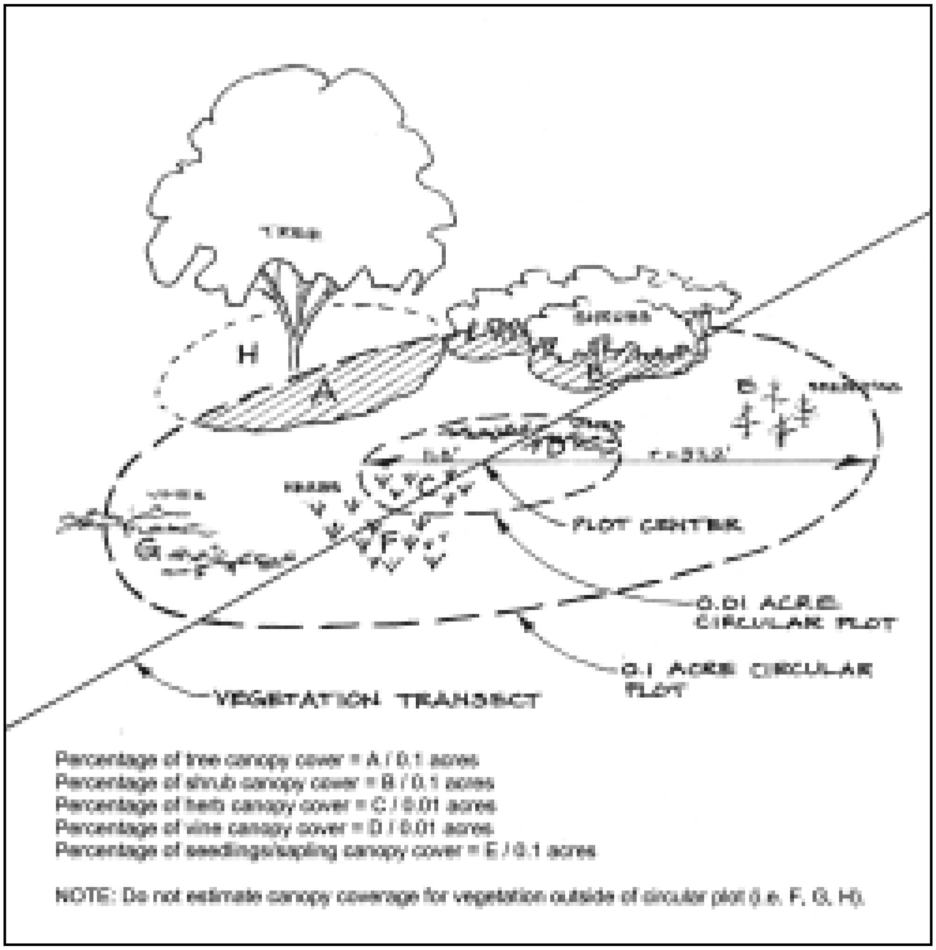


Table 5.11 Mean, standard deviation and range of percent cover for forbs for High, Moderate and Low subclasses

Disturbance Gradient	Sample Size	Percent Forbs Cover (Mean, SD, Range)	
Unaltered/Reference Standard	4	37 ± 21	(10.5 to 63)
Minimally Altered	13	26 ± 11	(10.5 to 38)
Moderately Altered	18	27 ± 20	(10.5 to 85.5)
Extensively Altered	20	23 ± 11	(3 to 38)
Unrecoverable	2	33 ± 42	(3 to 63)

Variable: HERBACEOUS COVER (V_{HERBC})

Scaling for High, Moderate, and Low gradient subclasses

MEASUREMENT CONDITION FOR V_{HERBCC}	INDEX
a. Average herbaceous cover > 3% and ≤ 10% **and** b. Cover class midpoint for the dominant herb species is not > 38% **and** c. Vegetation below top of bank is unaltered by human activities.	1.00
a. Average herbaceous cover > 3% and ≤ 10% **and** b. Cover class midpoint for the dominant herb species is not > 38% **and** c. Vegetation below top of bank is altered by human activities (*e.g.*, partial clearing of the vegetation by grazing of domestic livestock or clearing for crop production, parks, urban/suburban development, flood control access, *etc.*)	0.75
a. Average herbaceous cover > 10% and ≤ 30% **and** b. Vegetation below top of bank is altered by human activities (*e.g.*, partial clearing of the vegetation by grazing of domestic livestock or clearing for crop production, parks, urban/suburban development, flood control access, *etc.*)	0.50
a. Average herbaceous cover ≤ 3% **and** b. Cover class midpoint for the dominant herb species ≤ 3% **and** c. Vegetation below top of bank is recently altered (within the last 5 years) by human activities **or** d. Average herbaceous cover > 30% **and** e. Cover class midpoint for the dominant herb species is not > 63% **and** f. Vegetation below top of bank is altered by human activities (*e.g.*, partial clearing of the vegetation by grazing of domestic livestock, crop production, parks, urban/suburban development, flood control access, *etc.*)	0.25
a. Average herbaceous cover is 0% **or** b. Cover class midpoint for the dominant herb species is 98% due to human activities **and** c. Variable is recoverable and sustainable to reference standard conditions through natural processes if the existing land use is discontinued and no restoration measures are applied.	0.10
a. Average herbaceous cover is 0% **and** b. Variable is not recoverable and not sustainable to reference standard conditions through natural processes if the existing land use is discontinued and no restoration measures are applied.	0.00

Confidence The Authors' confidence that reasonable logic and/or data support scaling is HIGH for all subclasses.

