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Gualala River Prioritization Assessment Report

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Prepared for:

CALIFORNIA WATER BOARDS
State Water Resources Control Board

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Introduction

This report was contracted to Sonoma Resource Conservation District (SRCD) to provide technical support to the North Coast Water Board in its development of components of the Gualala Total Maximum Daily Load (TMDL) Action Plan Implementation Program. It is the third of four technical reports developed to support this effort. Where the *Prioritization Framework Report* described the development and structure of the prioritization methodology, this report presents the application of that framework and summarizes the resulting spatial patterns and subwatershed rankings.

A component of the program is to provide landowners in the Gualala River Watershed with road assessments to address erosion and sediment delivery to watercourses. The SRCD, with input from a Technical Advisory Committee, developed a framework to prioritize sub-watersheds within the Gualala River Watershed for road assessments and this report highlights the cumulative watershed scores from the prioritization analysis. This prioritization is intended to serve as a resource and land management tool for landowners and others in the watershed. It also may guide decision-making on how state contract funds are allocated to landowners who choose to participate in these North Coast Water Board supported road assessments if interest exceeds available capacity.

The prioritization results are a technical, non-regulatory resource to support land management decisions within the Gualala River Watershed. It does not impose or alter any regulatory requirements. Rather, it is intended as a tool available to landowners, watershed partners, agencies, and other entities to support informed decision-making for land management and water quality protection within the watershed. Results should be interpreted as relative indicators of priority to assess road-related sediment delivery conditions rather than absolute measures of watershed condition.

There are various landscape and watershed attributes that contribute to erosion and sediment loading of downstream rivers. The methods used to quantify and weight these attributes are described in detail in the *Prioritization Framework Report*; however, this report summarizes those inputs and focuses on the resulting distribution of scores across the watershed. The attributes were normalized to a score between 0-1 to understand the relative importance compared across different metrics. A metric weight was applied to the individual scores to represent the significance in watershed health and beneficial uses. The sum of the weighted metrics provides the subwatersheds' total score.

Watershed/Landscape Attributes Descriptions and Rationale:

Subwatershed Boundaries:

The Gualala River Watershed was divided into subwatersheds by using the California Interagency Watershed Map version 2.2.1 (Calwater). By using the Calwater 2.2.1 Hydrologic Planning Watershed scale, the Gualala watershed was divided into 29 subwatersheds (Figure 1). These subwatersheds serve as the unit of analysis for presenting results and comparing relative conditions across the watershed.

Figure 1. Subwatersheds used for prioritization

Revised Universal Soil Loss Equation (RUSLE):

The Revised Universal Soil Loss Equation (RUSLE) is an empirical equation to model soil erosion and is a multi-criteria analysis based on five distinct factors: rainfall erosivity, soil erodibility, slope length and steepness, vegetation cover, and land use and farmland state. Soil loss is the product of these five factors, and results reflect annual soil loss in tons per hectare per year.

- Rainfall Erosivity (R)[1]: evaluates the erosion potential from kinetic energy of rainfall impact and runoff (Figure 2). The results highlight rainfall erosivity is most prominent in the southeast watershed (Pepperwood Creek, Britain Creek, Wolf Creek, and Tombs Creek), decreasing further north in the Gualala watershed. Big Pepperwood Creek, Doty Creek, Robinson Creek, Stewart Creek, Billings Creek, and Upper Rockpile Creek experience the least rainfall erosivity.

