# Current and Potential Riparian Forest Condition along Scott River Watershed Tributaries

J. A. Kennedy, F. M. Shilling, and J. H. Viers
Department of Environmental Science & Policy
University of California, Davis
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## Introduction

In February 2005, members of the Scott River TMDL technical advisory group met in Ft. Jones, California, to review a number of elements of the ongoing work performed by the North Coast Regional Water Quality Control Board, including their affiliates. The TAG members had the opportunity to review preliminary results from a macro-scale stream shade indexing model, RipTopo. This model, developed by UC Davis scientists and funded by the Regional Board, accounts for riparian and topographic shading conditions and is intended to support development of the temperature TMDL in the Scott River watershed. RipTopo used existing statewide vegetation data, augmented by existing riparian vegetation digitized from aerial photographs, to depict the current and potential height of streamside vegetation in the watershed. The TAG members who reviewed the model results expressed concern about the lack of site specificity when depicting potential vegetation height conditions in selected areas of the watershed, particularly in those areas, which currently lack forest cover. The members felt that the TMDL effort could be improved through additional scientific input and recognition of potential ecological and land-use constraints in selected reaches of the watershed.

In response to these concerns, this report covers elements of 1) an extensive review of the technical, scientific, and historical literature relevant to potential riparian conditions in the Scott River watershed; and 2) the input from a combination of local expert stakeholders, agency scientists, and ecological scientists who reviewed in the field existing conditions in particular sub-watersheds. This report is intended as written findings from the supplementary review of the literature, and ecological conditions identified in the site visits, to be evaluated by the North Coast Regional Control Board as part of the temperature TMDL for the Scott River.

## Background and Rationale

The rationale for including tributary conditions in the Scott River Temperature TMDL is that elevated water temperatures can lead to a decline in salmon reproduction. One contributing factor to elevated stream temperatures is a reduction of streamside, or riparian, vegetative cover and hence shading. In support of the Scott River Temperature TMDL, the North Coast Regional Water Quality Control Board expressed interest in evaluating the results from the RipTopo stream shade indexing method in support of watershed wide characterization of current and potential stream conditions, as determined from a restoration potential perspective. RipTopo uses a spatial depiction of vegetation, and related vegetation height, to index shading conditions; since

Jeffrey A. Kennedy (jakennedy@ucdavis.edu), Fraser M. Shilling (fmshilling@ucdavis.edu) and Joshua H. Viers (jhviers@ucdavis.edu).
Department of Environmental Science and Policy, University of California, Davis. 1 Shields Avenue, Davis, CA 95616

vegetation height can increase through time, it follows that a comparison can be made between results from a current riparian forest condition and a potential riparian forest condition. The model, of course, assumes certain regional environmental conditions, including height potential of riparian vegetation types occurring in the watershed.

The RipTopo model assumptions were reviewed by the Scott River Technical Advisory Group, site visits were made in both West-side and East-side creek watersheds in order to revise the input parameters to the model. This revision includes modifications of the rules for the model and a more thorough examination of the ecological requirements of the riparian forest and the conditions currently available and potentially available in the watershed.

*Tree Species*

Currently, remnant stands and individuals of native black cottonwood, pacific willow, Ponderosa pine, and alder can be found in riparian areas throughout the watershed. In addition there are non-native golden willow, both planted and self-recruited, and a single anomalous population of Fremont cottonwood. These species depend on different methods of propagation and therefore will naturally recruit at different rates depending on sources of propagules (i.e., mature reproducing trees). These can all be artificially propagated and will have variable dependence on local ecological conditions (e.g., depth to water table and rate of water receding) and land uses (e.g., exclusion of grazers).

*Riparian Conditions*

The riparian forest cover is very narrow or non-existent along the majority of the mainstem of the Scott River and many of its tributary creeks. This is a result of a combination of factors including historical clearing, flood management, grazing, channel incision, lowering of the water table, and lack of nearby or upstream sources of propagules. The current conditions make natural establishment of riparian vegetation have low likelihoods of success. The riparian areas are often exposed banks that are several feet above the surface of the creek or river. These banks have various levels of slumping from trampling, lack of anchoring vegetation, and lowered or rapidly changing water table. Banks that have not slumped and that are vegetated are often substantially above (1m +) the waterbody due to channel down-cutting.

*Hydrologic Conditions*

Surface water management on the mainstem and creek tributaries leads to changes in the natural hydrograph and reduction in peak/flooding flows. This can have negative effects on downstream riparian forests accustomed to a particular range of conditions. These impacts include 1) sediment starvation in reaches downstream of diversions, leading to bank erosion and channel incision, 2) reduction or tempering of flood flows causing accumulation of sediment in aggrading reaches and reduced floodplain deposition, 3) Higher flows than normal during certain times of year for human uses (e.g., irrigation).

Ground water management in the watershed consists primarily of pumping for irrigation and domestic use and passive percolation-return. There is no substantial knowledge base or database about the extent of ground water or short and long-term changes in depth to ground water as the water has been pumped. There is anecdotal evidence and continuing documentation of surface waterways that are gaining reaches from return flows of ground water. There is no substantial knowledge of the connections between surface water and ground water.

*Land-Use Conditions*

The primary human uses of private lands in the watershed are irrigated pasture and crops, grazing, logging, and mining. The primary human uses of public lands are a combination of grazing, logging, and recreation. There are legacy impacts of riparian forest logging, but currently most logging does not occur in the riparian zone. There are legacy effects of mining on riparian forests and gravel mining in the riparian in many locations. At higher elevations and stream gradients, grazing is one of the primary influences on riparian forest condition, recruitment, and physical habitat conditions.

The physical, chemical, and biological characteristics and processes in riparian soils (e.g., permeability, pH, and nutrient cycling) could be altered due to a combination of water management and land uses (FISRWG, 1998; http://www.nrcs.usda.gov/technical/stream_restoration/newtofc.htm). In developed areas, such as the agricultural regions of the Scott Valley, extensive agriculture is likely to have changed these riparian soil properties. This could change conditions for riparian vegetation that relies on certain hydrologic and chemical conditions and micro-faunal properties for reproductive success and plant growth.

*Restoration Projects*

The earliest restoration projects cited by ad hoc participant in the TAG field trip (April 18th) Ben Tozier was a 50-year-old golden willow planting by his father upstream of the Meamber Bridge road crossing of the mainstem Scott River. Trees in this planted area were as much as 50 feet tall.

More recent restoration plantings have been perceived as variably successful. Certain plantings had low survival rates (e.g., on East-side of mainstem Scott River North of French Creek confluence), but the rates were seen as adequate by RB staff Bryan McFadin and inadequate by other TAG members. Other recent plantings (e.g., Tozier property) had surviving and growing trees (primarily willows) once exclusion fences were included.

## History of the Watershed

A very comprehensive historical digest has been assembled by the Scott River Watershed Council (2004), which has been included verbatim, here, as an historical timeline in Appendix A and a summary narrative in Appendix B. These appendices document a hydrologic system that is highly dynamic, and subject to alternating periods of both intense flooding and irregular droughts. Superimposed on this dynamic natural system is a history of land use and resource extraction that has significantly affected stream hydrology, channel morphology, sediment flux regimes, ground water recharge and, as a consequence, riparian vegetation.

*The 19th Century*

Early eradication of beavers, and consequently their dams, probably reduced channel complexity, the depth, duration and timing of aquifer recharge, and herbivory on certain riparian species. Although no specific documentation remains in the written record for such effects in the Scott River watershed, the ecological ramifications of beaver extirpation are well-documented for North America (see Naiman et al. 1988 for a review).

Early hydraulic mining and subsequent in-channel dredge mining dramatically increased in-stream sediment loads, thus reducing the over-bank flood capacity of the main channel downstream of Callahan. Early agricultural use resulted in a type conversion of some riparian habitat to agricultural fields (Sommarstrom, personal communication). Tall trees were cut in the horse plow years, reportedly because they shaded the fields, delaying ground thaw and impeding plowing by horse teams (Dr. Jim Young, of Young's Ranch, as reported by Sommarstrom, personal communication). Cottonwoods were favored as a fuel for the early steam threshers, reportedly because they burned without producing sparks (ibid.). And in at least one report (Scott Valley News of January 24, 1890, as reported in Graban 1949), "Men went in force to fell and haul trees into the stream … in order to turn the current … [away from buildings in Fort Jones]." To this day, some ranchers view cottonwoods as "junk" trees, because they are short lived and have a tendency to fall into the adjacent stream channel, causing bank erosion and pasture loss; these trees are preemptively cut as a consequence (Gary Black, personal communication).

*Flooding*

Flood debris clearance in August, 1938, involved the removal of riparian vegetation, channel straightening and levee building along the central and northern portions of the main stem of the Scott River, from approximately one half mile below Etna Creek at Sweezy Bridge to just below Highway 3 and the lower portions of Kidder Creek (Alvin Lewis and Sari Sommarstrom, personal communication; Galindo 1996):

Volume XLI, Number 14 of the Etna, CA newspaper, the Western Sentinel, dated Wednesday, August 10, 1938 states, in pertinent part (in an article, titled "Scott River is being cleared by government"):"*The Bureau of Rivers and Harbors, with the US Army Engineers, are clearing the rivers throughout Scott Valley of debris from floods, started this week on Scott River. The work is under the supervision of Roscoe C. Hilderbrand of Richmond. He was here for a few months in the spring, making a survey, and has been doing nine miles of work on the Shasta and Humboldt Rivers and at Hornbrook. This is flood control work and is sponsored by the government. They are using a 40 AC and 60 caterpillar tractors with a blade for each, for the work. Colonel Hannum of the Division of Engineers, southern Pacific division, and Lieutenant Dorst, who is district engineer of the San Francisco district, have been going over the work with Mr. Hilderbrand.*" A separate web article on the flood history of Scott Valley alleges that this project not only removed "flood debris," but also straightened the channel and removed native riparian vegetation in the process (Armstrong 2003(?)).

This resulted in enormous bank destabilization, channel widening and downstream deposition of wide and deep gravel bars (Galindo 1996; see also, Appendix C for a selected transcript of the Orel Lewis oral history interview). Subsequent storms in 1955 and 1964 further mobilized channel sediment and impeded the recovery of riparian vegetation.

*Upland Forests*

Clear-cut logging practices and construction of wide logging roads in the western drainages of the Scott River watershed in the 1980s greatly increased erosion and sediment production, resulting in channel aggradation. Clear-cutting was used by the US Forest Service with the intent of type converting the Red Fir forests to more valuable Douglas-fir forest (Sari Sommarstrom, personal communication). The motivation for logging practices on private lands, other than removal of logs, is unknown.

In the years between the major storms, several pronounced droughts occurred (e.g., 1976-77, 1991, 1994, 2001) and many riparian tree species were either directly killed by drought, by heavy beetle infestation, or by oystershell scale. These species included: scattered ponderosa pine (*Pinus ponderosa*), white alder (*Alnus rhombifolia*) in 1994 and willows (*Salix spp.*,) (Alvin Lewis and Sari Sommarstrom, personal communication).

*Grazing*

Throughout the valley's history, up until very recently, cattle grazing occurred in many riparian zones of the valley, in which access was allowed for feed and stock watering. Many riparian plant species are very susceptible to damage by browsing and trampling; cottonwood seedlings are exceptionally sensitive to damage from grazing (Steinberg, 2001 and DeBell 1990). Quantitative documentation of grazing damage in the Scott Valley does not exist, although there is extensive literature on the effects of grazing on riparian ecosystems in the western United States (see Belsky et al. 1999 for a review).

*Water Diversion and Withdrawal*

Finally, early water diversions from both west-side tributary streams and from the main stem of the Scott River (notably at Young's Dam), changed the amount of water available for in-stream use by fish and adjacent riparian vegetation. Subsequent shifts to groundwater extraction, following the Scott River water rights adjudication in 1980 have also changed the pattern of ground water recharge, while the cone of depression surrounding each well has doubtless changed the depth to the water table, locally. This latter dynamic is of great concern as it relates to the several wells more or less immediately adjacent to the main channel of the Scott River between (roughly) Young's Dam and the Highway 3 bridge (see stream reach maps in Lewis 1992). Near-surface groundwater is critical to both the persistence and the re-establishment of riparian vegetation, yet a comprehensive groundwater study has yet to be implemented, and there is considerable property owner resistance to providing access for monitoring wells and to sharing well log and water depth data.

# Riparian Forest Ecology

### Riparian Vegetation Types

The CalVeg vegetation map, jointly prepared by the US Forest Service and the California Department of Forestry and Wildfire Protection maps the following riparian and/or wetland vegetation types for the Scott River watershed (Minimum Mapping Unit = 2.5 acres):

| #Polys | Code | CalVeg Vegetation Type | Acres | % of Total |
|---|---|---|---|---|
| 39 | HJ | Wet Meadows (Grass/Sedge/Rush) | 702.6 | 0.1350 |
| 53 | QO | Willow | 540.9 | 0.1039 |
| 49 | TA | Mountain Alder | 449.9 | 0.0865 |
| 37 | NR | Mixed Riparian Hardwoods | 268.1 | 0.0515 |
| 29 | WL | Willow (riparian scrub) | 233.6 | 0.0449 |
| 10 | QE | White Alder | 61.4 | 0.0118 |
| 4 | QQ | Quaking Aspen | 28.7 | 0.0051 |
| 1 | QX | Black Cottonwood | 4.4 | 0.0009 |
| 222 | TOTAL | | 2289.6 | 0.4399 |

In aggregate, these vegetation types encompass less than 0.5% of the entire watershed area. Wet Meadows are an herb-dominated type. Willow (riparian scrub) and Mountain Alder are shrub types. All others are hardwood forest types. This report will focus on the hardwood forest types, but omitting Quaking Aspen (QQ). In terms of species composition, these vegetation types correspond to the Northeastern California Riparian Forest region, as described in Roberts, et al. (1980), but with the addition of Pacific Willow (Salix lasiandra) from the North Coast Riparian Forest region, reflecting the transition zone between the California Floristic Province to the west and the Great Basin Province to the east.

## Riparian Species Accounts: Ecology and Management

The discussion that follows focuses primarily on the tree species of these vegetation types, with the exception of some large shrub species that can grow on point bars, close enough to the active channel to potentially provide stream shading. The vast majority of the ecological and life history traits detailed below are taken from Burns and Russell (1990) and the USDA Forest Service Fire Effects Information System (author varies by species for both references).

**Black Cottonwood (*Populus balsamifera,* ssp*. trichocarpa*) (Tory & Gray) Hult.**
For more details, see:
http://www.na.fs.fed.us/spfo/pubs/silvics_manual/volume_2/populus/trichocarpa.htm
http://www.fs.fed.us/database/feis/plants/tree/popbalt/all.html

Black cottonwood is the largest of the American poplars and is the largest hardwood tree in western North America (DeBell 1990). It develops extensive forests along major rivers, narrow forests along smaller streams, and sometimes irregular populations on gravel bars, floodplains and terraces. All members of the genus are dioecious (male and female plants occur as separate individuals), and the sex ratio may be skewed with male trees dominant on warm, dry sites (Steinberg 2001). To ensure sexual reproduction, when reestablishing Black Cottonwood from cuttings, care needs to be taken to ensure mixed sex populations in new plantings.