IN-CHANNEL COARSE WOODY DEBRIS (V_{INCWD})

Definition

In-Channel Coarse Woody Debris is the volume of down and dead trees and/or limbs (>3” diameter) within the active channel and below OHW.

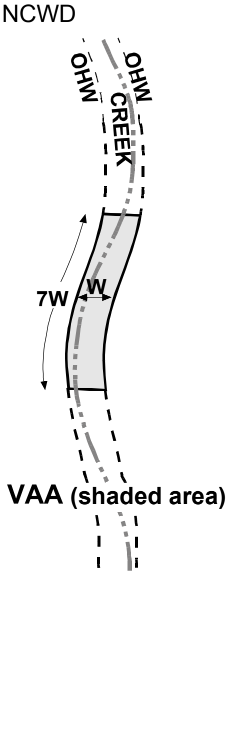
Rationale for Selection of the Variable

In channel coarse woody debris (CWD) in High, Moderate and Low gradient stream channels in SCSBC provides resistance to flow (*i.e.*, roughness) and hydraulic complexity in the channel reach. Movement of water over, under, or around CWD dissipates hydraulic energy and can reduce the average flow velocities within the channel, and increase the complexity of the flow regime or flow pathways (*e.g.*, turbulence, low velocity eddies)(Swanson and Lienkaemper 1978, Keller and Swanson 1979, Frear 1982, Bestcha 1983, Harmon *et. al.* 1986, Sedell *et. al.* 1988, Van Sickle and Gregory 1990, and Nakamura and Swanson 1993). During moderate to high flow conditions, CWD can become mobilized and form CWD jams, which further increase the hydraulic resistance to flow and hydraulic complexity. In both relatively undisturbed and degraded channel systems, CWD jams effect the development and maintenance of cross sectional and longitudinal channel geometry. CWD also provides important animal habitat and/or cover within the riparian ecosystem. Additionally, CWD in various states of decomposition contributes organic carbon (detritus) to terrestrial and aquatic ecosystems. This organic carbon serves as an energy source that provides the basis for numerous ecosystem processes (*e.g.,* decomposition, nutrient cycling, energy transfer, *etc.*).

Measurement Protocol

The VAA for V_{INCWD} consists of a channel reach length that is seven (7) times the OHW width of the main PAA cross section. The VAA is centered on the PAA cross section, so that 3.5 OHW channel widths are upstream, and 3.5 OHW channel widths are downstream from the PAA cross section

VINCWD



To develop a measurement of $V_{INCWD,}$ start at the PAA cross section. Walk upstream 3.5 OHW channel widths and downstream 3.5 OHW channel widths. During these walks, count the number of pieces of CWD (*e.g.,* down trees, branches, logs, dimensional lumber, *etc.* >3” diameter) below OHW. Measure the overall length and midpoint diameter of each piece counted (see Figure 5.7). If any piece >3" diameter of CWD intersects the OHW line but extends above OHW, count it and measure its length and midpoint diameter as well. Note whether cut wood (e.g., dimension lumber or sawn logs or stumps) is a substantial proportion of the in channel coarse woody debris. Convert each measurement of CWD length and diameter to volume (expressed in ft^3). An example of these calculations can be found in Appendix E.5. As indicated on the same sheet, sum the volumes of all CWD counted within the channel below OHW to develop a measure of total CWD volume (ft^3) in the VAA. Record your results on the Minimum Submittal Worksheet provided in Chapter 7.

Variable: IN-CHANNEL COARSE WOODY DEBRIS (V_{INCWD})

Data Located in Appendix B-1 through B-12.

Scaling Rationale The Authors scaled V_{INCWD} using a combination of reference system data, field observations, and best scientific judgment. Specifically, data for each subclass were analyzed separately. In addition, the Authors examined the effects of grouping all subclasses for analyses, especially in light of the Authors' lack of reference standard conditions in the Low gradient subclass (Table 5.12). Data for the High and Moderate gradient subclasses were reasonably consistent across disturbance gradients. They indicated CWD volumes ≥ 100 ft^3 in near reference standard to reference standard conditions. For Moderate and High gradient subclasses, the Authors observed a consistent trend of decreasing CWD volumes with increasing human alterations of the stream channel and associated riparian ecosystems (*e.g.*, removal of in-channel CWD by Santa Barbara County Flood Control). However in some cases, human alterations of CWD volumes (*e.g.,* slash disposal/dumping) resulted in augmentation of CWD volumes when compared to reference standard conditions.