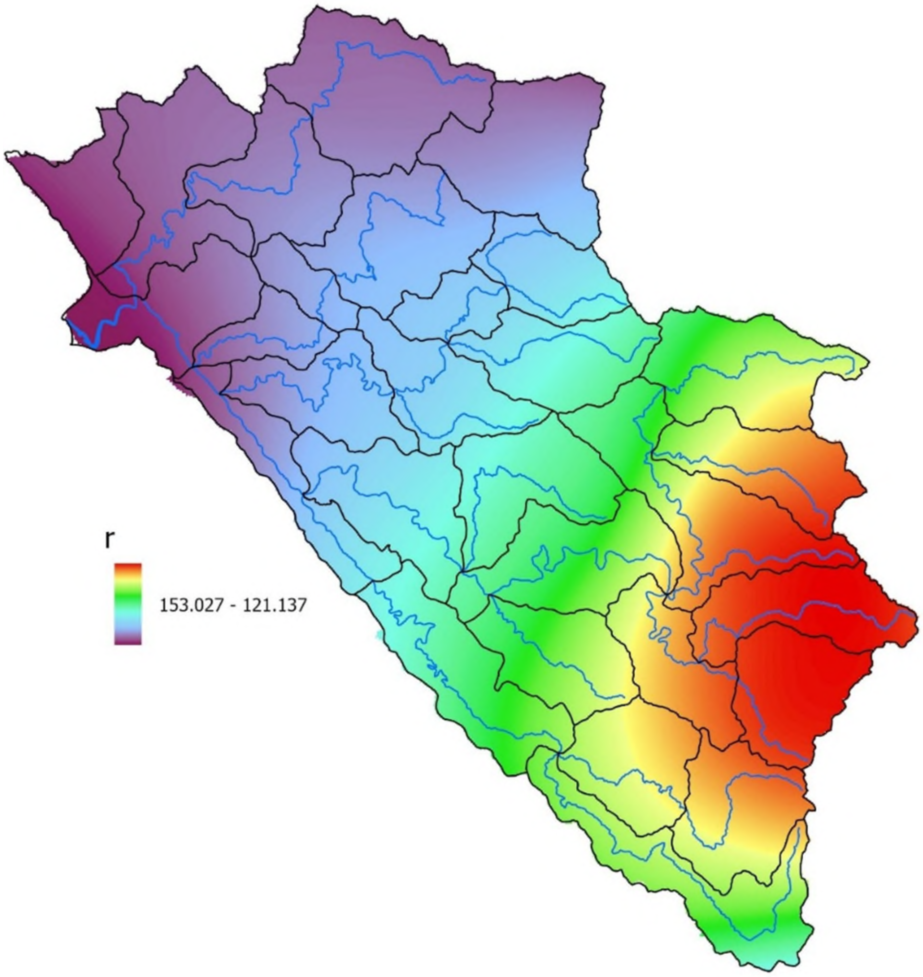

Figure 2. Rainfall erosivity (R) used for the RUSLE calculation

- Soil Erodibility (K)[2]: Represents the soil's vulnerability to erosion by rainfall and runoff. The results show a relative inverse from rainfall erosivity and highlight northern subwatersheds have the highest potential for soil erodibility under this consideration (Figure 3). Subwatersheds showing the highest erodibility are Stewart Creek, Robinson Creek, Red Rock, and large parts of Big Pepperwood Creek, Middle Rockpile Creek. There are specific areas within the Mouth of Gualala River, Upper Rockpile Creek, and Britain Creek that also indicate high soil erodibility.

[1] https://data.noaa.gov/metaview/page?xml=NOAA/nos/ocm//iso/xml/48224.xml&view=getDataView&header=none