This species grows on a wide range of soil textures, but is most numerous on medium- to coarse-textured, well-drained soils – Mollisols in older communities and Fluvents in young communities. It has high nutrient requirements, especially for calcium and magnesium, preferring neutral soil reaction. The most extensive stands occur on soils of the order Entisols, although it is also common on Inceptiosols. Black Cottonwood is very tolerant of short duration flooding, and in some cases, even frequent and prolonged flooding (Ibid.) Note that the genetics and traits of different populations can vary widely (DeBell 1990). In nearly all cases, the water table is close to the surface, where Black Cottonwood is dominant.

The root system is primarily shallow and spreading. Rooting depth is commonly 10 to 16 feet, with well-developed laterals. Horizontal roots grow approximately 2 to 8 inches below the surface, but some lateral roots, termed "sinker roots" extend horizontally for only a short distance, and then grow downward, like a taproot. Most members of the genus *Populus* are ectomycorhyzal, but may be colonized by arbuscular mycorhyzal fungi early in stand development, or when the site is flooded. Since Black Cottonwood requires water with dissolved oxygen content, it grows better near moving water than near stagnant water (Steinberg 2001). Black Cottonwood, like other members of the genus *Populus* are among the fastest growing of temperate trees, a trait useful for pioneering disturbed sites, so long as the site has continuously moist mineral soil in full sunlight (Ibid.). Without flood disturbance, this community will typically succeed to either conifer types on xeric or mesic terraces or willow types in more hydric settings.

Black Cottonwood is wind pollinated, and individuals produce seed at seven to ten years of age. Seed viability is high, but only lasts for one to two weeks (this, of course, assumes that trees of both sexes are in close enough proximity to ensure fertilization). High initial seedling mortality is a clear limiting factor in this mode of reproduction. Bare moist mineral soil is required for germination (a 24-hour process), and moisture conditions in the first month of establishment are the defining factor in seedling survival. (Steinberg 2001). Root growth rates for seedlings are among the highest for cottonwoods at up to 0.48 inches per day. But seedling mortality often arises when water table recession rates exceed root growth rates. As a consequence, cottonwood seedling establishment is often episodic, depending on flood dynamics (typically in five to ten year intervals). According to Steinberg (2001): "Because of light requirements, seedling establishment seldom occurs on sites where cottonwood is already dominant and other vegetation is established…. Most regeneration in established forests is by 'root suckers' or coppice sprouts."

Black Cottonwood can also reproduce vegetatively, via crown sprouts, root sprouts (particularly after top damage or pruning) and even via the unusual process of abscising small shoots with green leaves (cladoptosis), which then fall to the ground to be carried by flood waters to moist bare soil, where they can root. Cladoptosis is an important means of regeneration on gravel bars (Ibid.), but not in climates with hot, dry summers. Flood damage of saplings promotes sprouting via root suckering, when stems are removed, and via shoot sprouting, when stems are buried. These biological traits result in the following fluvial geomorphology relationships (Ibid.):

| Fluvial process | Flow | Landform | Community patterns |
|---|---|---|---|
| Narrowing | one to several years of flow less than that necessary to mobilize channel bed | channel bed | variable spatial patterns; usually not even-aged stands |
| Meandering | Frequent, moderate flows | point bars | moderate number of even-aged stands, arranged in narrow, arcuate bands; strong left-bank, right-bank asymmetry in ages based on meander pattern; flood training or stems common |

| | | | |
|---|---|---|---|
| Flood deposition | Infrequent, high flows | flood deposits | small number of linear, even-aged stands; flood training of stems rare |

The causes of decline in riparian cottonwood stands in western North America were summarized by Steinberg (2001), as follows:

| Factor | Impacts |
|---|---|
| 1. Livestock grazing | consumption and trampling of seedlings - death of older trees causes gradual decline |
| 2. Water diversion | drought stress |
| 3. Domestic settlement | clearing area for home development |
| 4. Exotic plants | saltcedar (*Tamarix* ssp.) and Russian-olive (*Elaeagnus angustifolia)*, among others, can reduce recruitment |
| 5. Stream reservoirs | Many stands were lost when dams were built in the West |
| 6. Channelization | this reduces meandering, a process critical to cottonwood establishment |
| 7. Agricultural clearing | this was greatest prior to 1950, there has likely been little net change since then |
| 8. Gravel mining | excavated areas and associated infrastructure require forest clearing, but cottonwoods often regenerate asexually |
| 9. Direct harvesting | during early European-American settlement the wood was used more than it is currently |
| 10. Beavers | populations of beavers are unnaturally high in many areas due to a lack of predators |

In southern Alberta (Ibid.), the causes of decline, ordered from largest to smallest impact were: 1) livestock grazing, 2) agricultural clearing, 3) water diversion, 4) domestic settlement, 5) stream reservoirs, 6) increase in beaver population, 7) gravel mining, 8) direct harvesting, 9) channelization, and 10) herbicide spraying. "Though they require flood disturbance for establishment, Black Cottonwood seedlings are generally not tolerant of much grazing disturbance" (ibid.). Steinberg (2001) summarized the causes of decline due to hydro-geomorphic changes as follows:

| Possible cause of decline | | Effects |
|---|---|---|
| Hydrologic Changes | A. Reduced water availability | Diversion of water off-stream or well pumping creates a water deficit, resulting in drought stress, slow growth, and increased mortality |
| | B. Reduced flooding | Spring flooding is essential to create moist seedbeds for seedling establishment |
| | C. Stabilized flows | Dynamic flows are essential for seedling establishment |
| Geomorphic changes | A. Reduced meandering and channelization | With reduced flooding, channel migration is reduced and suitable seedbeds are reduced |

Black Cottonwoods are susceptible to *Cytospora* canker (young trees or cuttings or fire-damaged mature trees). Young seedlings, in general, are particularly susceptible to pathogenic fungi, while wood-decaying fungi (esp. *Polyporus delectans* and *Philota destruens*) can infect mature trees, especially if fire damaged. Young saplings can be injured by late frosts and either killed directly, or indirectly, via increased susceptibility to fungal infection. Wind damage is common in exposed stands.

In terms of artificial restoration, this species is easily reproduced via both rooted and unrooted cuttings ("slips"). Best establishment and growth occur when the end of the cutting is in contact with the moist soil at or near the water table and with healthy axillary buds, at least one of which is above the ground surface after planting. The exposed cut top of slips should be sealed with water-based paint to retard dessication.

With regard to growth and site productivity, according to Steinberg (2001), "Black cottonwood may attain pulpwood size in 10 to 15 years, and saw log-size trees have been observed in plantations less than 25 years old in British Columbia and Washington. For example, dominant and co-dominant trees of 17 cm (6.7 in) in d.b.h. and 14.8 m (48.5 ft) in height at 9 years have been reported for a good moist site …. In the lower Fraser River Valley of British Columbia, planted black cottonwoods averaged 20 cm (8 in) in d.b.h. and 16.8 m (55 ft) in height at 10 years, and some individual trees were more than 30 ern (12 in) in d.b.h. and 21.3 m (70 ft) in height ….. *Growth is considerably less in* northerly and *interior locations* [emphasis added]. In the Willamette Valley of Oregon, black cottonwood matures in 60 years or less …, but studies in British Columbia show that the species grows well for as long as 200 years …. Exceptional trees have attained 180 to 300 cm. (72 to 120 in) in d.b.h. and more than 60 m (200 ft) in height …." Scott Valley qualifies as a lower productivity, more "interior" location, relative to the locations cited above, so growth and height will be less than the figures cited. (It is interior, but is warmer than BC)

**Pacific Willow (*Salix lasiandra*) Benth.**
For details, see:
http://www.fs.fed.us/database/feis/plants/tree/sallas/all.html

According to Uchytil (1989), "Pacific willow typically occurs in early seral communities along river banks or on moist alluvium …. In the Rocky Mountains these riparian communities are often adjacent to zones of big sagebrush (*Artemisia tridentata*), Douglas-fir (*Pseudotsuga menziesii*), or ponderosa pine (*Pinus ponderosa*) …. In California it occurs in riparian forests as a co-dominant with red alder (*Alnus rubra*), black cottonwood [*Populus balsamifera* ssp. *trichocarpa*], and Oregon ash (*Fraxinus latifolia*) …. Pacific willow is larger than most other willows, reaching 20 to 60 feet (6-18 m) in height at maturity …. Main stems reach 2.5 to 7.5 inches (10-30 cm) in diameter …, with very brittle wood…. Sites typically have high water table year-round. Soils are normally coarse-textured alluvial deposits of sand or gravel …, but textures range from sandy to clayey…. In the Rocky Mountains, Pacific Willow is commonly found with Black Cottonwood [*Populus balsamifera* ssp. *trichocarpa*], Yellow Willow (*Salix lutea*), Sandbar Willow (*Salix* [*exigua*]), Woods Rose [*Rosa woodsii*] and Red Osier Dogwood (*Cornus sericea*) at lower elevations. At middle elevations, it is commonly found with … Thinleaf [aka Mountain] Alder (*Alnus incana* ssp. *tenuifolia*)."

This species reproduces primarily by wind-blown seed. Plants are dioecious, with male and female flowers on separate individuals. The seed capsule splits open in spring or summer, releasing large numbers of seed, to be transported by either wind or water. Seeds are not dormant, and will germinate within 12 to 24 hours after landing on a moist seedbed. According to Uchytil (ibid.), "… seeds contain significant amounts of chlorophyll, and photosynthesis generally occurs as soon as the seed is moistened. Germination rates increase with increased amounts of light."

It can also reproduce vegetatively, via broken pieces of stem deposited on moist alluvium by floodwaters. "Pacific Willow has very brittle branches, making this form of reproduction important in initial colonization of some disturbed areas" (Ibid.). <u>Note that this species does not root-sprout, but it can often resprout from the root crown or stem bases, following top-kill (e.g., by fire?) or stem removal by floods or pruning</u>. Most willows resprout following top-kill by fire, but the specific, post-fire sprouting capabilities of Pacific Willow are not known.

"Repeated flooding allows stands to persist …. Stands help stabilize the sand or gravel deposit, and in the absence of disturbance other communities of cottonwoods (*Populus* spp.) and willows establish and eventually replace it …. In California, Pacific Willow was a pioneer on mine spoils deposited along dredged streams" (Ibid.)

Although the palatability of Pacific Willow is only rated "poor" for cattle – and "fair" for deer --, overuse by cattle (in Montana) "…causes Pacific willow to lose vigor and causes soil compaction problems. Loss of vigor is indicated by uneven stem age distribution, highlining, clumped appearance, or dead clumps. With continued overuse, plants may be replaced by Woods rose (*Rosa woodsii*) and Kentucky bluegrass (*Poa pratensis*). Bare ground resulting from livestock overuse may be vulnerable to erosion during flooding" (Ibid.).

**Sandbar (Narrowleaf, Coyote) Willow (*Salix exigua*) Nutt. – A Willow Complex**
For details, see:
http://www.fs.fed.us/database/feis/plants/tree/salexi/all.html

According to Uchytil (1989), this species encompasses three recognized sub-species (ssp. *exigua*, ssp. *interior* and ssp. *melanopsis*), each with two varieties, and much taxonomic disagreement. "Sandbar willow usually occurs in early seral communities. These are typically riparian and occur as narrow bands immediately adjacent to the stream or river edge. Throughout the Rocky Mountain States, it commonly occurs as a dense shrub layer adjacent to bottomlands of cottonwood (Populus spp.) and birch (Betula spp.)…. Sandbar Willow can form stands or thickets several meters thick, with densely spaced stems." (Ibid.)

"Sandbar willow is a short-lived deciduous shrub or small tree up to about 26 feet (8 m) tall, with soft weak wood, and thin gray-green to brown bark …. The three subspecies as a whole are characterized as (1) having numerous slender stems, (2) forming thickets through the underground spread of root suckers, and (3) having long and narrow mature leaves (5 to 20 times as long as wide) which are equally green on both surfaces …. The three subspecies intergrade, making identification difficult" (Ibid.). Like Black Cottonwood and Pacific Willow, Sandbar Willow is dioecious, having male and female floral parts on separate individuals.

"Sandbar willow is found almost exclusively in riparian habitats, occupying banks of major rivers and smaller streams, lakes and ponds, marshy areas, alluvial terraces, and ditches …. It characteristically forms zones immediately adjacent to the water's edge. These areas are subjected to periodic flooding which often deposits sand and cobble below the high water mark. With severe annual flooding it may be the only shrub to survive in this zone [ emphasis added ]. Although often found below the high water mark, it must have a portion of its crown out of the water during part of the summer to survive …. Sandbar willow may also occur on moist, well-drained benches and bottomlands …. It normally does not exist in the understory due to its shade intolerance, and is generally replaced by cottonwoods" (Ibid.). It occurs on a wide range of soil textures found in alluvial settings. Adjacen t drier areas may be dominated by cottonwoods (*Populus* spp.), Thinleaf (Mountain) Alder (*Alnus incana* ssp. *tenuifolia*) and other willows (*Salix* spp.) (Ibid.) In Kansas, Sandbar Willow forms early seral stands tha last about ten years, before being invaded by cottonwoods and shaded out (Ibid.).

As with Black Cottonwood, Sandbar Willow is able to reproduce by sprouting from underground shoot buds on lateral roots. "This method of vegetative reproduction (suckering) is uncommon in willows and occurs only in section Longifoliae …. Suckering allows this plant to spread and form colonies or thickets that may be several meters in diameter …. On a sandbar in Wisconsin estimated to be approximately 45 to 50 years old, more than 97 percent of sandbar willow (ssp. interior) stems sampled were clones 1 to 3 years old …. Regeneration may also occur through broken pieces of stems and roots which are transported and deposited by floodwaters and later sprout. This is a common method of vegetative reproduction in willows and may be important in initial colonization of some disturbed sites, although seeding seems to be more important …." (Ibid.). Flowers are insect pollinated, commonly by bees. Fertile seeds are covered with a cottony down and are viable for less than a week. Seeds require continuously moist bare soil and abundant light for germination, and thus are not found where overstory trees block the light, or where dense, tall grasses block the light and compete for moisture.

When artificially revegetating, unrooted willow stems (slips) can be used, although Uchytil (1989) maintains that survival rates are higher with rooted stock. This is only likely to be true where the water table is very close to the surface. When using slips, planting deep with long cuttings allows the slip end to reach the permanently moist soil zone and "allows for more rooting surface to extract soil moisture and higher amounts of carbohydrates as stored food reserves. Sandbar Willow cuttings root along the entire length of the stem, with roots appearing in about ten days." (Ibid.) Slips should be soaked in water for four to five days immediately prior to planting to promote root initiation (Platts, et al. 1987, Bentrup and Hoag 1998, Hoag 1998). Although S.exigua is only rated "poor" for cattle browse and "fair" for deer browse, revegetated areas, regardless of the method of reproduction used, should be fenced to protect them from trampling and loss of carbohydrate stores in tender shoots to browsing. (Uchytil 1989)

Although Sandbar Willow is only a large shrub to small tree in stature, its importance for shade should not be underestimated. What it lacks in height, it makes up for in proximity to the watered channel. This is an important factor in the Scott River system, where past bank cutting and sediment deposition has left banks far apart and gravel bars wide. A short Sandbar Willow's shadow might actually reach the watered channel, where the longer shadow of a tall cottonwood, much further removed from the channel might not. Planting Black Cottonwood on the high, inner portions of a point bar near the terrace bank, while planting *S. exigua* on the lower, more exposed portions of the bar may help to facilitate natural succession and also trap sediment on the bar, thus narrowing and deepening the watered channel.