For Low gradient systems, data ranged from 0 ft^3 to 144 ft^3 in the disturbed sites. The Authors observed no reference standard conditions. However, historical evidence suggest that Low gradient systems sustained large volumes of CWD contributed by species such as *Salix lasiolepis*, *Salix laevigeta*, *Platanus racemosa*, *Quercus agrifolia*, *etc.* In addition, the Authors have observed that Low gradient reaches receive significant CWD inputs from intact upstream sources. Given accounts of historical conditions, and the Authors' direct observation of low CWD volumes in degraded Low gradient channel reaches, the Authors used best professional judgment and lumped the Low gradient channel reach CWD variable scaling with the Moderate and High gradient subclasses. The Authors suspect, however, that relatively unperturbed Low gradient channel systems would have had significantly higher CWD volumes.

Table 5.12 Mean, standard deviation and range of the total CWD volume below OHW for the High, Moderate and Low gradient subclasses

Land Use Gradient	Sample Size	Total CWD Volume Below OHW (Mean, SD, Range)	
Unaltered/Reference Standard	4	162.51 ± 187.23	(96.8 to 440.39)
Minimally Altered	12	28.75 ± 38.95	(.54 to 98.81)
Moderately Altered	19	35.09 ± 54.77	(0 to 234.50)
Extensively Altered	20	20.53 ± 43.04	(0 to 144.54)
Unrecoverable	0	0	

Variable: IN-CHANNEL COARSE WOODY DEBRIS (V_{INCWD})

Scaling for High, Moderate, and Low Gradient Subclasses

MEASUREMENT CONDITION FOR V_{INCWD}	INDEX
a. Total CWD volume below OHW and within the VAA is ≥ 100 ft^3 **and** b. VAA has been unaltered by human activities.	1.00
a. Total CWD volume below OHW and within the VAA is ≥ 75 ft^3 and < 100 ft^3 **and** b. CWD volume within the channel has been altered by human activities.	0.75
a. Total CWD volume below OHW and within the VAA is ≥ 50 ft^3 and < 75 ft^3 **or** b. ≥ 100 ft^3 due to artificial (human) augmentation via dumping of slash material, *etc.*	0.50
a. Total CWD volume below OHW and within the VAA is ≥ 25 ft^3 and < 50 ft^3 **and** b. CWD volume within the channel has been altered by human activities (*i.e.* flood control removal).	0.25
a. Total CWD volume below OHW and within the VAA is < 25 ft^3 **and** b. Variable is recoverable to reference standard conditions and sustainable through natural processes if the existing land use is discontinued and restoration measures are applied.	0.10
a. Total CWD volume below OHW and within the VAA is < 25 ft^3 **and** b. Variable is not recoverable to reference standard conditions and sustainable through natural processes if the existing land use is discontinued and restoration measures are applied.	0.00

Confidence

The Authors' confidence that reasonable logic and/or data support the variable scaling for Moderate and High gradient subclasses is MEDIUM to HIGH. For the Low gradient subclass, the Authors' confidence is LOW.

LAND USE ($V_{LANDUSE}$)

Definition

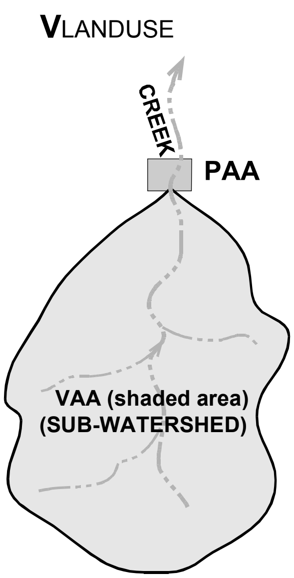
Land use, is calculated from the ETM Landuse Classification map, within the project site sub-watershed.

Rationale for Selection of the Variable

The type and distribution of land use, within that portion of the watershed (*i.e.*, sub-watershed) that contributes runoff to the project site, affects the timing and volume of runoff, sediment loads, and the volume and concentration of nutrients, organic matter, and contaminants that are transported to the project site. In addition, land use has a direct influence on the type and structure of vegetation communities and faunal habitats in the project site sub-watershed.

Measurement Protocol

The VAA for $V_{LANDUSE}$ is defined as the sub-watershed that contributes runoff to the PAA. To develop an estimate for $V_{LANDUSE}$, use the GIS to display or print an ETM Land Use Classification map showing the watershed that contains the PAA (see example map provided in Appendix F). Plot the location of the PAA on the map. Using topographic contours on the map, delineate the sub-watershed that contributes runoff to the project site (on screen-digitize the sub-watershed boundary if calculating the variable in the GIS) (see Appendix D).