[2] https://www.arcgis.com/home/item.html?id=ac1bc7c30bd4455e85f01fc51055e586

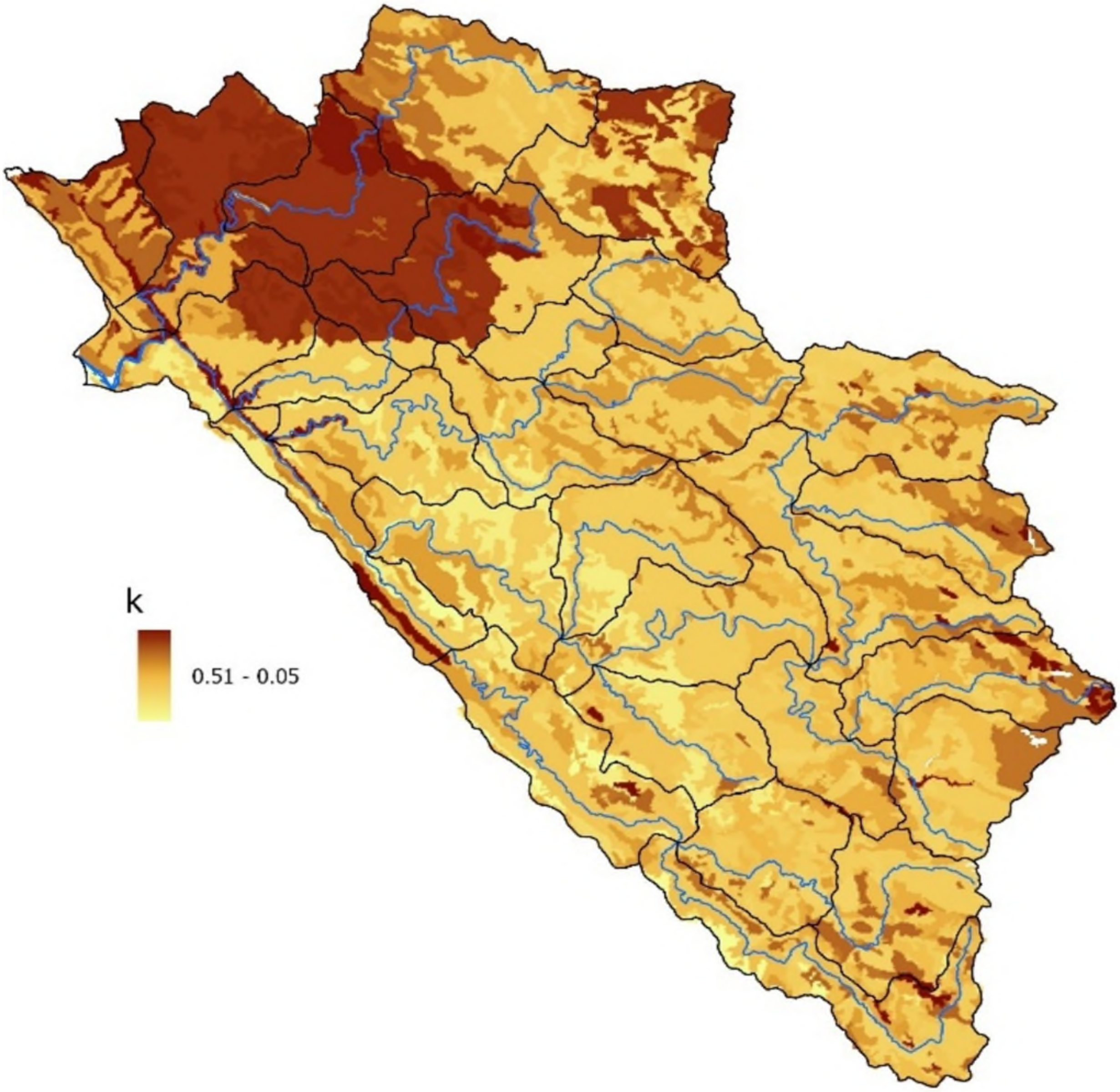

Figure 3. Soil erodibility factor (k) used in RUSLE calculation

- Slope Length and Steepness (LS)[3]: Reflects the effect of topography on soil erosion as the combination of total length and angle of slopes. It is derived from the flow accumulation and slope layers. Higher LS values appear on steep hillslopes, and lower values appear on both ridgetops and valley bottoms. Values vary at the hillslope scale (see inset), but are generally higher in areas with steeper terrain and longer slope lengths (Figure 4).

[3] https://apps.nationalmap.gov/downloader/

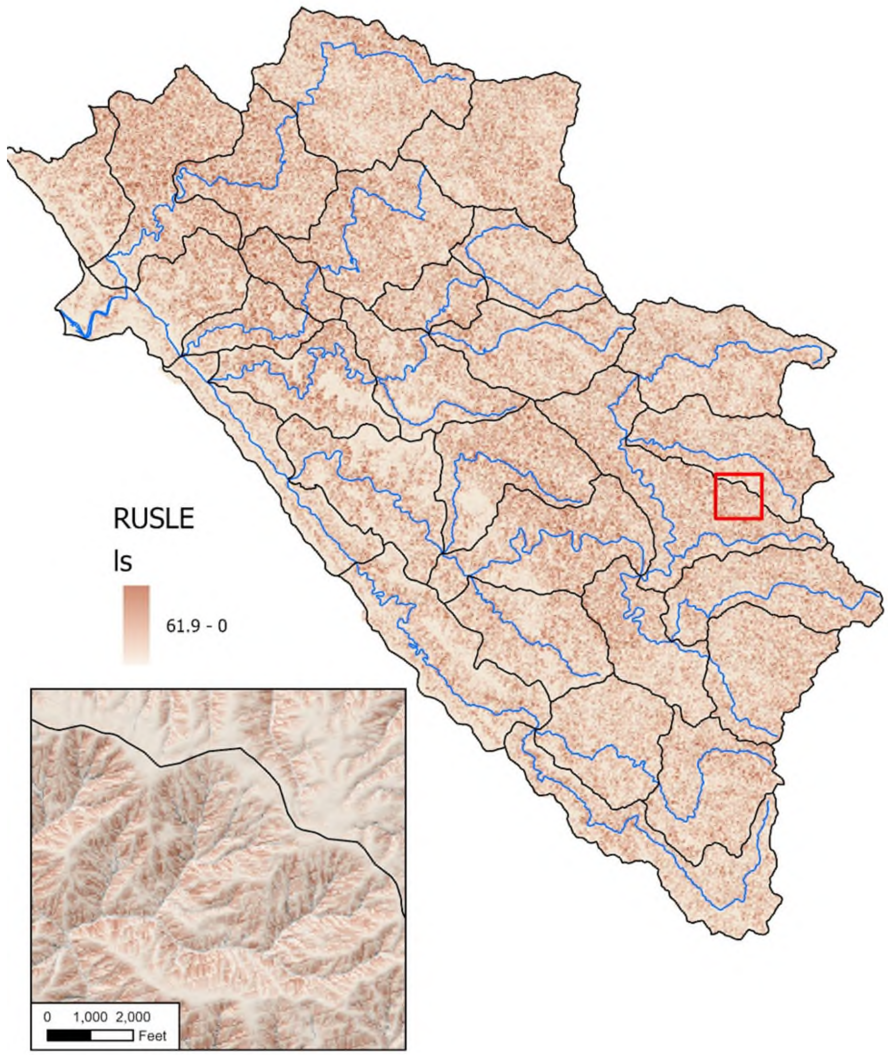

Figure 4. Length-Slope factor used in RUSLE calculation

- Vegetation Cover (C)[4]: Canopy cover helps dissipate the kinetic energy of rainfall and roots play a major role in increasing soil cohesion. In essence, more dense vegetation cover will result in lower rates of soil erosion. The Eastern areas of the Gualala River watershed have the least vegetation cover comparatively (Figure 5). Subwatersheds highlighted for potential soil erosion due to limited vegetation cover include Haupt Creek, Lower Marshall Creek, Pepperwood Creek, Britain Creek, Wolf Creek, Tombs Creek, and parts of Buck Mountain, North Fork Osser Creek, and Billings Creek.