Although the literature I consulted did not discuss evapotranspiration, it would be prudent to investigate the extent to which Sandbar Willow might transpire limited summer water, further dewatering the channel.

**Golden Willow (*Salix alba* var. *vitellina*) (L.) Stokes – Native to Europe**
For more details, see Newsholme (2003); also Hickman (1993)

Hickman describes the parent species, *S. alba* L. (White Willow), as a tree less than 25 meters (~80 feet) in height, with stems erect, spreading or pendant, and twigs brownish to golden yellow, sometimes brittle at the base, with a silky surface becoming glabrous, It is generally found below an elevation of 1000 meters (3280 feet), mostly cultivated as an ornamental, but with many cultivars and hybrids more or less naturalized. Var. *vitellina* (L.) Stokes (twigs bright yellow or golden, spreading) and hybrids with *S. fragilis* are the most common taxa in California. The term "vitelline" means "colored orange/yellow, like an egg yoke" (Newsholme 2003).

Golden Willow was a non-native varietal introduced into the Scott Valley for stream bank stabilization projects funded by the USDA Soil Conservation Service, now called the Natural Resource Conservation Service (Alvin Lewis, personal communication). The fact that it didn't root sprout allegedly made it an attractive plant material, in the belief that it would be less likely to invade irrigation ditches (Sari Sommarstrom, personal communication).

Newsholme describes the parent species as being "a large, fast-growing, elegant tree, with deeply furrowed bark … [and] a many-branched, somewhat conical crown [with] branchlets being compactly arranged and drooping at their tips." The leaves are dull glabrous green above and glaucus silky below, such that, when ruffled by wind, the leaves appear silvery white, when viewed from a distance. The parent taxon is "widely distributed in the lowlands and fertile valleys of the British Isles and Europe, and it was introduced to N. America in colonial times." Its wood is used to make Cricket bats. Clones of var. vitellina have been cultivated in Britain ever since Roman times, when its tough, flexible coppiced rods were used for tying and bundling. I could find no ecological or management information on the parent species or the cultivar.

**White Alder (*Alnus rhombifolia*) Nutt.**
For more details, see:
http://www.fs.fed.us/database/feis/plants/tree/alnrho/all.html

"White alder is distributed from the Pacific coast of Baja California, north in the coastal valleys to just north of San Francisco Bay, in the interior foothills of the Coast Ranges and low to mid elevation slopes of the Sierra Nevada. It is found farther north along the lower eastern slopes of the Cascades in Oregon and Washington and in the dry interior valleys of Oregon, extending into southern British Columbia. It extends eastward along the main tributaries of the Columbia River to the lower valleys of southeastern and south-central Washington, and northeastern Oregon, reaching its eastern limits in Idaho along the Clearwater and Snake Rivers." Uchytil (1989)

"White alder is restricted to riparian woodland communities. In these communities it is often found with Fremont cottonwood (*Populus fremontii*), … willows (*Salix* spp.), ash (*Fraxinus* spp.), … and Douglas-fir (*Pseudotsuga menziesii*)," (Ibid.), as well as Ponderosa Pine (*Pinus ponderosa*). "White alder occurs primarily in forest riparian areas but also extends along major streams into non-forested bunchgrass, sagebrush-grass, and chaparral types …. <u>It is restricted to streams that run all year, and in dry years is a better indicator of water than either cottonwoods or willows …. Trees are mostly restricted to the flooding zone and become infrequent farther away from streams</u> [emphasis added]. Throughout most of California, white alder is often a dominant or codominant in riparian deciduous forests …. White alder tends to replace red alder in the southerly valleys between the Cascades and the Coastal Range in Washington and Oregon." (Ibid.) "White alder is closely related to red alder (Alnus rubra). Although the two species are difficult to differentiate when growing together, their distribution and habitats do not overlap to any great extent." (Ibid.)

"Common associates are Fremont cottonwood, Oregon ash (Fraxinus latifolia), velvet ash (F. velutina), arroyo willow (Salix lasiolepis), red willow (S. laevigata), Pacific willow (S. lasiandra), Hinds willow (S. hindsiana), boxelder (Acer negundo), valley oak (Quercus lobata), and Oregon white oak (Q. garryana) …. In California, white alder occurs at elevations ranging from sea level to over 8,000 feet (2,438 m)." (Ibid.)

"White alder is a small to medium-sized deciduous tree. It ranges from 16 to 115 feet (5-35 m) in height, but mature trees are typically 50 to 80 feet (15-24 m) tall…. In California, trees commonly reach 11 inches (28 cm) in d.b.h. and can reach up to 21 inches (53 cm) in d.b.h. …. Mature trees typically have several trunks arising from a single clump." (Ibid.)

"White alder regenerates well from both seeds and sprouts. Seeds seem to be important in the colonization of new areas, such as sand bars, but established plants show a high degree of vegetative reproduction, mostly from root or trunk sprouting…. In a California riparian study, 60 to 70 percent of mature or pole-sized white alder trees had either root or trunk sprouts…. Another California riparian study found that stands growing on river sediments reproduced mostly from layering …. Layering did not occur after terrace buildup along the river caused the ground surface to become higher and therefore drier.

White alder trees are monoecious [male and female flowers occur on the same plant, in catkins] and primarily wind pollinated. After fertilization, female catkins develop into woody cones, which contain numerous, winged, nutlike seeds …. There are approximately 650,000 air dried seeds per pound (1,430,000/kg), of which about 65 to 71 percent are viable …. The wind and water transported seeds germinate rapidly on sunny, wet mineral sites exposed from receding flood waters. Seedling establishment appears restricted to sites with a continuously moist substrate. Seedlings probably do not survive on sites that dry out during the summer. … With time, some stands form a dominant canopy and may be self-prepetuating." (Ibid.)

"White alder is a deciduous tree. In Oregon, white alder flowers in March and the fruits ripen in late September to early October [ 34 ]. In the southern portion of its range in southern California, it retains its leaves most of the year, but farther north leaves are shed before the onset of winter." (Ibid.)

**Pacific Ponderosa Pine (*Pinus ponderosa* var. *ponderosa*) Dougl**.

For more details, see:
http://www.fs.fed.us/database/feis/plants/tree/pinponp/all.html

The Pacific ponderosa pine (ponderosa) occurs along the Eastern Pacific rim mountains, from Southern California to British Columbia. Its range also extends inland to the dry regions of the Northern US Continental Divide. It generally occurs in low to mid-elevations (<6,500 feet in California), with occurrence varying with latitude and longitude.

Ponderosa stands are often dry and occur in association with shrub and grassland species and communities. It is drought-tolerant, though soil moisture will limit growth, generally occurring where precipitation is 10 to 20" annually. Ponderosa can grow on a wide range of soil types, but grows best on deep, wet, sandy, clayey loams with a slightly acidic pH (a wide range of pH is acceptable for survival and growth pH 4.9 to 9.1). Ponderosa can grow in shallow rocky soils too, originating from volcanic and glacial sources.

Ponderosa is associated with a wide range of plant communities in various seral and disturbance regimes. It tends to be the dominant climax species when it is growing with little competition on dry and warm sites. In wetter sites it may be a successional species for other trees, such as Douglas fir and true firs. In the Scott River Valley, it grows in association with grasslands, shrubs, mixed pine forests, upland hardwoods, riparian hardwoods (e.g., alder and cottonwood), and very disturbed sites.

Ponderosa is a conifer that can reach 70 m (230 feet) in height, 263 cm (104 inches) in diameter at breast height (dbh, and 600 years in age. They commonly occur throughout their range with heights over 100 feet and dbh >36 inches. They have single stems that are often clear of lower branches at maturity.

Ponderosa reproduce sexually and produce seeds from their cones. Trees greater than 60 years old and/or 25" dbh will start producing optimal seed crops (combination of amount and viability) every 2 to 8 years (with less seed in the intervals). Seedlings can root in dry soil, prefer no competition, and prefer exposed mineral soils. Young seedlings (<1-2 years-old) are vulnerable to cold and frost damage. Until seedlings get tall enough, their stems and twigs are vulnerable to browsing and nibbling by cattle, deer, gophers, squirrels, rabbits, and porcupines. Ponderosa trees are fire-resistant, with high lower branches, deep roots, thick bark, and an open crown. Stand reproduction is favored by fire-induced exposure of mineral soils and clearing of vegetation that may compete with seedlings, but not heavy grazing that may favor competitive shrubs.

*Ponderosa Resources*

Baumgartner, David M.; Lotan, James E., compilers. 1988. Ponderosa pine: The species and its management: Symposium proceedings; 1987 September 29 - October 1; Spokane, WA. Pullman, WA: Washington State University, Cooperative Extension: 133-139.

# Input from Scott River Watershed Technical Advisory Group

On April 18th and on May 16th, 2005, the UCD project team and Regional Board staff met with members of the Scott River Technical Assistance Group. The group traveled to several sites within the watershed representing the mainstem in the valley, major creek tributaries, degraded sites, upper watershed conifer forests, and remnant riparian forest conditions. The group was asked to consider several main questions – what were the potential riparian forest conditions at each site, what were the potential heights of riparian trees at each site, what factors at each would limit riparian forest reaching its capacity, and what riparian conditions could be assumed to be recoverable on agricultural reaches.

The primary input from the group was the following:

1) Individual tree species would have different height potential based upon local (sub-watershed) precipitation. The upland east-side of the watershed is drier by ~50% than the west-side, thus reducing potential height of trees in this area compared to similar upland areas on the west-side.

2) Areas that had been attributed a height potential of zero in the first run of RipTopo probably deserved a higher potential – for example, in riparian areas of grazed "annual grassland".

3) Areas where the nibble function had resulted in a certain vegetation attribute given, e.g., mixed conifer, were not always vegetated by that attribute type.

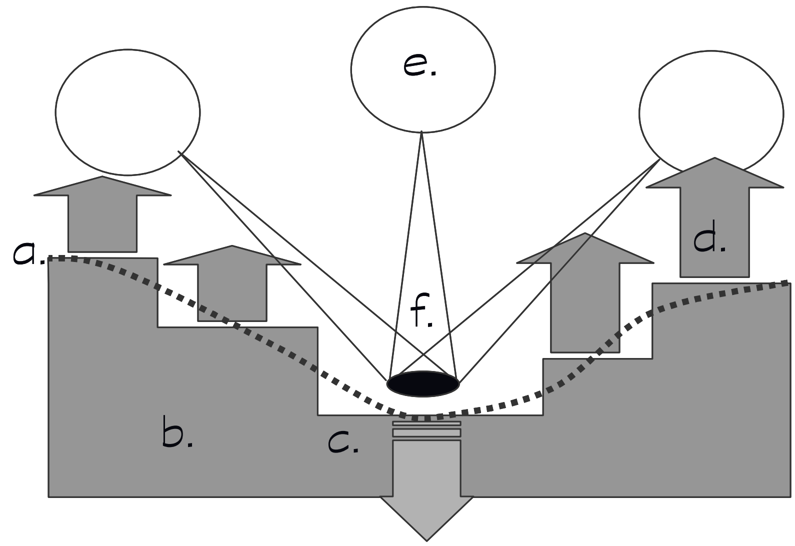
4) A healthy riparian forest was possible in certain areas depending on water reliability, previous land uses, floodplain dynamics, connectivity to groundwater, channel incision, and surrounding existing land-use.

5) There are areas where previous attempts at riparian restoration have seemingly failed due in part to lack of exclusion fences and poor connection of the introduced plants (e.g., willows) to the water table. The non-native willow – golden willow – has been used extensively for horticultural restoration.
6) Certain mid-elevation riparian areas have a naturally-occurring mixture of willow, alder, cottonwood, and pine.

7) The CALVEG plant community types and the estimated potential heights for vegetation seemed to match up with field observations of current vegetation at the reach scale.

# Revised RipTopo Rules and Outputs

RipTopo is a spatially-explicit, riparian-topographic, stream-shading indexing model that uses readily available geographic information and existing algorithms to provide a simple relative shade score, as determined by topography and nearby vegetation (Figure 6 – Appendix E). The results are aggregated at the reach, subwatershed, and watershed scale to depict generalized conditions. RipTopo scores shade for a stream reach based on sun position on a given day, topography (from a 10 m digital elevation model), stream location and orientation (from a map of hydrography), the unvegetated channel width (from calculated bankfull width), and the distribution of vegetation types in the watershed (CALVEG 2000). Scenarios can also be run, such as an adjusted potential height of mature vegetation. For more detailed methods, see Appendix E.




**See Figure 6 – Appendix E**. Schematic of RipTopo: a.) Cross-section of stream valley as characterized by b.) a Digital Elevation Model and c.) adjusted for stream bankfull width is the basis for d.) adding tree height from vegetation cover data to screen e.) hourly sun angles, which are f.) summed for each cell and summarized for each stream segment.

Based on a combination of input from the TAG and an extensive review of the technical literature, the UCD team revised the set of rules used to run RipTopo. In summary, individual species were given different potential heights based on the region of watershed (east vs. west; Figure 1), the stream gradient, and the calculated (from dbh) current height for mature communities. In addition, a reduced stream network was used which bisected the Scott River watershed into east and west components; hydrography was initiated as having a section drainage area (640 acres) in the eastern half and quarter-section (160 acres) in the western half. The table in Appendix E shows the matrix of height potentials used for each species and environmental variable (e.g., stream gradient). All figures are shown in Appendix F.

Figure 2 shows the distribution of current riparian vegetation heights for the entire watershed based on the distribution of vegetation and the size class given in CALVEG. The primary finding is that the majority of the lower gradient watershed (e.g., the river valley between Ft. Jones and Etna) lacks gallery riparian forest. The potential heights for existing vegetation or vegetation that could be restored is shown in Figure 3. In many lower gradient places in the watershed, riparian vegetation (e.g., willows and alders) was considered to be restorable and thus could provide effective shade. The difference between the potential (Figure 3) and current (Figure 2) heights is shown in Figure 4a. In some places lacking riparian vegetation, the differences in heights are over 30 meters, because of the potential for species such as cottonwood growing in these locations. The rectangular box on the map shows the location of Quartz Valley, which was chosen as a location for a closer look at the model input (vegetation height). Figures 4b and 4c show the close-up of Quartz Valley with the difference between potential and current riparian vegetation heights adjacent to the buffered channel. In certain areas, such as lower Shackleford Creek, barren areas that are probably dredge tailings have low differences because the potential height was low. In most places, the difference was greater than 10 and 20 meters because there is the potential to restore gallery riparian forests in this valley. Figure 5 shows the effective shade that would occur given the restoration of the potential riparian vegetation shown in Figure 3. The red color signifies a riparian area where channel surface shading would be low even with riparian vegetation restoration; the green color signifies high shading from the potential shading. A qualifier to this map is that it does not show total shading (i.e., shading of the ground and channel surface), which is an important outcome of the restoration of riparian vegetation.