Using the ETM land use classes provided in the map key and the 1:24,000 mapping scale dot grids provided in Appendix E, or an equivalent GIS technique such as "Tabulate Area" in Arc/Info Spatial Analyst, calculate the proportion of ETM land use types within the project site sub-watershed. Make sure that your estimates sum to 100%. Record these estimates on the Minimum Submittal Worksheet provided in Chapter 7. Use the land use calculations in the project site sub-watershed, with any available field indicators, to score $V_{LANDUSE.}$

Data

Located in Appendix B-65 through B-100

Variable: LAND USE ($V_{LANDUSE}$)

Scaling Rationale

The Authors scaled the $V_{LANDUSE}$ variable linearly using a combination of reference data, field observations, and best scientific judgment. The land use classes described in Appendix D (GIS & Remote Sensing Methods) are the basis for the scaling of the $V_{LANDUSE}$ variable. The High and Moderate gradient subclasses were grouped together based upon similarities in the reference data and the observation that land use within the reference domain changed significantly from the High and Moderate gradient subclasses to the Low gradient subclass due to human disturbance. For example, the reference standard sites in the High and Moderate gradient subclasses averaged over 90% of the sub-watershed in ETM Class 5 (native chaparral/forest) and Class 6 (native chaparral/woodland) whereas the non-reference standard sites averaged approximately 75% in these two land use classes. If the less disturbed Moderate gradient project sites are removed from this calculation, the average for these two ETM land use classes drops significantly to approximately 50% of the sub-watershed.

The Authors chose to incorporate ETM Class 4 (scrub-shrub/coastal chaparral) into the scaling of the $V_{LANDUSE}$ variable for the Low gradient subclass in order to account for the increased human disturbance within the subclass. The project sites in the Low gradient subclass averaged approximately 65% of the sub-watershed in ETM land use classes 4, 5, and 6.

Variable: LAND USE ($V_{LANDUSE}$)

Scaling for High and Moderate Gradient Subclasses

MEASUREMENT OR CONDITION FOR $V_{LANDUSE}$	INDEX
a. Project site sub-watershed is dominated by land use classes that are composed of a high proportion (> 85%) of native chaparral/forest (ETM Class 6) and native chaparral/ woodland (ETM Class 5) **and** b. No evidence of human alteration of the project site sub-watershed (*i.e.,* hiking trails, abandoned fire or ranch roads, old/abandoned homesteads, *etc.* are acceptable under this condition).	1.00
a. Project site sub-watershed is dominated by land use classes that are composed of a high proportion (> 85%) of native chaparral/forest (ETM Class 6) and native chaparral/ woodland (ETM Class 5) **and** b. Some evidence of human alteration of the project site sub-watershed (*e.g.,* light grazing by domestic livestock, infrequently used fire or ranch roads, broadcast structures, power line rights of way, very low housing density (*e.g.,* 1 house/100 acres), *etc.* are acceptable under this condition).	0.75
a. > 60% and < 85% of the project site sub-watershed is composed of native chaparral/ forest (ETM Class 6) and native chaparral/woodland (ETM Class 5) land use classes **and** b. Evidence of human alteration of the reference sub-watershed (*e.g.,* moderate grazing (ETM class 7 - grasslands) by domestic livestock, agriculture (ETM class 3 - irrigated agriculture), frequently used fire, ranch, and/or public roads, power line rights of way, low housing density (*e.g.,* 1 house/10 acres), *etc.* are acceptable under this condition)	0.50
a. ≥40% and < 60% of the project site sub-watershed consists of native chaparral/forest (ETM Class 6) and native chaparral/woodland (ETM Class 5) land use classes **and** b. Evidence of human alteration of the project site sub-watershed (*e.g.,* moderate to heavy grazing by domestic livestock (ETM class 7 - grasslands and ETM class 8 - heavily grazed/exposed soils), agriculture (ETM class 3 - irrigated agriculture), frequently used fire, ranch, and/or public roads, power line rights of way, medium housing density (*e.g.,* 1 house/acre), *etc.* are acceptable under this condition).	0.25
a. >20% and < 40% of the project site sub-watershed consists of native chaparral/forest (ETM Class 6) and native chaparral/woodland (ETM Class 5) land use classes **and** b. Evidence of extensive human alteration of the project site sub-watershed (*e.g.,* heavy grazing by domestic livestock (ETM class 8 - heavily grazed/exposed soils), frequently used fire, ranch, and/or public roads, power line rights of way, high housing densities (*e.g.,* multiple houses/acre (ETM class 2 - urban/impervious surfaces)), *etc.* are acceptable under this condition).	0.10
a. ≤ 20% of the project site sub-watershed consists of native chaparral/forest (ETM Class 6) and native chaparral/woodland (ETM Class 5) land use classes **and** b. there is evidence of extensive human alteration of the project site sub-watershed (*e.g.,* heavy grazing by domestic livestock (ETM class 8 - heavily grazed/exposed soils), frequently used fire, ranch, and/or public roads, power line rights of way, high housing densities (*e.g.,* multiple houses/acre (ETM class 2 - urban/impervious surfaces)), *etc.* are acceptable under this condition).	0.0

Variable: LAND USE ($V_{LANDUSE}$)