[4] https://www.arcgis.com/home/item.html?id=fd61b9e0c69c4e14bebd50a9a968348c

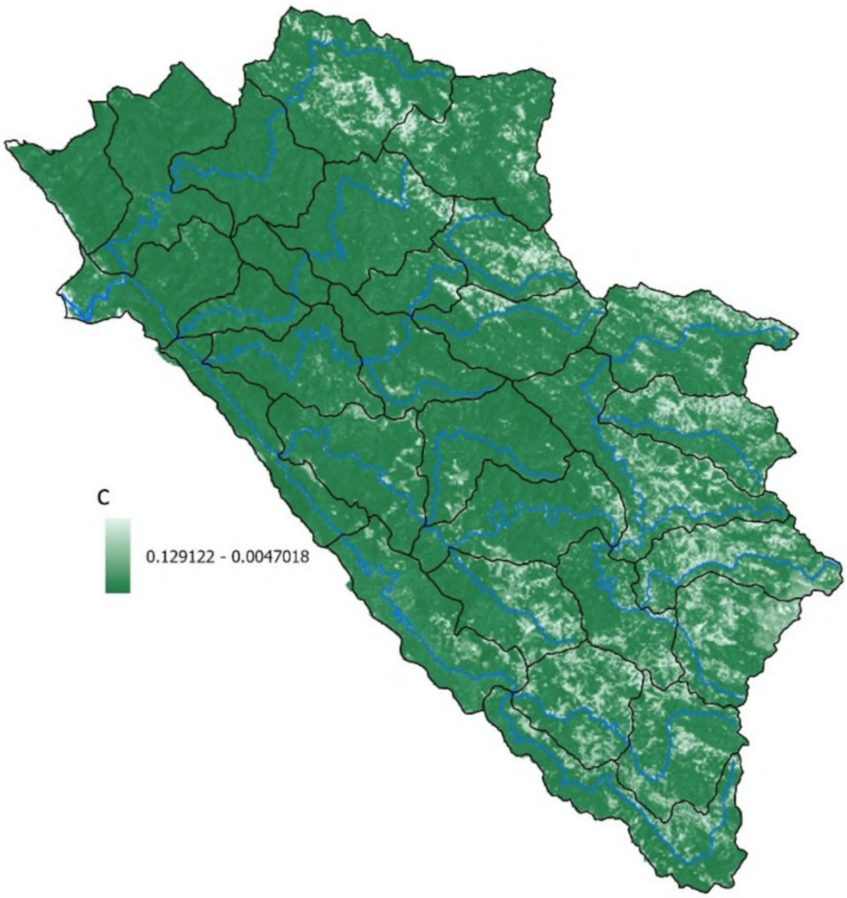

Figure 5. Landcover (c) factor used in RUSLE calculation

- Land Use and Farmland State (P)[5]: This data set estimates the effects that different types of land use and farming practices have on the amount of runoff and therefore the rate of soil erosion. The equation utilized the Farmland Mapping and Monitoring Program dataset and assigned P factor values based on this table:

Land Use	P factor
Forest and Rangeland	1
Unique Farmland	0.75
Farmland of local importance	0.5
Urban and Water	0

Table 1. Land use types in Gualala River Watershed and corresponding P Factor value

The results highlight this dataset as a non-contributing factor to the assessment analysis as all subwatersheds score relatively the same with only a few minor differences across the Gualala River Watershed (Figure 6). This is expected as a small percent of the watershed is urbanized or used for farmland. Variability in timber or grazing operation methods and intensity may impact

[5] https://gis.conservation.ca.gov/portal/home/search.html?q=FMMP

the P factor by altering runoff process, but spatially explicit management specific data were not consistently available across the watershed. Land use specific to a parcel should be noted when conducting field-based assessments. While the land use (P) factor showed minimal variation across subwatersheds and therefore had limited influence on results, other factors, such as rainfall, vegetation, and slope, drive the observed spatial variability in RUSLE score.