# Summary and Recommendations for Understanding and Reaching Riparian Capacity

Riparian forests within the Scott River watershed are highly impacted at lower elevations and variably impacted at higher elevations, depending on sub-watershed history and current land-use. The natural conditions that would limit riparian forest capacity include: precipitation, stream gradient, soil depth, soil pH and salt conditions, soil moisture, stream-slope aspect (e.g., northerly-facing), and depth to water-table. The land-use and legacy conditions that would limit riparian forest capacity include: grazing, logging, mining, flood-plain and flooding management, channel incision, water diversion, sediment availability, ground-water pumping, and reduced soil moisture due to water management.

RipTopo input parameters were modified to account for conditions observed in the field; however, the number and extent of these field visits were limited. Furthermore, the relationship of vegetation type to tree height has a natural variance about the mean. Thus, at any given locale, there may exists a substantial difference between the vegetation type assigned with its imputed potential height and actual conditions. Based on the second field survey, however, the TAG had the opportunity to observe and score these input parameters. Given the results of the RipTopo shade indexing, the analysis of current and historical conditions, the review of technical literature, and input from the field trip and TAG, the UCD team makes the following recommendations:

1) A ground-water study is needed for the Scott River valley and the lower elevations of tributary valleys in order to determine where riparian vegetation could feasibly be established. Ideally this study would consist of sampling throughout the valley from participating landowners, would take place during different types of water years, and would produce results that can be integrated with other studies.

2) An analysis of fluvial geomorphology (e.g., channel incision extent and contributing factors) needs to take place in parallel to the ground-water study to determine where geomorphic restoration will need to occur prior to horticultural restoration or encourage natural restoration. Ideally, this study would consider watershed-scale geomorphic processes, the length of time that particular current or legacy practices have been present, and produce results that can be integrated with other studies.

3) Riparian soil characteristics will be a fundamentally limiting factor in successful restoration of riparian vegetation. Site-specific and landscape-scale assessments of physical and chemical properties of soils should be conducted in order to support decisions about revegetation at these scales (FISRWG, 1998).

3) Sites/reaches should be identified in the valley that have elevated or accreting ground-water, minimal channel incision, and willing landowners to carry out large-scale (1 mile) restoration projects. Restoring riparian forest in these the potentially easiest locations would help in understanding how to begin restoration, would provide seed areas for adjacent restoration, and would demonstrate feasibility to other landowners.

4) Sites/reaches should be identified in areas that have just channel incision (but have ground-water accessible to growing riparian forest, and just reduced ground-water access (but no channel incision) in order to determine how best to restore forests in impacted areas, before moving to the most impacted areas.

5) Sites/reaches should be identified where geomorphic, soil conditions, and water-table limiting factors can be and cannot be feasibly repaired in order to measure how long and costly assisted natural restoration could take and would be.

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**Appendix A. Scott River Watershed Chronology of Natural Resource Events**.
(Compiled by Sari Sommarstrom, Scott River Watershed Council 2004)

| Year | Event |
|---|---|
| 8,000BC | Shasta Tribe (Iruaitsu people) occupied Scott Valley. |
| 1830s | Hudson Bay trappers discover "Beaver Valley" and the "Beaver River". Reportedly, 1800 beaver were trapped in one month on both forks of the Scott River in 1836. |
| 1850-51 | Gold discovered at Scott Bar, beginning settlement of area. Hay cutting and cattle grazing began. |
| 1852 | First sawmill built in Scott Valley. Wheat, oats & barley and livestock were raised. |
| 1852-53 | Flood washed out mining structures. Streams near placer mines were diverted into mining ditches, and repaired after washouts. By 1880, "great many" ditches. |
| 1861 | Very large flood destroyed "Old Etna" on Etna Creek. River rerouted below Callahan from the west side to the east side. |
| 1864 | Flood damage; "water covered all but the high places" in valley. |
| 1875 | Flood damage; "extremely high water". |
| 1880 | Flood damage, bridges washed out at Callahan. Total of 11 sawmills in valley with capacity for 3.5 million board feet per year. Hydraulic and sluice mining on South Fork, Quartz Valley, Oro Fino, north Patterson Ck., lower Scott. |
| 1915 | About 15,000 acres irrigated in valley; US Forest Service "largely devoted to the conservation of the water supply which means so much to the farmers in the valleys", but opening up large tracts for lumbering operations. |
| 1917 | Scott Valley Irrigation District constructed Young's Dam for diversion. |
| 1923-1934 | Prolonged drought period. |
| 1924 | Driest year on record. Scott River dries up throughout valley. Large (9,000 ac.) fire up Crystal Creek. |
| 1933-34 | California Conservation Corps (CCC) built roads to access upper westside forests on Klamath National Forest. |
| 1934 | Gold dredging with large Yuba-type dredgers began on upper Scott River below Callahan, Wildcat Creek, McAdams Creek. Largest excavated to a depth of 30-50 |

feet below water line, removing millions of cubic yards of soil and gravel and leaving large cobble tailing piles. River channel straightened.

| | |
|---|---|
| 1937-38 | Large flood damage. Nov. 1937 had 10 inches of rain in 2 weeks. County Supervisors request assistance from state and federal governments. |
| 1938 | Scott River "cleared of debris" from floods by US Army Corps of Engineers. Levees built along mid-Scott River for flood control; channel straightened in sections; riparian vegetation removed. |
| 1940-41 | Flood damage and extensive bank erosion. |
| Dec. 1941 | Gage Station began operation on Scott River at river mile 20.5. |
| 1944 | Aerial photos of Scott River reveal little or no stream bank vegetation. |
| 1949 | Siskiyou Soil Conservation District formed; bank stabilization high priority for district projects, designed by USDA Soil Conservation Service. |
| 1951 | End of mining activity by large gold dredgers. Increased logging activity, with 4 large and 9 small sawmills in the valley. |
| 1953 | Total water use for all purposes in Scott Valley was estimated by the State about 40,000 acre-feet; total of 6 irrigation wells. |
| 1955 | Very dry water year, followed by large (15,000 ac.) forest fire in upper Kidder/Patterson Creek area, followed by record flood in December. |
| 1957 | SVID constructed lower diversion dam on Scott River below Moffett Creek. |
| 1958 | One of the highest water runoff years: prolonged high flows and serious bank erosion. |
| 1964 | Largest flood of record with extensive damage; peak discharge of 54,600 cfs. |
| 1974 | Very large flood and runoff; peak of 36,700 cfs similar to 1955 flood. |
| 1976-77 | Extreme drought; 1977 second driest year on record. |
| 1980 | Scott River Adjudication became final. Groundwater in certain areas of valley was considered interconnected with surface water of the Scott River and included in adjudicated rights. |
| 1982-83 | One of the wettest years, with high runoff and record snowpack. |

(Repeat follows)

| | |
|---|---|
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**Appendix B: Historical Watershed Conditions**
(Section 5, Scott River Watershed Council 2004)

Scott Valley was named as "Beaver Valley", and the river as Beaver River, by the Hudson Bay trappers in the 1830s. What is seen today in the watershed is quite different from its beaver heydays 170 years ago. Historical descriptions of Scott River and its watershed reveal that many changes have occurred. Post-settlement impacts, from minor to major, have occurred from various activities over time: beaver removal, mining, urbanization, tillage, irrigation, channel alteration, livestock grazing, vegetation alteration, timber harvesting, road-building, and fire suppression. Identifying the changes that have occurred to the Scott watershed's landscape over the historic years of human activity is important toward understanding what is happening today. An assessment of more recent changes and conditions will be presented in each relevant chapter.

Watershed Conditions at the Time of Pioneer Settlement

The earliest visual indication of roughly pre-settlement conditions is the 1852 map of 'Scotts Valley' prepared for the U.S. Army, as shown in Figure 4-1 (Williams). Another source describing the area's "original" state of its natural resources is the written account made of the October 1851 visit to the valley by Colonel Redick McKee, in his role as U.S. Indian Agent, from the diary of George Gibbs.

*Vegetation*

The northern and western sides of Scott Valley were indicated on the map as "timbered". Fire scars, tree rings, and early descriptions indicate that the trees were scattered, denser on northern aspects, and quite large on the average (KNF 2000). On the drier east side hills, with serpentine outcroppings, plant life was not as diverse. Conifers were much less common, limited to isolated areas of north-facing slopes or seeps. Oaks and junipers dotted the lower slopes. As shown on the 1852 map, the eastern side of the valley was noted as "hills covered in grass – no timber". This grass was "fine bunch-grass", "affording excellent and most abundant pasturage" (Gibbs).

Much of Scott Valley was covered with grass – bunch grass and wild clover – in the "main prairie" (Gibbs); the valley's yellow grass was described as "knee high" in an October 1, 1854 diary entry by a miner (Stuart). "Pine Barrens" – of primarily ponderosa pine – were mapped along the western, gravelly flat between Etna and Quartz Valley. Pine also covered the eastside portion of the valley and other areas that were not too wet. The richest soils were noted to be in the vicinity of "old beaver dams" in 1851, which created a tangle of sloughs. The map indicates the beaver dams to be in the vicinity of Kidder and Big Slough west of the Scott River. At that time, much of the valley was described as "being too dry and gravelly for cultivation". Along the Scott River and its tributaries were riparian shrubs and deciduous trees, as well as conifers in some riparian areas. It is not clear how well vegetated the alluvial fans found in the lower reaches of the west-side tributaries would have been.

*Fishery Resources*

Spring-run chinook salmon were very important historically in the Klamath Basin, substantially outnumbering the fall chinook run (Hume in Snyder 1931). The snow-fed runoff into the Scott

River would have supported spring chinook. "Salmon ascend the river in large numbers, before the waters subside in the spring", remarked Gibbs in 1851. Fall chinook were also common in the Scott. Salmon "three to four feet long" were "forcing their way up the stream over the riffles where the water was not deep enough for them to swim", observed a miner in Scott Valley on October 2, 1854 (Stuart). Winter steelhead would probably seek the upper tributaries for spawning and rearing (as they do now), while summer steelhead would most likely have over-summered as adults in the main stem Scott River and used both the river and the lower reaches of the nearby tributary streams for spawning and juvenile rearing (as they do now in the Salmon River) (Maria, personal communication).

Though historic references for the Scott River are lacking, Coho salmon would likely have inhabited the extensive sloughs created by the beavers and their dams in the valley and up the forks, based on their identified habitat preferences. Coho were originally called "silver salmon" in California, and were not differentiated by commercial fisheries and fish culturists as a separate species until about 1908; before then, all salmon were commercially classed as "Quinnat". The California Fish and Game Commission remarked upon this relatively new distinction in its 1911-12 biennial report: "[The silver salmon] run abundantly in the Klamath and Smith rivers…[It] is not considered as valuable a fish as the Quinnat; they are smaller, run late in the fall, and are lacking in color and oil. Nevertheless, they are an excellent food fish when taken as they enter the rivers from the sea."

Populations of these anadromous fish species inevitably cycled due to natural causes, such as floods, droughts, and ocean conditions.

### *Wildlife Resources*

Beaver were once abundant throughout Scott Valley. According to one Hudson Bay trapper who first trapped here in the 1830s, "Beaver Valley" was "the richest place for beaver I ever saw" (Meek, in Wells). An indication of their population numbers is the trapper's story claiming to capture 1800 beaver on both forks (East and South) of the Scott River in one month. Beaver dams were also once concentrated in the Kidder/Big Slough area, based on the 1852 map. Wildlife formerly present included grizzly bear, elk, and antelope, as well as the current species.

### *Stream Condition*

The Scott River within the valley was described as "from thirty to forty yards in width, deep in many places, with a current from five to seven miles per hour" in May 1855, by one observer (Metlar). Through the wide, alluvial Scott Valley, the Scott River has changed course many times over its history. Indicators include gravelly channels in farm fields far from the river and ox-bow patterns of channel remnants apparent on aerial photos. For example, the 1861 flood, of greater than a 100-year recurrence in magnitude, caused the upper Scott River to alter its course from the west side to the east side of the valley downstream of Callahan (Jackson).

At the northern end of Scott Valley, the river channel was very winding and heavily vegetated with willow and cottonwood (Jackson; Lewis, personal communication). Tributaries on the east side were mainly ephemeral, with springs supporting base flow in some headwater areas. In 1851, Gibbs commented that "only two or three small branches" of the Scott River in the valley "continue to flow during the dry season", with "arroyas" from the mountains cutting up the gravelly valley through the "pine barren" near "Seino's Hill" (Whiskey Butte near Etna). He also observed the river had a "bed of sand and gravel".

*Fire Disturbance*

Fire greatly affected the natural landscape of the watershed (KNF 2000). Lightening fires would have occurred somewhere in the watershed nearly every year, as they do now. Smoke was common during the fall. The severity of impact would have depended on available fuel, weather conditions, and topography. Vegetation patterns, such as the mosaic of brush fields and hardwoods within the dominant coniferous forest zone, reflected the fire regime. During the pre-settlement period (1627- 1849), fires in the Klamath region occurred on an average of every 14.5 years (Taylor and Skinner in KNF), ranging from 8 years on south aspects to 16 years on east aspects. Native Americans also used fire as a tool to encourage certain seed crops and to drive deer. Fires were set when the oak leaves began to fall to capture deer.

*Floods & Droughts*

The natural hydrologic cycle of high and low rainfall and runoff patterns affected the Scott's watershed condition. In 1851, Scott Valley was already known for having parts of it covered with water (Gibbs). The watershed is susceptible to experiencing warm rains on top of a deep snowpack in late December. Intense winter storms can completely alter a stream channel's course and encompass a huge floodplain, as "Old Etna" discovered when it was washed out by the flooding of Etna Creek and Whiskey Creek in 1861-62 (Campbell and Young). This flood was determined to be comparable in magnitude to the one in 1955. However, an even larger flood inundated the valley in 1964 (54,600 cfs peak discharge at river mile 21). Geological and botanical evidence indicate that an even larger flood occurred in about 1600, and floods of the 1964 magnitude have occurred in the "more recent past" in the Scott River (Helley and LaMarche- TBO). Even smaller floods like those of 1852, 1875, and 1880 (see Timeline on page 5-10) covered "all but the high places" in the valley.

Droughts also occurred periodically, based on the hydrologic record of the past century. Without tree ring analysis of local old growth trees for drought patterns, speculating about the frequency and severity of droughts in the watershed over the past few centuries can be challenging. However, tree ring analysis has indicated a fire frequency pattern, which might be related to drought frequency (see above).

<u>Native American Resource Use</u>

In the Scott, the Iruaitsu band of Shasta was one of the four tribes that originally occupied the Scott Valley, Shasta Valley, and Klamath River region (Renfro). Before European contact, the regional Shastan-speaking population is estimated to have numbered anywhere from 2,000 to 10,000, with most villages supporting only 25 to 40 inhabitants. Their ancestors likely arrived from Asia at least 10,000 years ago.

Most villages were placed along streams, with each village claiming fishing rights to a certain portion of the river. As a hunter-gatherer society, the Shasta followed food sources seasonally within their tribal territory. Acorn, deer meat, and salmon were the staples of their diet, supplemented with nuts, berries, roots, bulbs, and greens. To encourage the growth of certain plants, the Shasta bands used fire to remove or suppress competing and less desirable species. Insects, such as grasshoppers, crickets and yellow jacket larvae, and freshwater shellfish (mussels and crawfish) were also collected for food. Deer for food and hides were supplemented with bear, mountain lion, elk, and bobcat. Small game included rabbits, beavers, minks, squirrels, and quail.