Scaling for the Low Gradient Subclass

MEASUREMENT OR CONDITION FOR $V_{LANDUSE}$	INDEX
a. Project site sub-watershed is dominated by land use classes that are composed of > 65% native chaparral/forest (ETM Class 6), native chaparral/woodland (ETM Class 5), and scrub-shrub/ coastal chaparral (ETM Class 4) **and** b. No evidence of human alteration of the project site sub-watershed (*i.e.,* hiking trails, abandoned fire or ranch roads, old/abandoned homesteads, *etc.* are acceptable under this condition).	1.0
a. Project site sub-watershed is dominated by land use classes that are composed of > 65% native chaparral/forest (ETM Class 6), native chaparral/woodland (ETM Class 5), and scrub-shrub/ coastal chaparral (ETM Class 4) **and** b. Some evidence of human alteration of the project site sub-watershed (*e.g.,* light grazing by domestic livestock, infrequently used fire or ranch roads, power line rights of way, very low housing density (*e.g.,* 1 house/100 acres), *etc.* are acceptable under this condition).	0.75
a. ≥ 45% and ≤ 65% of the project site sub-watershed is composed of native chaparral/forest (ETM Class 6), native chaparral/woodland (ETM Class 5), and scrub-shrub/coastal chaparral (ETM Class 4) **and** b. Evidence of human alteration of the project site sub-watershed (*e.g.,* moderate grazing by domestic livestock (ETM Class 7 -grassland), agriculture (ETM Class 3 - irrigated agriculture), frequently used fire or ranch roads, power line rights of way, low housing density (*e.g.,* 1 house/ 10 acres), *etc.* are acceptable under this condition).	0.50
a. ≥ 25% and < 45% of the project site sub-watershed is composed of native chaparral/forest (ETM Class 6), native chaparral/woodland (ETM Class 5), and scrub-shrub/coastal chaparral (ETM Class 4) **and** b. Evidence of human alteration of the project site sub-watershed (*e.g.,* moderate to heavy grazing by domestic livestock (ETM Class 7 - grassland and ETM Class 8 - heavily grazed/exposed soils), agriculture (ETM Class 3 - irrigated agriculture), frequently used public roads, power line rights of way, medium housing density (*e.g.,* 1 house/acre), *etc.* are acceptable under this condition).	0.25
a. ≥ 10% and < 25% of the project site sub- watershed is composed of native chaparral/forest (ETM Class 6), native chaparral/woodland (ETM Class 5), and scrub-shrub/coastal chaparral (ETM Class 4) **and** b. Evidence of extensive human alteration of the project site sub-watershed (*e.g.,* heavy grazing by domestic livestock (ETM Class 8 - heavily grazed/exposed soils), frequently used public roads, power line rights of way, high housing densities (*e.g.,* multiple houses/acre) (ETM Class 2 - urban/impervious surfaces), *etc.* are acceptable under this condition).	0.1
a. ≤ 10% of the project site sub-watershed is composed of native chaparral/forest (ETM Class 6), native chaparral/woodland (ETM Class 5), and scrub-shrub/coastal chaparral (ETM Class 4) **and** b. Evidence of extensive human alteration of the project site sub-watershed (*e.g.,* heavy grazing by domestic livestock (ETM Class 7 & 8), frequently used public roads, power line rights of way, high housing densities (*e.g.,* multiple houses/acre) (ETM Class 2 - urban/impervious surfaces), *etc.* are acceptable under this condition is observed).	0.0

LONGITUDINAL PROFILE ($V_{LONGPROF}$)

Definition

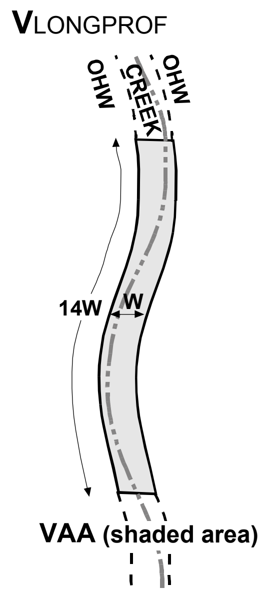
Longitudinal Profile is the integrity of the natural longitudinal profile of the channel within and/or upstream and downstream from the main channel cross section.

Rationale for Selection of the Variable

Maintenance of the integrity of the natural longitudinal profile of channel systems is a fundamental physical feature that, when combined with features such as channel width, depth, water volume, and bedload materials, defines the ability of the channel system to perform work (Leopold 1994, Dunne and Leopold 1978). Manipulation of the longitudinal profile of channel systems (*e.g.,* installation of in-channel dams or diversion structures, water bars, bridges, culverts, *etc.*) in the SCSBC immediately leads to adjustments in the ability of the channel system to allocate kinetic energy. Thus, changes in channel slope will lead to changes in cross sectional and longitudinal channel geometry (*e.g.,* width, depth, degree of entrenchment, sinuosity, *etc.*) These responses have important direct and collateral effects on the ability of the riverine ecosystem to maintain characteristic hydrologic processes through all phases of the hydrograph, and thus to support characteristic geochemical, plant community, a faunal support/habitat functions. For example, manipulation of channel slopes can have immediate effects on water residence times, sediment transport, and the degree to which water can contact floodplain surfaces. Plant community and faunal support/habitat functions in riverine ecosystems are directly influenced by channel slope, because water residence time, water turnover (flux/storage), and the characteristics of the channel cross section and sediment dynamics are all largely controlled by longitudinal slope and variations in slope. The longitudinal gradient is delicately adjusted in a natural channel to most efficiently transport sediment in a natural channel. Any change causes readjustment through deposition or erosion of the bed and banks.