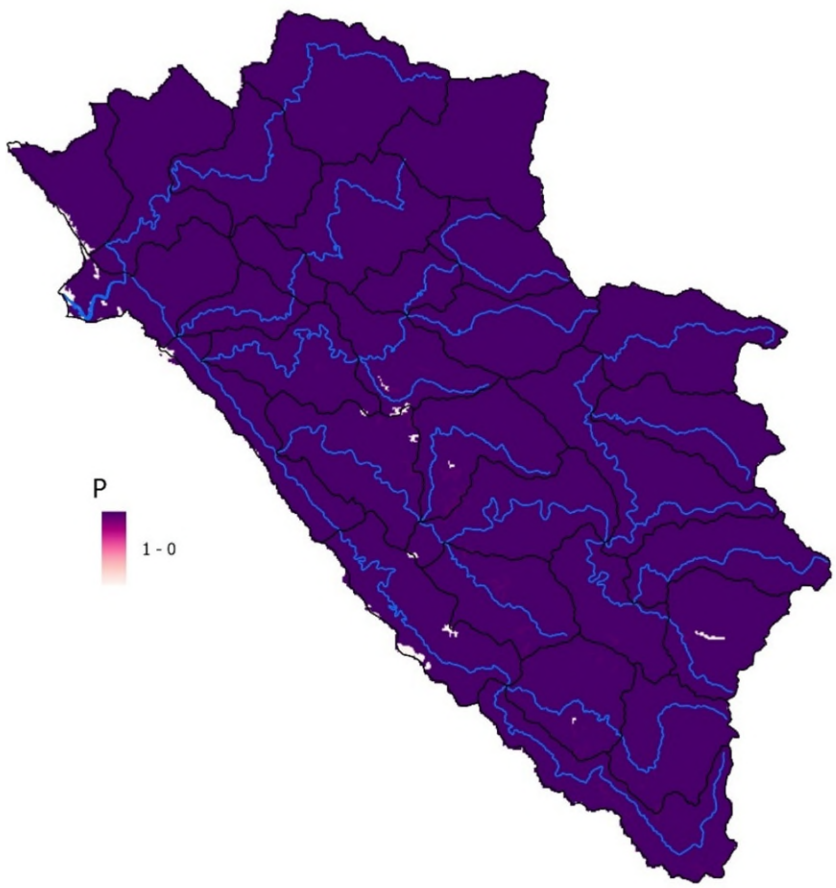

Figure 6. Land Use (P) used in RUSLE calculations

RUSLE Method of Scoring:

The values of each individual RUSLE characteristic were multiplied together in the formula A = RKLSCP, where A equals cumulative ton of soil lost per hectacre per year. The RUSLE metric was given a weight of 2 towards the final input in the total subwatershed score. RUSLE values vary across the watershed, with lower values generally in the western watershed and higher values in the southeastern portion (Figure 7). The southeastern portion of the watershed has higher rainfall, and lower vegetation cover. This portion of the basin covers a small area of the Cedars, which is a serpentine geologic formation with naturally low vegetation cover and high erodibility.