The mouth of the Scott River was one of the three known sites in the Klamath River for a major weir or fish dam, while net fishing, spears, and basket traps were used elsewhere. Social and religious customs governed when and where salmon were harvested, possibly evolving from past experiences with food shortages after periods of over-harvest (McEvoy). Spring chinook were unlikely to have made up a large part of their salmon diet since the fish's high body fat made it unsuitable for drying and smoking (McEvoy). Besides salmon, other fish were harvested by the tribe: steelhead trout (and resident rainbow), Pacific lamprey, and suckers.

## Settlement History and Land Use Changes

This section describes activities and changes that occurred between the 1830s and about the 1970s. More recent natural resource uses and effects are discussed in later chapters.

### *Mining*

Mining activities have left a strong imprint throughout the watershed. Gold miners arrived in Scott Bar in 1850 on the lower Scott River and soon spread upstream to sites around Scott Valley. Mining ditches and flumes were built in almost every stream from the South Fork to Scott Bar (Stumpf). Hydraulic and sluice mining were very active in the 1880 on the South Fork, Quartz Valley, Oro Fino Creek, north Patterson Creek, and the lower Scott (Wells). These operations washed large portions of stream banks downstream (Lewis). From 1934 to 1951, huge Yuba dredges excavated gold from ancient river deposits in the floodplains and left extensive, cobble-sized tailings piles in the floodplains of the upper Scott below Callahan, Wildcat Creek, and McAdams Creek. Sediment plumes from these dredges extended far downstream and reduced the population of aquatic insects in the Scott River below the operations through siltation (CDFG; Taft and Shapovalov). Since 1950, gold mining has mainly occurred through small-scale operations, such as suction dredging in the lower Scott near Scott Bar. Sand and gravel mining in the mainstem and in Kidder Creek has continued at varying intensities over the years.

### *Land Ownership*

Tribal lands changed ownership, mostly by the late 1850s, to the settlers and the federal government. Family farmers and ranchers developed the productive agricultural land in the valley and surrounding hills. The Klamath National Forest was created in 1905. Public ownership of forest lands focused on the more remote areas "especially on the upper watersheds of the many full flowing streams" since the U.S Forest Service's early activities "were largely devoted to the conservation of water supply that means so much to the farmers in the valleys" (French). In 1915, public lands in the Forest reserves were still being homesteaded in Siskiyou County. More accessible tracts near roads and in the middle to lower elevations were developed as private timberlands. Residential and commercial property was centered in the two cities and four towns. The Quartz Valley Indian Reservation came to represent the remaining tribal lands in the watershed.

*Farming and Ranching*

Hay cutting in the valley and cattle grazing in the valley and the hills began as early as 1851 to support the increasing population of miners in the Scott and Salmon watersheds (Wells 1881). Native bunch-grass and clover gave way to farmed crops in the fertile soil. A large ranch in the upper East Fork supported 2,000-3,000 head of cattle by 1880 (Jones). Stock also was brought to the mountains for summer grazing. Grazing by large numbers of cattle, sheep, and horses has reduced the amount of perennial grasses and forbs in uplands over the years (KNF 2000). Dairies were developed in the Greenview area. Farmers tried various crops and settled on alfalfa hay, grain, and pasture as the primary production crops for this mountain valley.

*Water Diversions & Use*

Stream diversions to irrigate pastures and crops began in the 1850s. Placer mining of the 1800s demanded numerous water diversions. Many of these original mining ditches were eventually converted for irrigation purposes. In 1915, about 15,000 acres were estimated to be under irrigation. Scott Valley's water use was more colorfully described by French: "cascading torrents bound joyously to serve the needs of miner and rancher." Young's Dam, the only permanent diversion dam on the Scott River, was constructed in 1917 for irrigation to the eastside. It was washed out in the 1955 and 1964 floods and was rebuilt in 1965. Surface water became supplemented with groundwater for irrigation and domestic use, increasing in relative use after the 1950s (Mack). Trends in water use over the past 50 years are described in Chapters 11 and 13.

*Stream Alterations*

Removal of most of the beaver in the valley was the first major change to the Scott River stream system. Beaver dams would have slowed the movement of water in lower stream reaches, trapped woody debris, and increased water storage in the small ponds. Hydraulic mining created very significant changes in the channel and floodplain of the Scott and its tributaries. By 1855, the lower Scott near Scott Bar was almost constantly "turbulent and muddy", while the Klamath River was usually "clear and transparent" (Metlar). Gold mining impacts to the channel were most extensive in the South Fork, McAdams, Oro Fino and Shackleford/Mill Creeks, with lesser activity in French Creek and the East Fork. A 5-mile length of the upper Scott River and its floodplain remains covered with tailing piles of large cobble as a legacy of the Yuba dredge operations of 1934-51, constricting flood flows and inhibiting channel restoration.

Following a serious flood in the winter of 1937-38, Siskiyou County requested the U.S. Army Corps of Engineers to "clear the rivers throughout Scott Valley of debris from flooding". This work began in August 1938, and included constructing flood levees along the middle channel near Black Bridge (Etna *Western Sentinel*, 8/10/38). The Corps' "debris clearing" also removed much of the remaining riparian vegetation through the middle of the valley (Lewis, personal communication). Aerial photos of the river from 1944 reveal little or no vegetation along the Scott River's banks.

A series of damaging floods from 1940 to 1974 further altered the Scott River channel through the valley through bank erosion and channel widening. Earthen flood control levees were built along lower Etna, Kidder and Moffett Creeks. Designed by the U.S. Soil Conservation Service (now the Natural Resource Conservation Service – NRCS), permanent bank stabilization structures were also tested, with large rock proving to be the most flood-proof. As a result, rock riprap has been placed with the assistance of the Siskiyou RCD along much of the Scott and its tributaries to prevent loss of farmland.

*Fish Barriers*

Barriers to fish migration were created by mining dams, unscreened diversions, and inadequate culverts at road crossings. This problem began to be addressed fairly early. An inventory of major fish barriers in the Scott stream system identified mining dams and unscreened diversions on almost every tributary in June, 1934 (CDFG). Fish screening of diversions started in earnest in the Scott Valley in the 1930s, by both the U.S. Forest Service and the State, after a report that ditches in the county were destroying more fish than the Mount Shasta hatchery was propagating (Western Sentinel, 3/9/1938 ). In the 1950s, the California Dept. of Fish and Game (DFG) began an aggressive program in the Klamath Basin to remove abandoned mining dams, which blocked salmon and steelhead (Coots). By blasting or laddering natural barriers and removing log jams, DFG opened up additional spawning areas. Fish ladders were added to Young's Dam and the Etna City dam on Etna Creek.

*Urbanization*

Mining camps grew and shrank, while towns became established at logistical sites of commerce in the cities of Etna (1855) and Fort Jones (1852) and the towns of Callahan, Greenview, Mugginsville, and Scott Bar. By 1880, Scott Valley's "white" population was 2,862 (Jones). Community water systems and city streets were developed.

*Roads*

Trails (often narrow and steep) were immediately built to connect the extended mining camps and emerging towns via foot, mule or horse (Campbell and Young). Roads were built over some of the trails, with toll roads to Yreka (1854) and over Scott Mountain (1854-59) and Salmon Mountain (1891). The California-Oregon Stage Road followed the east side of the valley and over Scott Mountain as the primary "interstate" route between Sacramento and Portland, until the railroad in Shasta Valley was completed in 1887. Upper elevation road construction began on the Klamath National Forest in the 1930s by the Civilian Conservation Corps, with the road system mainly designed to serve fire protection needs (KNF). Access roads for timber harvest on public lands did not begin until the late 1950s. On private lands, logging roads had already accessed the timber in the middle elevations. Roads were extended into the steeper areas in the 1960s-70s, often with poor designs for roadbed stability and erosion control (KNF). The highly erosive granitic soils on the western mountain slopes were particularly impacted by road building during this era (Sommarstrom, Kellogg, and Kellogg).

*Timber Harvest*

Timber was originally needed for mining as well as for construction purposes. Logging became intense around Scott Bar during its peak mining years (KNF) and probably around Quartz Valley and other valley mining areas also. The first sawmill in Scott Valley was built in 1852. By 1880 eleven sawmills supported production of 3.5 million board feet per year (Wells). By 1915, “large tracts” of forest were being opened up for lumbering operations (French). Although small mills remained active during the Depression, logging became more intense after World War II. In 1953, 13 mills in the valley were producing 205,000 board feet per day (or 75 million board-feet per year) (Mack). Early logging practices were known to produce some serious environmental effects in the Klamath region, such as siltation and loss of aquatic habitat (Coots). In response, regulatory oversight of timber harvest on private and public lands became stricter in California by the late 1970s, and has continued to increase.

*Fire Suppression*

Human-caused fires increased with the influx of miners and settlers (KNF). Ranchers would burn the rangeland as a common practice to create better forage production. Since 1905, fires have tended to be suppressed in the watershed when the Klamath National Forest initially began controlling wildfires. KNF later adopted an aggressive response program in 1920, followed by the State of California for private forestlands. In fact, a momentous State experiment took place in Moffett Creek in 1922 by the California Forestry Committee to evaluate the practice of excluding fire from forest land, which led to the State adopting the Forest Service’s fire exclusion policy statewide (Clar).

Earlier fires were easier to control due to less vegetation and fuels, but modern equipment since 1948 has improved the success rate of fire suppression. As a result, most fires during the past century were contained to less than one acre. However, a few large fires have occurred, mostly in drought years: Moffett Creek (9,600 acres in 1920), Crystal Creek (8,900 acres in 1924), Kidder Creek (14,562 acres in 1955), and Kelsey-Deep-Tompkins in the lower Scott (8,790 acres in 1987). (Clar; Morford; KNF). Instead of the “natural” fire frequency of 14.5 years, the post-suppression return rate is 21.8 years. Concern is now expressed that a century of effective fire suppression has created high fuel loadings, which have increased the probability of large, severe fires in the Scott River watershed. (KNF)

*Fish Harvest*

Salmon were commercially caught for a cannery in the lower Klamath River from 1876 until commercial river harvest was outlawed in 1933. DFG operated an egg collecting station on Shackleford Creek from 1925 to 1940 to help supplement the local fishery. In 1938, the Etna newspaper’s editorial bragged about the Scott River as being “widely famed as one of the finest fishing streams in the state” (*Western Sentinel*, 3/9/38). In a study of angler use of the Scott in 1970-71, the harvest of an estimated 7,152 juvenile steelhead, mostly in the lower 25 miles, and an estimated 682 adult steelhead (about 15-30% of the mainstem population) was determined to be “intensive” (Lanse). The report recommended significantly reducing the harvest of juvenile steelhead from the Scott River through delaying the season past May and reducing the daily bag limit from 10 to 3 fish.

### *Summary and Conclusions*

Multiple historic activities have contributed to both temporary and permanent changes in the Scott River watershed over the past 170 years. Many of the negative impacts were unintended consequences of good intentions, during a period of new and expanded use when resource availability often appeared to be inexhaustible. Changes to the natural landscape and streams were needed to sustain the area's residents, develop communities, and support the local economy. However they have occurred, undesirable changes have led to increased concern regarding the management of the watershed's natural resources. This watershed Action Plan is an outgrowth of that concern. An evaluation of current watershed conditions and recommendations to address them follow in succeeding chapters.

**Appendix C: A Partial Transcript of the Video-taped Interview of Orel Lewis, Orofino, Scott Valley, Siskiyou County, California, 5 August 1996**

**Orel Lewis: A Lifetime's Changes in Scott Valley, May 3, 1903 – April 2, 1997** (43 Min.) Edited by Paloma Galindo, AmeriCorps WSP Volunteer. Produced through YCTV, Yreka Community Television, Yreka, California.

Note: What follows is a *very* rough, unedited transcription of selected portions of the videotaped interview, prepared by Jeff Kennedy, vegetation scientist with the UC Davis Information Center for the Environment.

Introductory, On-Screen Text

"Son of William Lewis and Lenna Lewis, Orel Eastlick Lewis was born in the family home in the town of Orofino, California and grew up in the ranch house near Orofino Creek. He was the grandson of two pioneer families, both of whom came west by covered wagon. Jacob and Mildred Lewis settled in Orofino in 1853. Lafayette and Sarah Eastlick arrived in the Scott Valley in 1863. Orel graduated from Orofino Grammar School, Etna High School and the University of California at Berkeley. …

Following his graduation, he married Eleanor Ashley and returned to the Scott Valley. They had two children, Janet and Bill. During World War II, he was assigned active duty with the rank of captain in the ordinance corps. After the war, he worked until retirement as a road surveyor. He continued to raise cattle and pursued his hobby of gunsmithing, as well as conducting classes for the Scott Valley Junior Rifle Club and Kidder Creek Camp.

Virgin Watershed Hydrology

"There are more floods now than then, when the ridges and watershed were covered in virgin trees with four or five inches to a foot of duff and litter. It would take three to four days of hard rain to start the rivers flowing again. Now, two hours and it's on its way. … The timber that seemed to hold the water back and that did the most good in the watershed were the Douglas-firs."

Drought and Cottonwoods

1924 was the driest year on record with no spring or winter rains and only half a crop of hay. "Jake Dangle [?? Name garbled] in Quartz Valley cut the cottonwoods and put the twigs and limbs in his barn to feed the cattle."

Mining and Sediment

"Mining brought more silt into the river. Other than that, there was no … The country hadn't been logged at that time, so the flow off the watershed was normal or better and the only effect it had on the river flow, as far as I could remember, was from the sediment. And there was a good flow on down. It didn't back up the way it does now. It backs up, now, due to the lack of flow, lack of water. The groundwater is taken out of the river for sprinkler systems and other things, and we just don't have the flow to carry the sediment down."

Logging and Base Flow

"The logging has reduced the [base] flow of water we used to have all summer long. And at the July Fourth Picnic, down by the [Scott] river, there used to be a flow of water 40 to 50 feet across and two feet deep, and you never thought a thing about a lack of water. Now the river at the same time of year is almost dry, and I think it's primarily due to the logging that destroyed our watersheds."

Early Logging vs. Late Logging

Orel returned from World War II in 1946: "I started running cutting lines [? garbled] for the Quartz Lumber Company that was working there. [lists names of people involved …] I saw most of that country along the west side of Scott Valley, before it was logged. There used to be magnificent growth of old growth timber along there, and of course, they went right in and logged it, patch after patch. [However] They didn't damage it nearly as much as the logging that was done before the Forest Service control in later years, because they allowed more road building and clear cutting and like that. So what it did, it led to intense logging that went on for a period of 20 or 30 years -- intensive logging that just destroyed the watersheds along the west side of Scott Valley. And that is primarily the reason for the lack of water, I think. That's my theory. Now I can't prove it, of course."

Impacts on the Scott River System and Kidder Creek

"Of course, I saw the country when, you might say, it was almost virgin territory; and the population of Scott Valley has greatly increased; and the damaging methods of farming and logging and everything like that have been developed, and it's seriously affected the flow of water in Scott River. Well, we used to have a pretty stream that's really served its day [? garbled ?] in the country, and now we don't have it.