Variable: LONGITUDINAL PROFILE ($V_{LONGPROF}$)

Measurement Protocol



The VAA for $V_{LONGPROF}$ consists of a channel reach length that is fourteen times (14x) the OHW channel width at the main PAA cross section. The VAA is centered on the PAA cross section, so that 7.0 OHW channel widths are upstream, and 7.0 OHW channel widths are downstream from the PAA cross section. To develop a measurement for $V_{LONGPROF}$, first examine remote sensing information (*e.g.*, aerial photographs and other imagery, maps, *etc.*) to familiarize yourself with the VAA study reach. Then, walk the VAA study reach (7.0 OHW channel widths upstream and downsstream from the PAA cross section).

Record all human activities below OHW that are currently impacting the longitudinal channel slope within the VAA (see Figure 5.12). Examples of anthropogenic sources of disturbance that may impact longitudinal channel slope are clearing of vegetation, grading and/or dredging of the channel bed, grade control structures, trails and/or dirt roads, ditches, culverts, construction activities, filling in the channel bed, installation of impervious surfaces, *etc.* In addition, refer to available remote sensing materials (*e.g.,* aerial photographs) and to Table 5.13 to determine if an engineered hardened structure (*e.g.,* a debris basin) exists in upgradient reaches of the stream. This includes debris basins located in tributaries, as well as winin the main channel reach. Record your results on the Minimum Submittal Worksheet provided in Chapter 7.