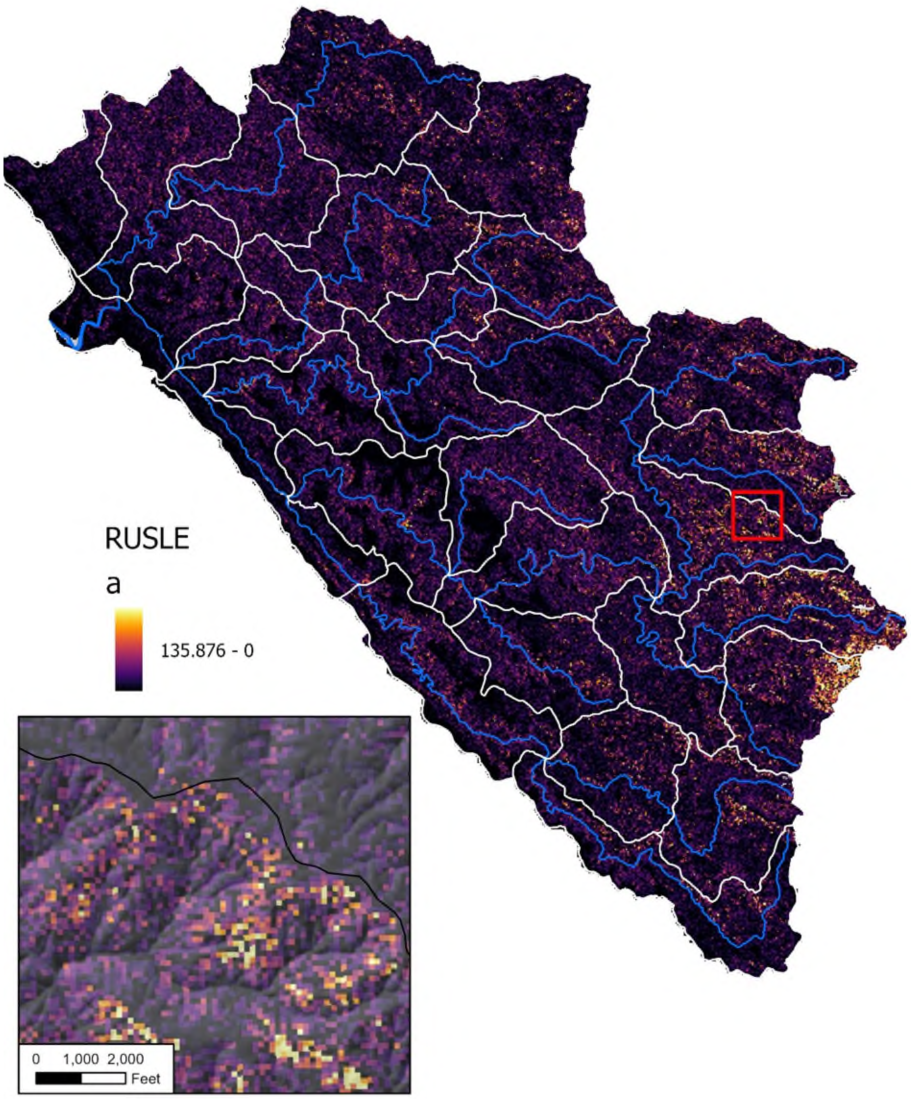

Figure 7. Results (A) of RUSLE calculations

Salmonid Population Distribution:
Salmonids are a key indicator species of water and physical habitat quality in the Gualala River watershed. Their presence and abundance are an indicator of habitat suitability for many species including invertebrates and amphibians. Historical accounts by the Kashia Band of Pomo Indians indicate that salmonid presence was widely distributed throughout the watershed and therefore the relative amount of potential salmonid habitat for both Coho Salmon and Steelhead trout was used as an indicator of the ecological importance of a subwatershed.

Method of scoring:
Subwatersheds were evaluated by length of stream representing potential habitat within each basin. The Coho Salmon Intrinsic Potential – Central California Coast[6] dataset was developed by NOAA and provides an estimate for the spatial distribution of intrinsic potential habitat for the Central California Coast Coho Salmon and Steelhead trout utilized in recovery planning (Figure 8). Datasets for current distribution are not currently conducted watershed wide, and restoration and improvements to water quality would increase the distribution to streams with intrinsic potential and therefore make

[6] https://services2.arcgis.com/Uq9r85Potqm3MfRV/arcgis/rest/services/biosds2785_fnu/FeatureServer

improvements more vital to recovery efforts. Subwatersheds with greater normalized lengths of intrinsic habitat scored higher, indicating areas where sediment reduction efforts could provide greater ecological benefit. These results prioritize locations where physical processes and biological sensitivity intersect. A higher weight was applied to Coho Salmon due to being federally listed as Endangered under the Endangered Species Act versus a Threatened designation for Steelhead.