And it's due to several things. One is the underground water that's taken out and used by sprinkler systems. The other one is the flow has been reduced. … I would say I am most familiar with the flow of Kidder Creek than any other tributary that feeds Scott river here, because I took cattle for nearly 30 years on Kidder Creek, and I saw the flow be gradually down, down, down, because it's almost just gone in the summer time. There's no …. We used to be able to drive up to the head of the road there, and fish right there where you leave the team [stream? Hard to make out]. Now the last …. They, of course, don't allow fishing now, but if you were to catch any fish now, of course, you'd have to go way up to where the North Fork comes in to the …. There are five forks of Kidder Creek, and the Babs Fork, the Shelly Fork and the Hayes Fork have all been pretty well stripped of timber. The North Fork used to be called the Right Hand Fork [and it] is pretty much in its original condition, because it was in the wilderness area.

And we saved another mile of stream channel [water? Hard to make out], due to the effort of the Audubon Society. International Paper had plans all made to log it, and had culverts hauled up there to put in culverts in the gulches and everything. And we were able …. We had a trip up there, and due to the fact that there were some peregrine falcons on the high rocky summits between Kidder Creek and Mill Creek. We found them and were able to keep the logging on that [… garbled], and eventually, that extra mile of Kidder Creek went into the wilderness area."

[NB: Orel would often start a sentence, then leave it incomplete, while he began a new sentence to rephrase what he started to say. This, together with long, run-on, compound sentences and a fuzzy sound track, made dialog transcription difficult.]

Kidder Creek in the Early Days

"Well, they had, of course, the native trout, and I suppose we had some … The steelhead run didn't go very far up Kidder Creek, because, well, it wasn't too necessary and the channel was too rough. There were falls that they couldn't get over, so most of the fish were native trout.

And it was magnificent virgin territory in there. There at the forks of Kidder Creek was a campground and great big four and five foot [diameter] Douglas-firs in the campground. Of course, when the fire went through there, in 1955, that was completely burned out. Even the big trees were burned. There were just stumps [sic], and the Hayes fork burned out, and the [? Garbled] Fork burned out and it burned up the North Fork about, I would say, a mile and a half to two miles. Just about to Lake [? garbled]. This one section that I mentioned that later came into the wilderness, it seemed like that's about where the fire stopped, at the edge of that. The fire stopped on the Glendenning fork, before it burned completely out."

## 1938: The Army Corps of Engineers Flood Debris Removal Project

"The big change in the river came in 1938, when the Army Engineers came in and straightened the channel and saved 'the island,' what they called 'the island,' country that is between Patterson Creek and Kidder Creek, that came in … there wasn't any river channel and they used to call the land between the two streams "the island." And in the wintertime, it was nearly always flooded -- all the houses in there were built high enough that they'd be above the flood water level – and they had difficulty getting off the island over the road. They had to come off on horseback or by Cat [tractor], usually, to get out.

So the [County] Supervisors, including Mike Davis [sic, should be Davidson, according to Alvin Lewis, personal communication], thought there ought to be something to be done to make life a little bit easier for those people. So they called the Army Engineers in, and they surveyed the Scott River and decided the thing to do was straighten the channel, so the Scott River could carry the water off and not flood. So the Army Engineers sent a detail in here in 1938, and they did that very work. They cut the timber back, where the river wound and had cottonwoods and willows along the bank. They straightened the channel and cut the timber, and the way they did it is cut the timber and dike the logs up and bulldoze gravel over it.

Well, the thing that happened, that they didn't expect, is with the first high water we had, the river broke through those barriers and got behind them and couldn't get back into the channel they prepared, so they just devastated probably, I imagine in Scott Valley, probably a total of 60 or 70 acres. And a lot of it was right down here at the mouth of Orofino Creek. And one of the things they did down there …. In the early days, there was [sic] two crossings there. And, of course, there was water enough in the Scott River, at the time the trappers came in here and when I was a boy, that you couldn't just cross the Scott River anywhere you came to it. And these two fords …. There was one down there …. I think Evelyn Hammond told it, it was Ramer's [sp?] Point, that was down there where the far road is, where Dunlap [? garbled] built his little cabin, built his house. The other one was right here at the mouth of Orofino Creek, where the point of Chaparral Hill comes down [and] hits the river. There was a rock reef [that] crosses there in the ford.

Well, the Army Engineers apparently didn't do anything about that one, but they did go in and they dynamited the one down there at Ramer's Point. They straightened the channel. I used to – when I was a young boy or a young man, high school age – I used to hunt ducks down in that stretch of river, between Orofino Creek and Ramer's Point. And, uh, the river channel wound through there, and there was quite a lot of flooded, rank vegetation in there. But after the Army Engineers straightened that, and the river got behind their dikes and went through there, why there was a gravel bar about 1000 to 1400 feet wide that was just a gravel bar. That's all there was, and of course, it changed the appearance of the Scott River drastically.

And also, in 1938 [sic; should be 1936], the dredging started there up below Callahan. And that went on for about, well, it went on 'til about 1946 [sic; should be 1951, according to Sari Sommarstrom; see Appendix B]. And of course, when the river came through those tailings, it picked up a lot of sediment and gravel and stuff like that. It completely filled the channel and completely changed the whole aspect of the river. So that's why the big change came"

<u>"Dog" Salmon Run on Orofino Creek</u>

(to be completed; discusses the Chinook salmon run in Orofino Creek)

<u>Water Temperature and Deep Holes</u>

(only rough notes, at this point)

- Temperatures started to change (i.e., warm-up) "in the 1950s, about…"

- There used to be lots of deep, narrow, well-shaded, cold-water "swimming holes" with big fish in them: "place, after place, after place where you'd be in over your depth"

- Fish size: numerous three-foot salmon; "mountain trout" were mostly 7-8 inches (13 inches was big); the early fishing limit was "fifty fish, which you could catch in two-and-a-half hours"

<u>Scott Valley Irrigation Diversion</u>

[this is the diversion dam at Young's Ranch, not too far north of Fay Lane, built ~1917]
"It reduced the flow of the river quite a bit. At that time, that was the main source of water for all the ranchers. They ran that canal and [? 'had that pool full' ? voice hard to make out] by the cemetery, down to Fort Jones and had a siphon under a fraction of the town and over onto the other hill. And they probably, at Young's Dam, took out probably a quarter to a third of the water in the river. … [I] didn't see any immediate changes [from that diversion]…."

Agricultural Practices

"…it's [agriculture is] quite a [tiny? small? mumbled] fraction of the valley, but it doesn't really affect the watershed. I think that is where the damage to the watershed has come from, the watershed destruction. We could probably survive in the valley with flood irrigation in the valley, the way they used to do, and all that didn't seem to be too much of a factor, but when they started clear cutting and cut the flow to the creeks down, that really showed up. And the unfortunate part of it is, people don't recognize it. You talk to a lot of the old time loggers and fellows that felled timber in here, and they will tell you the truth. But at the time it went on [it was the accepted way to log, or words to that effect – I need to listen to that part again, but no time. JK]

**Appendix D: Individuals Contacted**

Armstrong, Marcia H.: District 5 Supervisor, Siskiyou County; former Executive Director, Siskiyou County Farm Bureau; author of a Flood History of Scott Valley, Fort Jones, CA

Black, Gary: Senior Project Coordinator, Siskiyou County Resource Conservation District, Etna, CA

Conway, Francis L., SPN: Librarian, US Army Corps of Engineers, San Francisco District Office, San Francisco, CA

Dunning, Lorry: Consultant, Antique & Historic Farm Machinery and founder, Antique Farm Equipment Collection, UC Davis, Davis, CA

Earhart, Carolyn (Meamber): daughter of a long-time pioneer (Meamber) family, dating back to Gus Meamber (1852), Castro Valley, CA

Elfgen, Mark: Fish Habitat Specialist, California Department of Fish & Game, Yreka Area Office, Yreka, CA

Glass, Robert: Archivist, National Archives and Records Administration, San Bruno, CA

Harper, Pat: Librarian, Siskiyou County Library, Yreka, CA

Hegenbart, Barbara: Librarian, Agriculture and Resource Economics Library, UC Davis, Davis, CA

Hendryx, Michael: Director, Siskiyou County Museum, Yreka, CA

Horney, Marc R., Ph.D.: Rangeland Management Specialist, USDA Natural Resource Conservation Service, Klamath Basin Watershed Office, Yreka, CA

Hull, Barbara (Meamber): daughter of a long-time pioneer (Meamber) family, dating back to Gus Meamber, 1852, Yreka, CA

Humphrey, Adrian R., SPN: Librarian, US Army Corps of Engineers, San Francisco District Office, San Francisco, CA

Jopson, Tom: Owner, CalForest Nursery, Etna, CA

Krum, Bill: President, Siskiyou Resource Conservation District, Etna, CA

Lewis, Alvin: Retired USDA Soil Conservation Service engineer and fifth [sixth?] generation resident of Scott Valley, Fort Jones, CA

Ly, Jason: Biologist, USDA Natural Resource Conservation Service, Klamath Basin Watershed Office, Yreka, CA

McFadin, Bryan: Water Resource Control Engineer, North Coast Regional Water Quality control Board, Santa Rosa, CA

Nealand, Daniel: Director, Archival Operations, National Archives and Records Administration, San Bruno, CA

Pimentel, Carolyn: District Manager, Siskiyou Resource Conservation District, Etna, CA

Scott, Neil: Flood control Engineer, Siskiyou County Department of Public Works, Yreka, CA

Sommarstrom, Sari, Ph.D.: Board Member, North Coast Regional Water Quality Control Board and Principal, Sari Sommarstrom & Associates, Watershed Planning and Management Consultants, Etna, CA

## Appendix E -- RipTopo Methods

The spatially explicit, riparian-topographic stream shading model RipTopo uses readily available geodata and existing algorithms to provide a simple surrogate index measure for stream shading conditions. The results of which are be aggregated at the reach, subwatershed, and watershed scale to depict generalized conditions. The geographic information system coding and computation is implemented in a variety of raster processors, including ArcInfo GRID, ArcView 3.x Spatial Analyst, and ArcGIS 9.x Spatial Analyst. The computations and methodologies are intended to be adaptable to any raster GIS and utilize existing spatial data. The basis for relying on readily available geodata is to make the model extensible and easily adapted by others. Similarly, the use of existing algorithms is intended to provide tools to local communities and resource managers at minimal expense. The RipTopo model correlates effective shade for a stream reach based on sun position on a given day, topography, stream location and orientation, the unvegetated channel width, and the distribution of vegetation types in the watershed. Scenarios can also be run, such as an adjusted potential height of mature vegetation.

This modeling exercise should be contrasted with other stream shading / stream temperature models that require specialized inputs and calibration. For example, riparian aquatic interaction simulator (Welty and others 2002) and similar models (Chen and others 1998a, Chen and others 1998b) require extensive local information and modifying parameters. Alternately, Stillwater Science Temperature Model (USEPA 1999) and Stream Network Temperature Model (Theurer and others 1984) use generalized spatial data to describe stream conditions; however, each of these models requires extensive onsite calibration for their respective outputs of stream temperatures. Indeed, the prediction of stream temperatures at any given location is highly variable given local microclimates, channel geometry, and proximity to aquifers. Each of these more detailed, physically-based models is site specific. This is especially true with next generation models, such as Heat Source, which can incorporate thermal infrared remote sensors (ODEQ 2000). Unfortunately, localized conditions are often both unknown or prohibitively expensive, in terms of time and monetary resources, to obtain at a watershed scale.

RipTopo is a macro-scale surrogate measure indexing model for stream shading on a spatially explicit basis. It is not intended to be an appropriate measure for all stream or river systems; however, it has been used effectively to show landscape level differences in condition that can be used to structure and prioritize further study and management activities. We acknowledge that while channel shading is not invariably a strong influence on stream temperatures per se, we do feel that it is one of the few components resource managers can effectively manage in some capacity. Furthermore, vegetative cover within adjacent riparian areas can influence channel microclimate by reducing wind speed and lowering air temperature; thus, this indexing method does not attempt to account for all the positive benefits achieved by managing riparian forest cover.

### *GIS Methods*

The summary method of RipTopo is to tabulate hourly sun angles on a surface depicting riparian cover and topography, minus stream cells at bankfull width (Figure 6). The underlying framework, or backbone, of RipTopo is a Digital Elevation Model (DEM). The United States Geological Survey (USGS) developed the DEM used in our research (see http://seamless.usgs.gov/ for data source); it has a nominal 10m-cell resolution. Several RipTopo calculations rely on the integrity of the DEM, thus every effort was made to identify and smooth

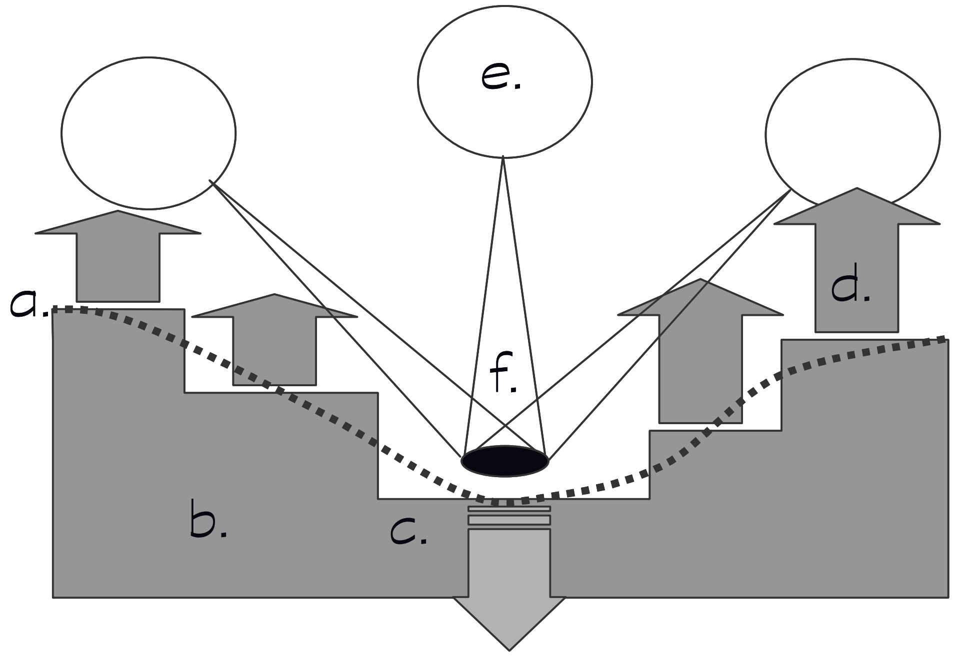


**Figure 6**. Schematic of RipTopo: a.) Cross-section of stream valley as characterized by b.) a Digital Elevation Model and c.) adjusted for stream bankfull width is the basis for d.) adding tree height from vegetation cover data to screen e.) hourly sun angles, which are f.) summed for each cell and summarized for each stream segment.

any errors, such as sinks or peaks, on a localized basis, as opposed to using comprehensive correction filters. This corrected DEM was used for creating inputs of flow direction and flow accumulation (Jenson and Domingue 1988), as well as the development of a hydrographic network (Tarboton and others 1991). The hydrographic network was segmented into tributary to tributary stream links as implemented in ArcInfo through the STREAMLINK algorithm (ESRI 2005). Segmentation of flow accumulation varied by the East-West zonation of the Scott River watershed (see Figure 1), where the minimum drainage area for stream initiation in the West zone was 160 acres and in the East zone was 640 acres.