Data

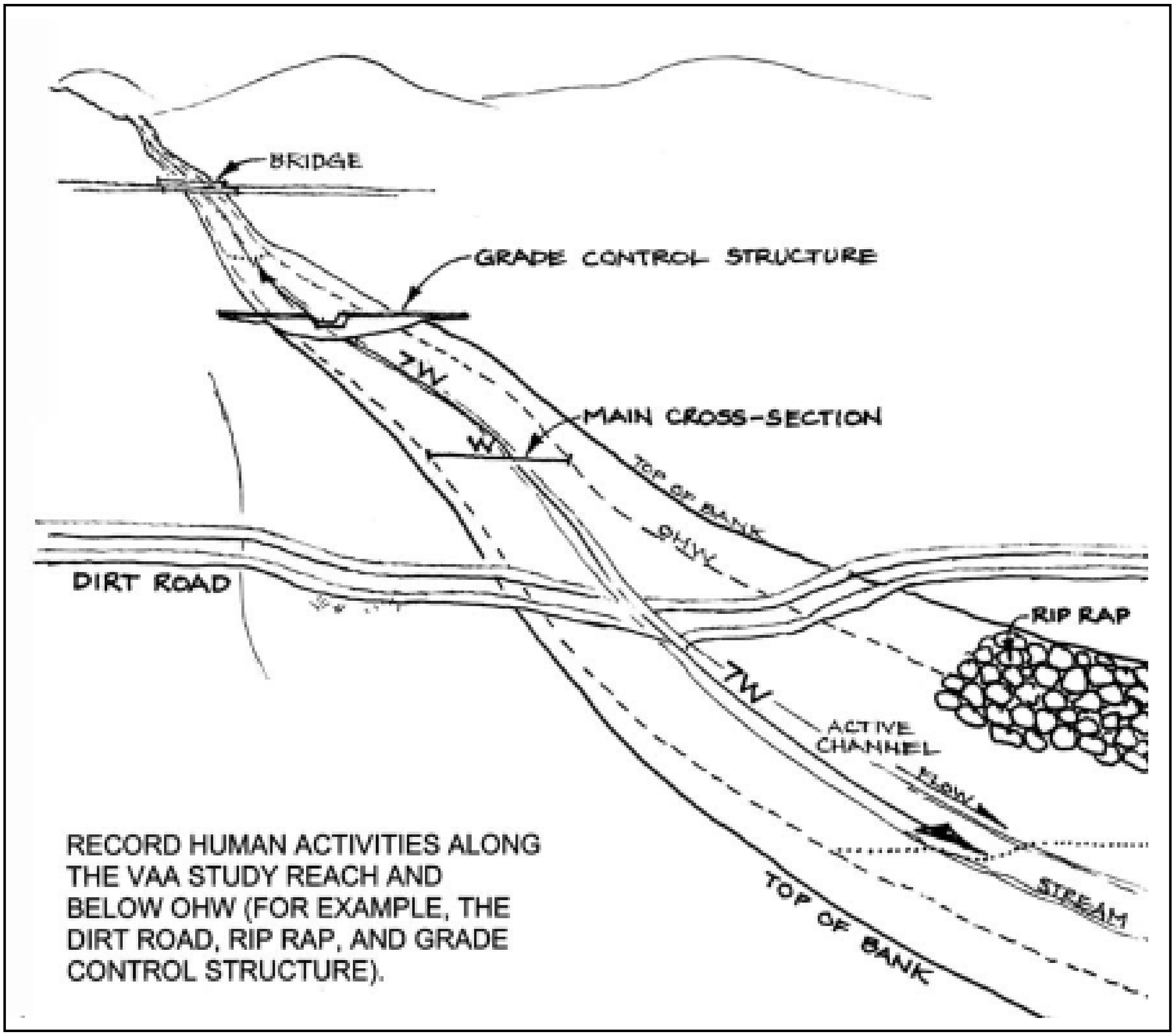
Located in Appendix B-13 through B-20

Scaling Rationale

The Authors used a combination of field observations and best scientific judgment to scale this variable. The Authors recognize that channel slope is a fundamental physical feature of channel systems that is highly correlated with maintenance of channel geometry and many associated ecosystem processes. The Authors also recognize a wide range of natural and anthropogenic causes of variation in the longitudinal profile of High, Moderate, and Low gradient channel systems in SCSBC. Specifically, the Authors see that natural deposits of natural materials into Santa Barbara stream ecosystems can cause abrupt long or short term changes in the longitudinal slope of channels. For example, a large boulder or a fallen tree that dislodged from debris flow material and which moved to the channel bottom, should result in variation in longitudinal profile. Such variation may indicate a past adjustment to channel or bank modifications. The Authors argue that such natural variation in longitudinal profile is not inherently “bad” where a natural bed or bank condition controls that variation. However, during development of the reference system for this project, the Authors observed that anthropogenic manipulation of the bed and bank profiles of SCSBC channel systems usually represent long term and often irreversible departures from reference standard conditions.

Variable: LONGITUDINAL PROFILE ($V_{LONGPROF}$)

Figure 5.12 Measurement protocol for the longitudinal profile variable ($V_{LONGPROF}$)



Variable: LONGITUDINAL PROFILE ($V_{LONGPROF}$)

Table 5.13 List of streams in reference domain with a debris basin in the upper watershed

BASIN	DESIGN CAPACITY	WATERSHED IN ACRES	BASIN	CONSTRUCTION DATE
Arroyo Paredon Creek	24,000 c.y.	750	Romero	1971
Cold Springs Creek	20,450 c.y.	2350	Coyote	1964
East Toro Cyn Creek	15,000 c.y.	400	Romero	1971
Franklin Creek- Main	12,400 c.y.	450	Romero	1971
Gobernador Creek	46,500 c.y.	4500	Romero	1971
Hog Canyon Creek (Franklin)	---------	180	—	—
Hospital Creek (Atascadero)	---------	543	—	—
Lillingston Cyn Creek (Gobernador)	45,000 c.y.	3200	Romero	1971
Lower West Toro Creek	56,000 c.y.	380	Romero	1971
Maria Ygnacio Creek – East	60,000 c.y.	1000	Painted Cave	1990
Maria Ygnacio Creek – Main	30,000 c.y.	2100	Painted Cave	1990
Mission Canyon	15,000 c.y.	1550	Coyote	1964
Montecillo	3,000 c.y.	1796	—	2001
Rattlesnake Creek	8,300 c.y.	1400	Coyote	1964
Romero Creek	27,000 c.y.	1100	Romero	1971
San Antonio Creek	34,000 c.y.	2600	Coyote	1964
San Roque Creek	40,000 c.y.	2200	Coyote	1964
San Ysidro Creek	11,000 c.y.	1700	Coyote	1964
Santa Monica	208,000 c.y.	2100	CVWPP	1977
Upper West Toro Creek	29,000 c.y.	606	Romero	1971

Confidence The Authors' confidence that reasonable logic and/or data support the variable scaling is HIGH for all subclasses.

Variable: LONGITUDINAL PROFILE ($V_{LONGPROF}$)