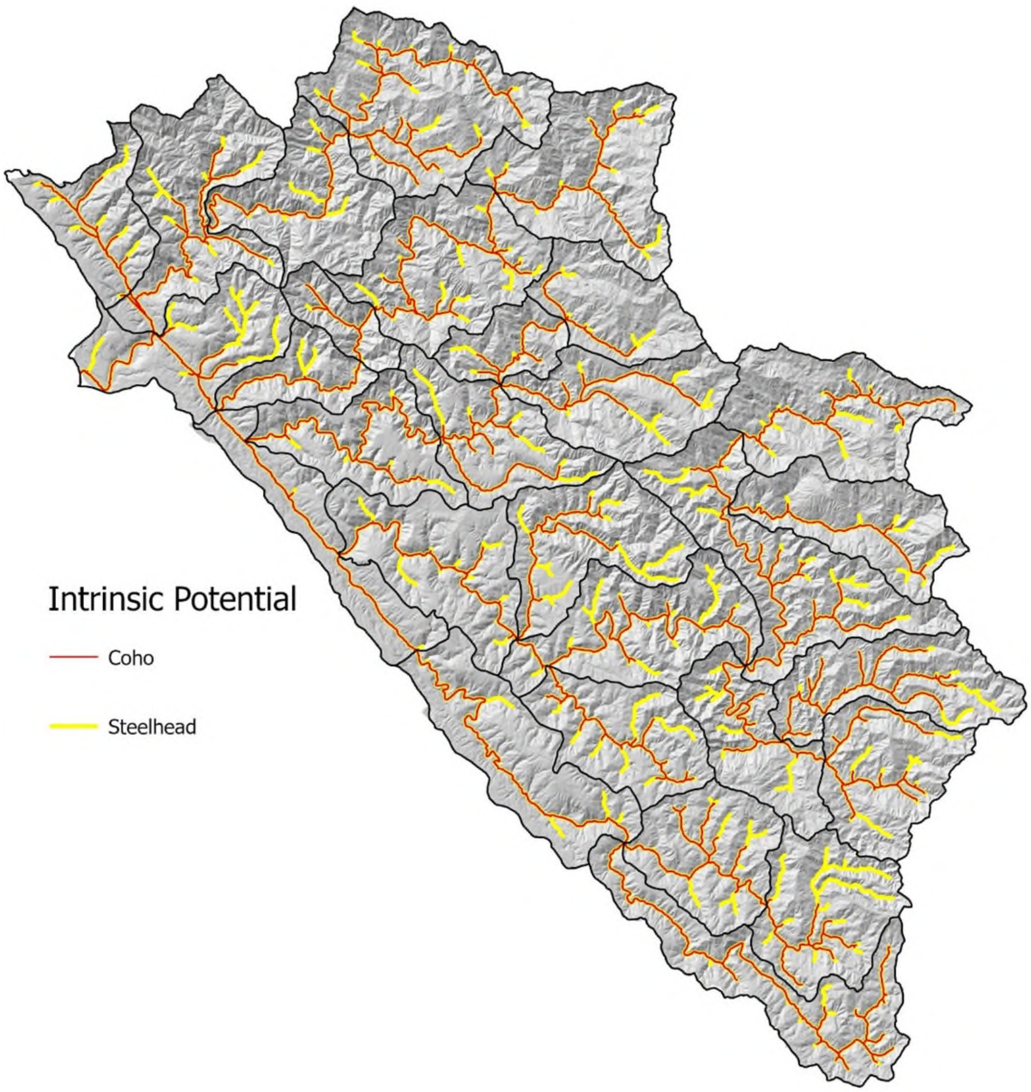

Figure 8. Map of stream lengths with intrinsic potential for Coho Salmon and Steelhead trout habitat

Central California Coast Coho Salmon - the subwatershed scores were calculated as the length of stream representing potential habitat relative to the total subwatershed area. Subwatershed total scores were normalized to a final score between 0-1 and then multiplied by the metric weight of 4 to give a final input into the overall subwatershed score.

Northern California Steelhead trout – length of habitat overlaps with all Coho habitat and extends higher into farther the headwaters. The subwatershed scores were the length of stream representing potential habitat normalized by the size of the subwatershed. Subwatershed scores were normalized to a final score between 0-1 and then multiplied by the metric weight of 3 to give a final input into the overall subwatershed score.

Landslide Potential:
Landslides act as one of the primary drivers of sediment loading within a watershed. By introducing vast volumes of rock, soil, and organic debris rapidly into stream channels, they can also trigger severe secondary impacts that can persist for decades. These spatial patterns highlight areas where sediment inputs may occur episodically but at high magnitude, complementing the more chronic erosion patterns captured by RUSLE.

<u>Method of Scoring:</u>
Data were collected from the [California Department of Conservation – Gualala River Watershed Maps and Data](https://www.conservation.ca.gov/cgs/fwg/maps/gualala)[7] which estimated relative landslide potential within the watershed. Values were averaged within the watershed subbasins and then normalized to a value between 0-1. Landslide potential was given a metric weight of 2 to give a final input into the overall subwatershed score.

Subwatersheds that showed areas with high potential for landslides include Lower Marshall Creek, Upper Marshall Creek, House Creek, Tombs Creek, Buck Mountain, and areas of Upper Rockpile Creek and Middle Rockpile Creek (Figure 9). Subwatersheds near the ocean on the western side of the Gualala River Watershed show the least landslide potential comparatively.