Vegetative cover, in our case a vector polygon dataset developed by the United States Department of Agriculture – Forest Service known as CALVEG (CDF 2000), was converted to the same raster dimensionality as the DEM; the value attributed to each cell was based on a conversion of vegetation type and size class, reflecting existing tree size attributes, to a nominal tree height based on cross-walk values to create a current condition tree height grid (see Table 1). Tree heights are added to the elevation values of the DEM except for cells depicting streams at bankfull width and digitized roads.

Bankfull widths were assigned using a relationship for the Mendocino Coast developed with techniques and equations described in (Leopold 1964) and stream channel geometry information developed for Mendocino Coast streams (NCRWQCB 2000). Bankfull widths were calculated for all streams using an empirically derived power equation developed in the Scott River basin ($3.2003\alpha^{0.3629}$ ), where $\alpha$ is the upstream accumulative area (km$^2$) derived from the DEM using the flow accumulation algorithm in GRID. Each hydrographic vector element is attributed with accumulative upstream area and used as a seed for the bankfull width power equation. The bankfull width calculation results were in turn used to buffer hydrographic vector elements and then converted to raster data with the same resolution as the DEM. Similarly, vectors representing roads were converted to raster data with the DEM dimensionality.

RipTopo can be run for any given day; however, we chose to run the model for June 21$^{st}$, or summer solstice; it represents a date where the sun is at zenith position and at its maximum. As such, it also minimizes shade values. For any chosen day, hourly sun inclination angles and azimuth readings are incorporated into a pro-ratioed matrix to be used with the hill shade algorithm in GRID. Each hourly hill shade calculation is given parameters for solar azimuth and solar angle, converted from integer to a floating point numeric, pro-ratioed by the percent of available solar incidence for the hour (Boes 1981), summarized for each cell, standardizing by the maximum hill shade value possible, and subtracting the value from 1. The resulting surface is masked to stream cells within the bankfull width (Figure 3), smoothed with a 3 x 3 focal maximum function, and stretched minimum to maximum to represent shade scores from 0–10. A zonal summary of statistics is calculated for each stream link, which can also be summarized for subwatersheds and the focal watershed. The result is shade scores, such as mean, minimum and maximum index values, or coefficient of variation, for each incremental stream segment. Each is then available for further analysis.

The RipTopo process is summarized in Equation 1, where *H* is the hill shade algorithm with parameters for the azimuth (*Az*), zenith angle (α), and proportion of incoming radiation (*I*) are provided on an hourly basis (*i*) for *n* number of hours and standardized by the maximum hill shade value ($H_{max}$). The maximum value for the HILLSHADE algorithm is 255. This calculation is summarized for all hours of sunlight and subtracted from 1.0 to create a percent effective shade for the cell. The proportion of incoming radiation was calculated from (Boes 1981) for the months of June-August at 37˚ – 43˚ N latitude. The results for each cell were stretched from 0 – 10 by using a minimum – maximum stretch.

$$\left[1-\sum_{i}^{n}\left[\frac{H\left(Az_i{}^\circ,\alpha_i{}^\circ\right)*I_i}{H_{\max}}\right]\right]$$

**Equation 1**. Generalized RipTopo equation performed on a cell-by-cell basis.

## Appendix F -- Figures

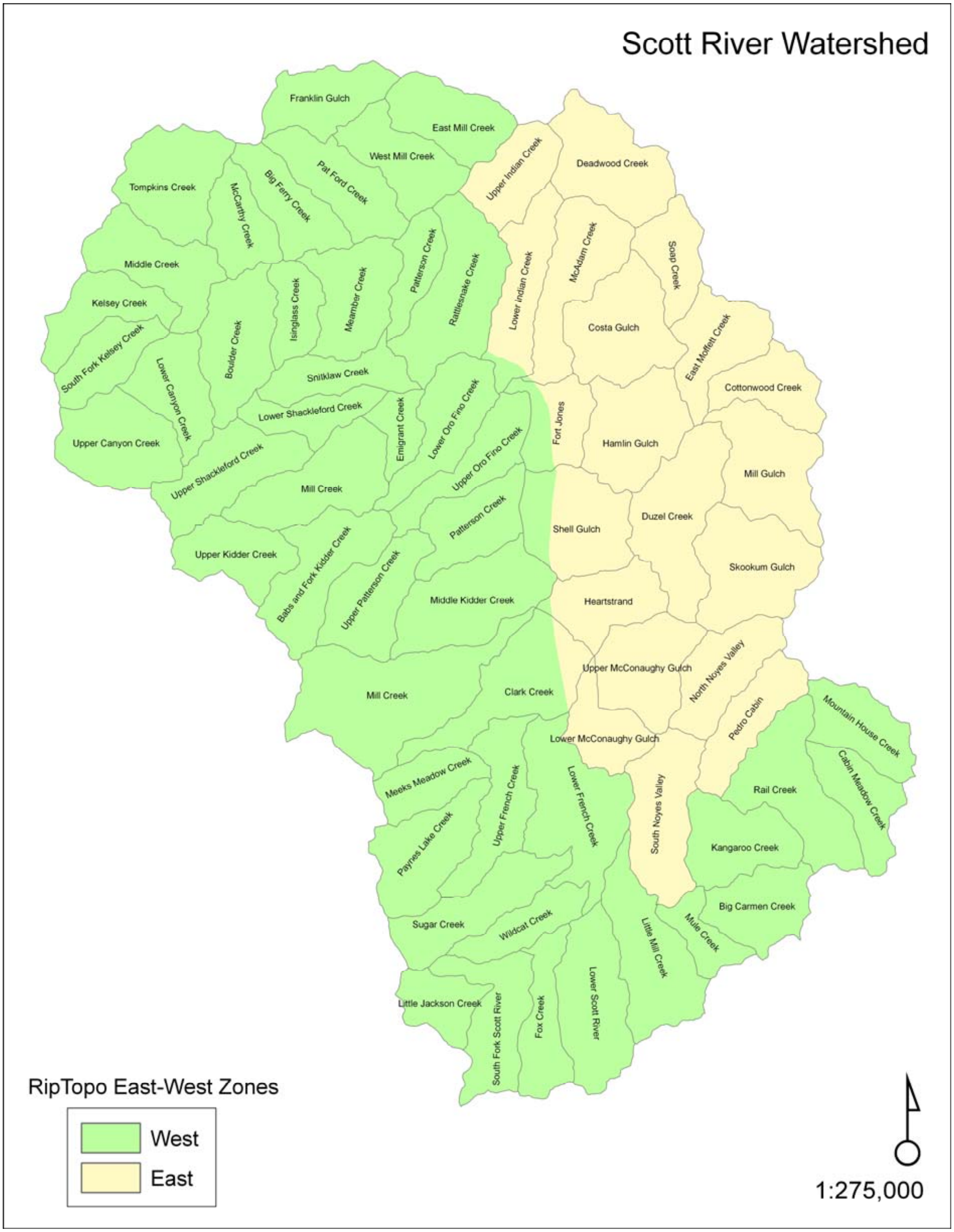


**Figure 1** East-West zonation of the Scott River watershed. Sub-watersheds were chosen based on expert opinion to either belong in the drier East zone (yellow) or wetter West zone (green).

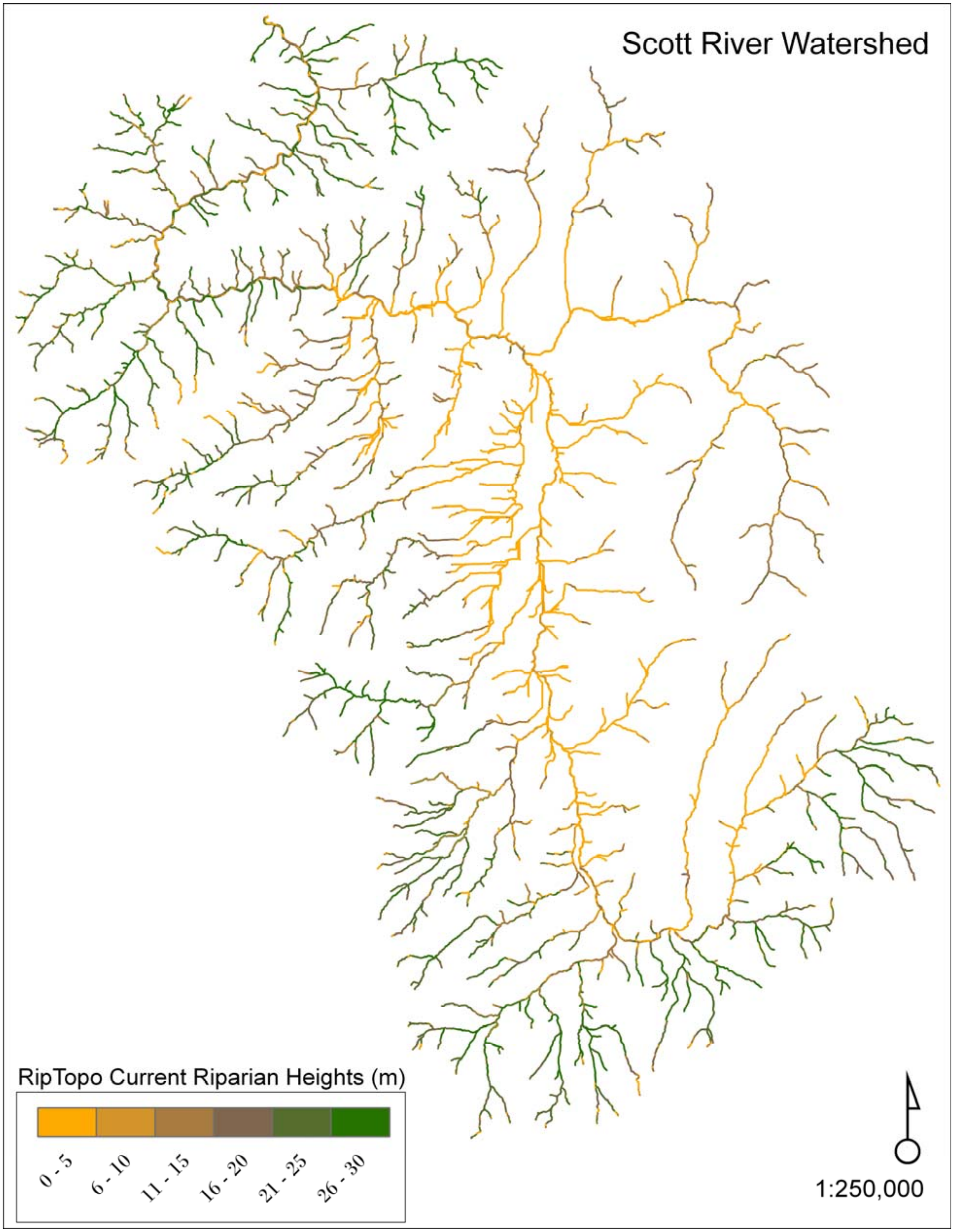


**Figure 2** Current height of riparian vegetation. Heights were calculated based on CALVEG size classes within the buffered channel area.

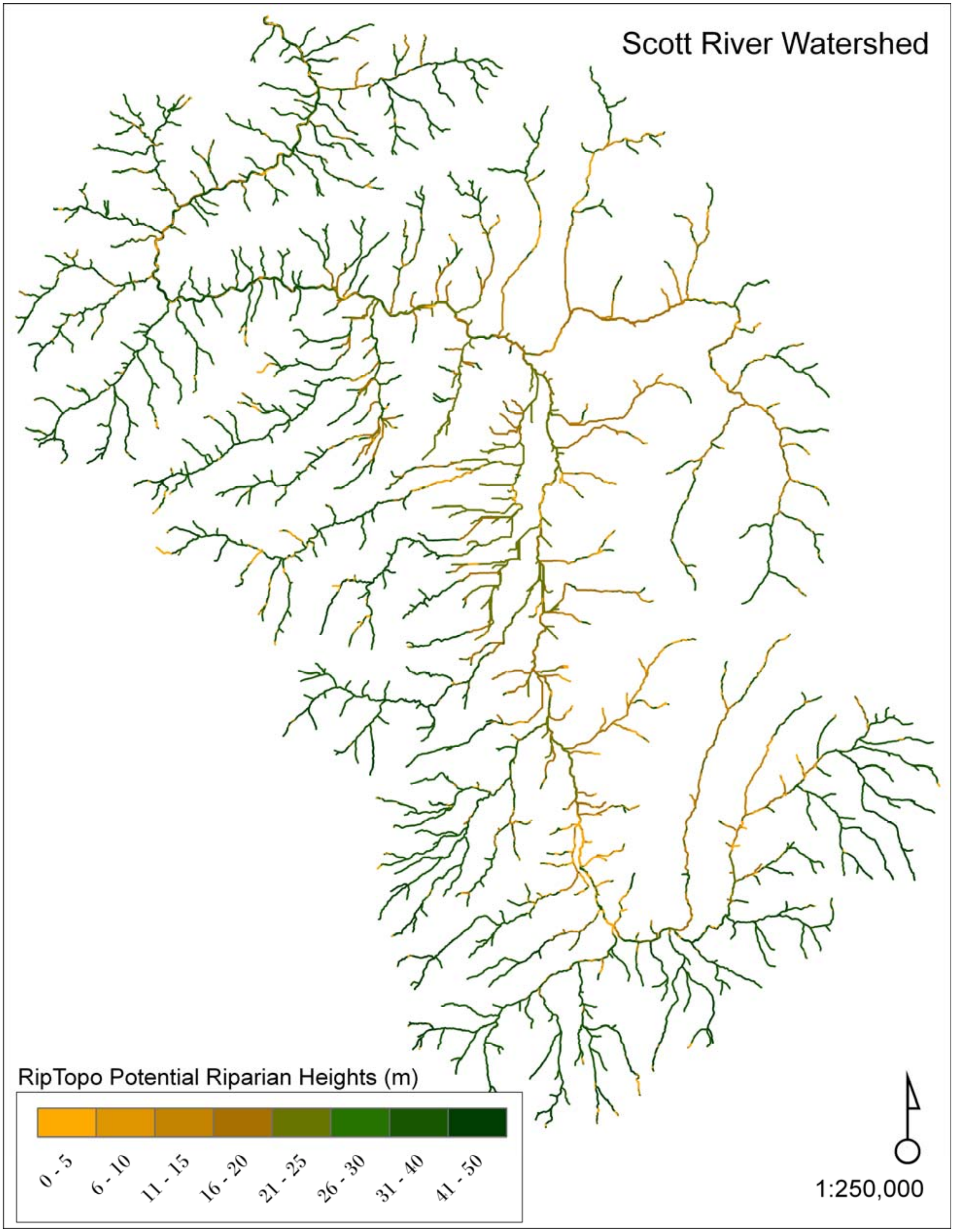


**Figure 3** Potential height of riparian vegetation – RipTopo input. Heights were estimated based on CALVEG distributions, expert opinion, and literature review for the buffered channel area.