Scaling for High, Moderate and Low Gradient Subclasses

MEASUREMENT CONDITION FOR $V_{LONGPROF}$	INDEX
The longitudinal channel slope within the VAA study reach (*i.e.,* upstream or downstream seven times the OHW channel width from the main cross section) **or** upstream **or** downstream from the PAA study reach is unaffected by human activities.	1.00
Human Activities: a. **Have not** occurred within the VAA study reach (*i.e.,* Upstream or downstream seven times the OHW channel width from the main cross section), **or** b. **Have** occurred upstream or downstream of the VAA boundary, however, these activities **have not** resulted in development of hardened, engineered structures in the channel (*e.g.* Clearing of vegetation, temporary road or foot trail crossings, culverts without hardened concrete drop-ins, limited, temporary construction activities, *etc.*)	0.75
Human Activities: a. **Have** occurred within the VAA study reach (*i.e.,* Upstream or downstream seven times the OHW channel width from the main cross section), **however** these activities **have not** resulted in development of hardened, engineered structures in the channel (*e.g.* Clearing of vegetation, small road or trail crossings, culverts without hardened/concrete drop-ins, limited, temporary construction activities, *etc.*) **or** b **Have** occurred upstream or downstream of the VAA boundary and have resulted in development of hardened, engineered structures in the channel (*e.g.,* debris basins, permanent road, foot or off-road vehicle trail crossings, culverts with hardened/concrete drop-ins, construction activities, post and wire channel controls, *etc.*)	0.50
Longitudinal channel slope upstream **or** downstream from the VAA has been altered by a In-channel grading (*e.g.,* to control vegetation) or dredging **and/or** b By the placement of non-permanent control structures (*e.g.,* temporary water diversions or bank stabilization efforts, post and wire bank stabilization structures, *etc.*).	0.25
Longitudinal channel slope within the VAA (*i.e.,* upstream or downstream seven times the OHW channel width from the main cross section) has been altered by: a Engineered and hardened grade control or other structure(s) (*e.g.* dirty or grouted rip rap channel banks and toe slopes, hardened grade control structures, *etc.*) **and** b Grade control activities (*e.g.* dredging, grading, installation of hardened engineered structures) upstream **and** downstream of the VAA, **and** c Variable is recoverable and sustainable through natural processes if the existing land use is discontinued and no restoration measures are applied.	0.10
Longitudinal channel slope within the VAA (*i.e.* upstream or downstream seven times the OHW channel width from the main cross section) and/or upstream or downstream of the VAA has been permanently altered by filling the channel bed with impervious materials (*e.g.*, concrete trapezoids, concrete weirs and ramps, grouted rip rap *etc.*). The variable is neither recoverable nor sustainable through natural processes, if the existing land use is discontinued and no restoration measures are applied.	0.00

OFF-CHANNEL COARSE WOODY DEBRIS (V_{OFFCWD})

Definition

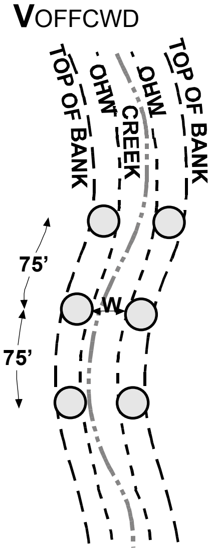
Off-Channel Coarse Woody Debris is the volume of down and dead trees and/or limbs (>3" diameter) above OHW and within the VAA.

Rationale for Selection of the Variable

Coarse woody debris (CWD) that occurs above OHW in High, Moderate, and Low gradient stream ecosystems in SCSBC has direct effects on hydrologic, geochemical, plant community, and faunal support/habitat functioning in areas both outside and within the influence of the active stream channel. During moderate to high flow conditions, wind storms, *etc.*, off-channel CWD can become mobilized and transported into the channel below OHW. Off-channel CWD inputs below OHW increase the hydraulic complexity of the channel, floodplain and channel roughness, *etc.* within the PAA. During moderate to high flow conditions, mobile CWD also has the potential to form many different types of debris jams. These jams can have direct and indirect effects on the development and maintenance of cross sectional and longitudinal channel geometry, diversity of on and off channel habitat conditions, *etc.* In and of itself, off channel CWD provides important plant and animal habitat and/or cover within riparian ecosystems. Additionally, off channel CWD in various states of decomposition contributes organic carbon (detritus) to terrestrial and aquatic ecosystems. This organic carbon serves as an energy source that provides the basis for numerous ecosystem processes (*e.g.,* decomposition, nutrient cycling, energy transfer, *etc.*).

Measurement Protocol

V_{OFFCWD}



VAA (shaded areas)

The VAA for V_{OFFCWD} consists of six 0.1-acre circular plots (radius = 37.3 feet) established along the two vegetation transects, located on stream right and stream left. To measure $V_{OFFCWD,}$ utilize the six plot centers on the two vegetative transects, stream right and stream left, to define 0.1-acre (radius 37.3 feet) circular plots. This is best accomplished by stretching a tape from the plot center to the targeted radius, and walking slowly in a circle around the plot center. Within each of the six circular plots, record the length and mid-point diameter of all off channel CWD (*e.g.,* down trees, branches, logs, dimensional lumber, *etc.* >3" diameter) that falls within the plots (Figure 5.7). All pieces of CWD that intersect sample plot perimeters should be recorded. If a piece of off channel CWD > 3" diameter is found in a circular plot and it extends beyond the plot boundary and into the active channel (*i.e.*, below OHW), then include length and diameter measurements for this piece in both the in and off channel CWD data. Record all measurements on the Minimal Submittal Worksheets in Chapter 7. Convert all measurements of off channel CWD length and diameter to volume (expressed in cubic ft) using the formula provided in Appendix E-5. As indicated on the same sheet, sum the volumes of all CWD obtained and divide by six to develop a measure of the average off-channel CWD volume (cubic ft) per 0.1 acre.