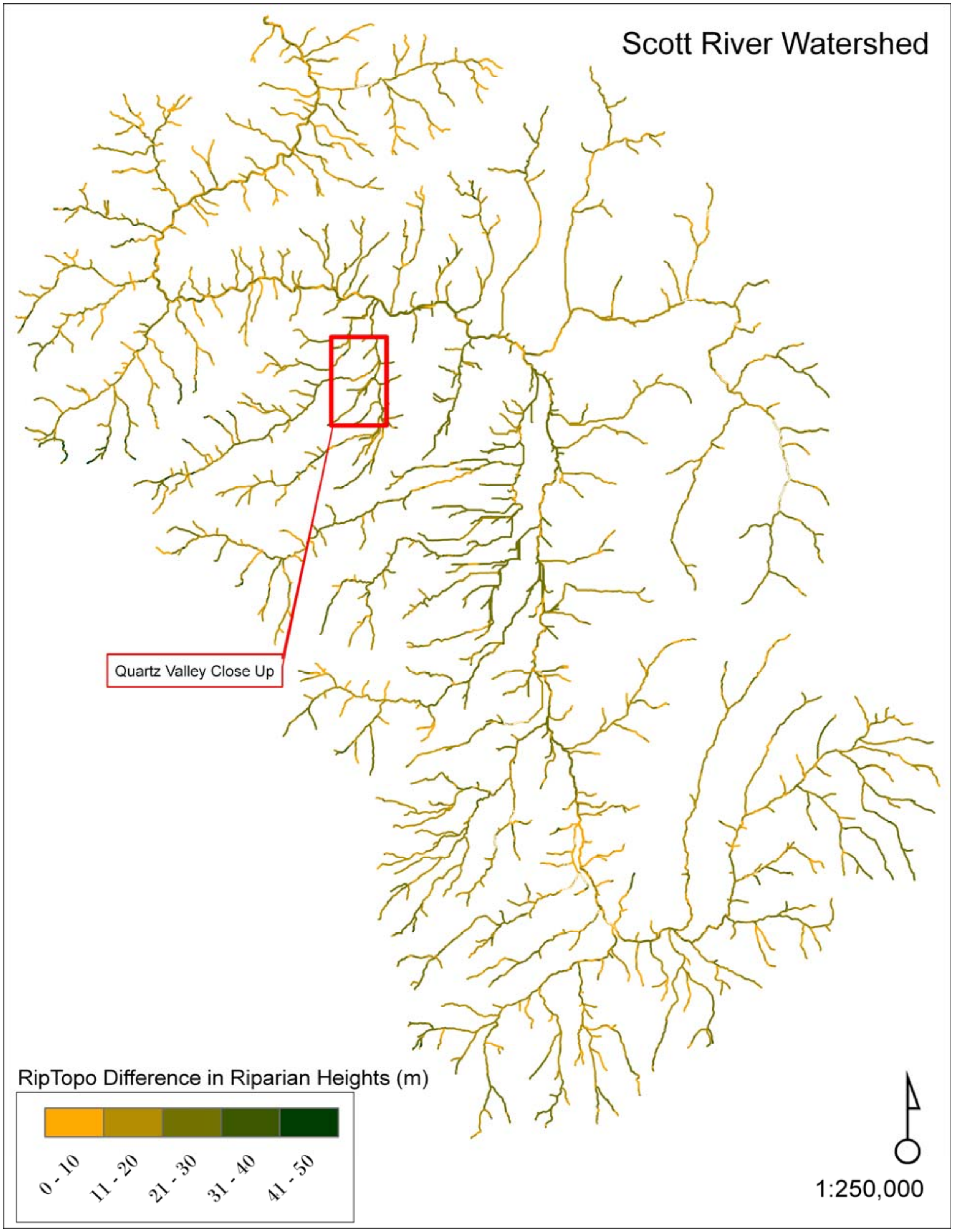


**Figure 4a** Difference between potential (Figure 3) and current (Figure 2) heights of riparian vegetation. Rectangular box indicates close-up area for Figures 4b & c.

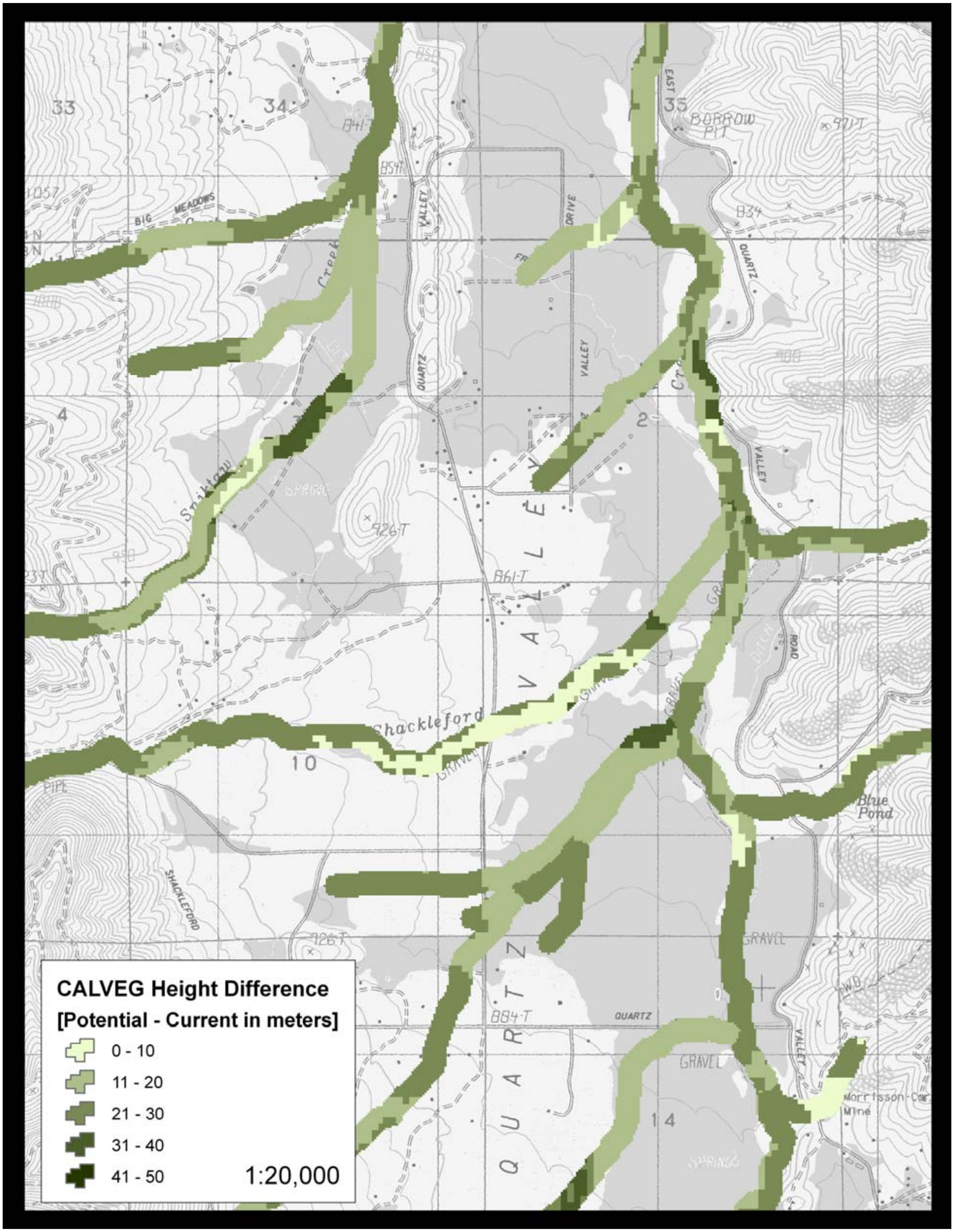


**Figure 4b** Difference between potential (Figure 3) and current (Figure 2) heights of riparian vegetation for Quartz Valley riparian areas (DRG background).

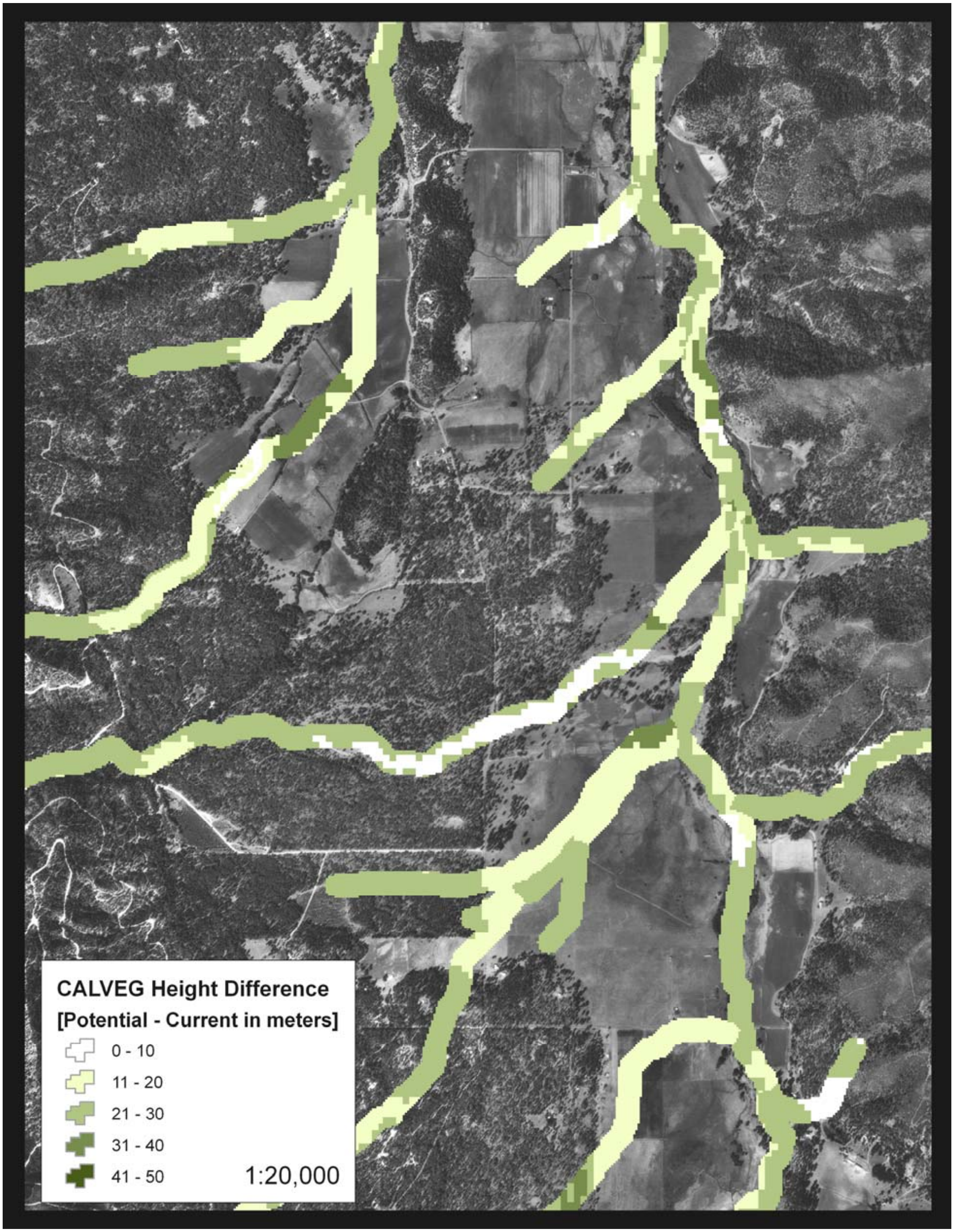


**Figure 4c** Difference between potential (Figure 3) and current (Figure 2) heights of riparian vegetation for Quartz Valley riparian areas (DOQQ background).

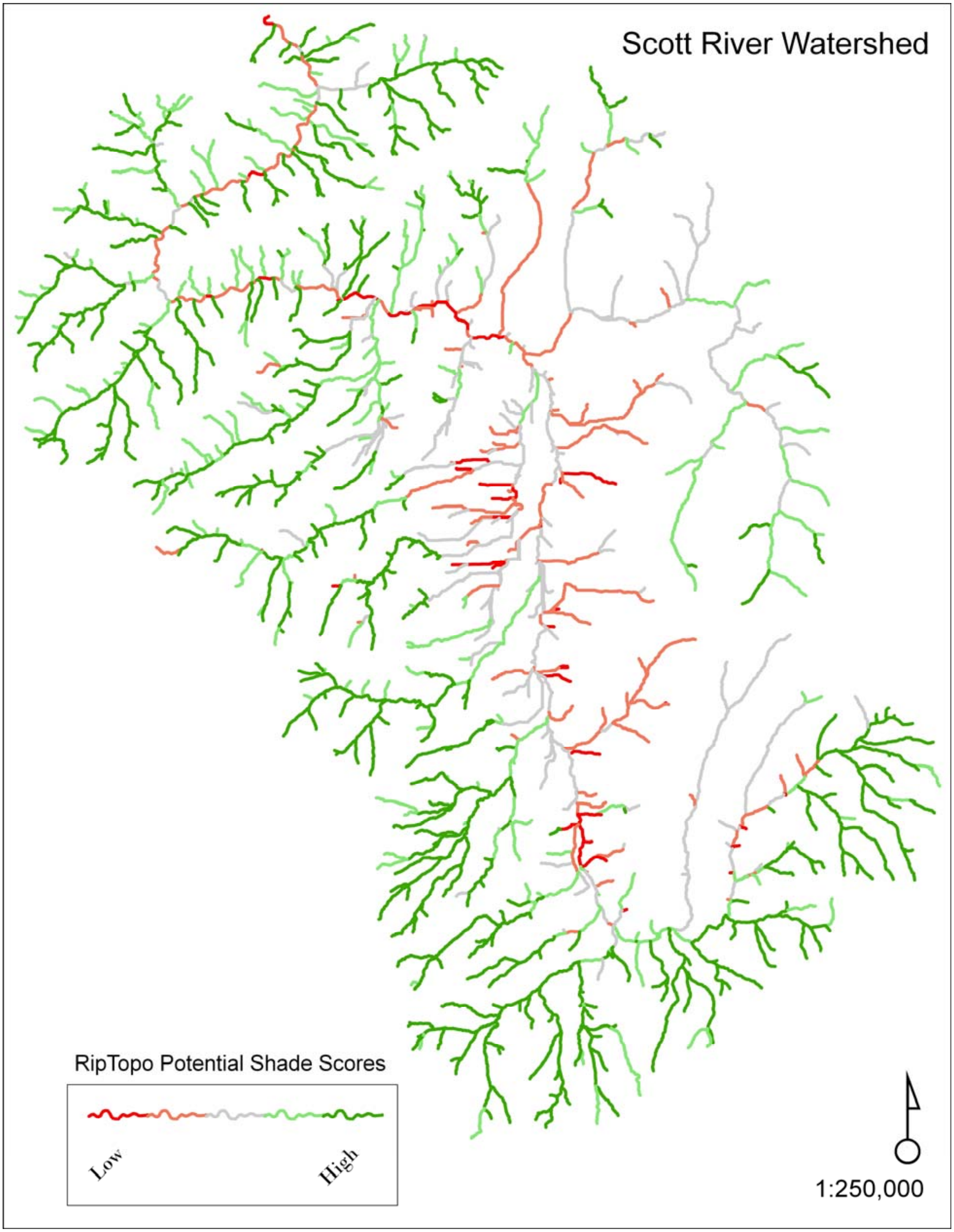


**Figure 5** Calculated channel shade based on potential riparian vegetation heights. Red indicates low shading of the channel surface, green indicates higher shading of the channel.