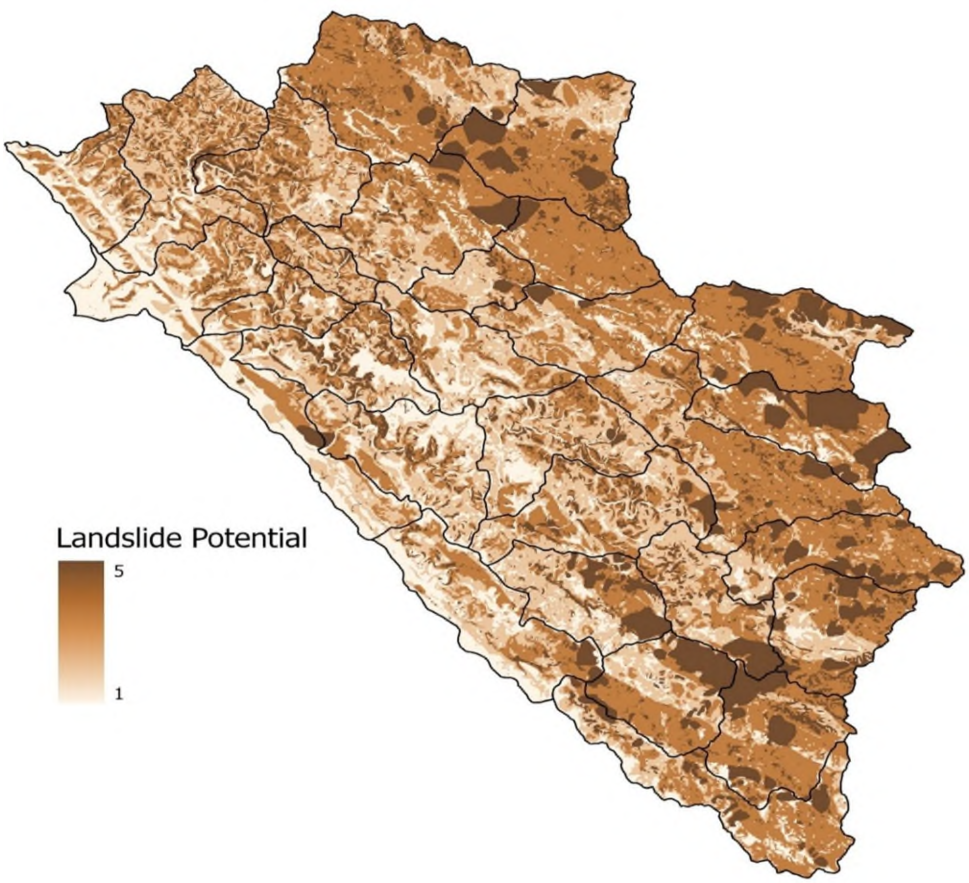

Figure 9. Map illustrating landslide potential used for subwatershed scoring

[7] https://www.conservation.ca.gov/cgs/fwg/maps/gualala

Surface Water Diversions:

Surface water diversions were used as a measure of human use of water in a subwatershed. Registered diversions are likely an undercount of true surface water use as many water uses are not registered.

Method of Scoring:

Data was collected from the California State Water Resources Control Board's Division of Water Rights which tracks all registered points of diversion in the State. The spatial and attribute information are maintained in the electronic [Water Rights Information Management System (eWRIMS)][8]. Each subwatershed contained a number of diversions that was normalized by the size of the watershed and scaled to a score between 0-1. Surface water diversions were given a metric weight of 1 so the normalized score is the value added to the subwatershed's total score.

Results indicate that diversion density is generally higher in western subwatersheds, with localized concentrations in areas such as Big Pepperwood Creek and Robinson Creek, as well as isolated higher values in eastern subwatersheds like Britain Creek (Figure 10). There are a smaller number of diversions in Upper South Fork Gualala River, House Creek, Doty Creek, and Annapolis.

Figure 10. Map showing locations of surface water diversions

[8] https://www.arcgis.com/home/item.html?id=377ec16dde834ecd9f0d0024bc7b6fc4

Subwatershed Total Score:

Each metric varies spatially across the watershed. To vary the relative importance between metrics, weights were applied. The scores for each individual metric were normalized to values between 0-1, with 1 being the highest score within the dataset. The normalized scores were then multiplied by metric weight and summed to give a total score for each subwatershed. Finally, the total score was normalized to values between 0-100 (Table 2).

The resulting scores represent the integrated effects of erosion processes, landscape susceptibility, and ecological sensitivity. The distribution of total scores reveals priority subwatersheds across the basin, with higher-scoring subwatersheds reflecting areas where multiple risk factors overlap. The results map (Figure 11) and table (Table 3) illustrate these patterns and provide a basis for identifying high-, medium-, and lower-priority subwatersheds for road assessment efforts.

The highest-ranking subwatersheds include Britain Creek, Upper South Fork Gualala River, Little Creek, and Lower Rockpile Creek, reflecting areas where multiple high-value factors overlap, such as elevated erosion potential, relatively high salmonid habitat availability, and moderate to high landslide susceptibility. These top-ranked areas tend to occur in the central and southeastern portions of the watershed, where combinations of higher rainfall-driven erosion (RUSLE), lower vegetation cover, and relatively high salmonid potential produce consistently higher cumulative scores.

Mid-priority subwatersheds represent areas where one or two key risk factors are present. Examples include House Creek, Tobacco Creek, and Grasshopper Creek, which demonstrate moderate erosion potential and salmonid potential but lower overall cumulative influence compared to top-ranked basins. The lowest-scoring subwatersheds such as Annapolis, Upper Rockpile Creek, and North Fork Osser Creek indicate areas where there are generally lower scoring metrics, representing limited habitat potential and lower sediment generating processes.

Table 2. Metric weights and formulas for normalization and subwatershed combined scores

Metric (M)	Weight (W)	Description
Coho Habitat Length	4	Length of potential coho habitat from IP model normalized by subwateshed area
Steelhead Habitat Length	3	Length of potential steelhead habitat from IP model normalized by subwateshed area
RUSLE	2	Revised Universal Soil Losss Equation Soil loss (A) = Rainfall Erosivitiy (R) x Soil Erodibility (K) x Slope Length and Steepness (LS) x Vegetation Cover (C) x Landuse (P)
Landslide Potential	2	Relative landslide potential
Diversions	1	Count of registered diversions
Normalized Metric (M')	$M' = \frac{M - M_{min}}{M_{max} - M_{min}}$	Each metric normalized, 0-1
Final Subwatershed Score (S)	$S = \sum_{i=1}^{n} M'_i \; W_i$	For each subwatershed, the normalized metric is multipled by the weight, and the final score is sum of values. The Score is normalized 0-100.

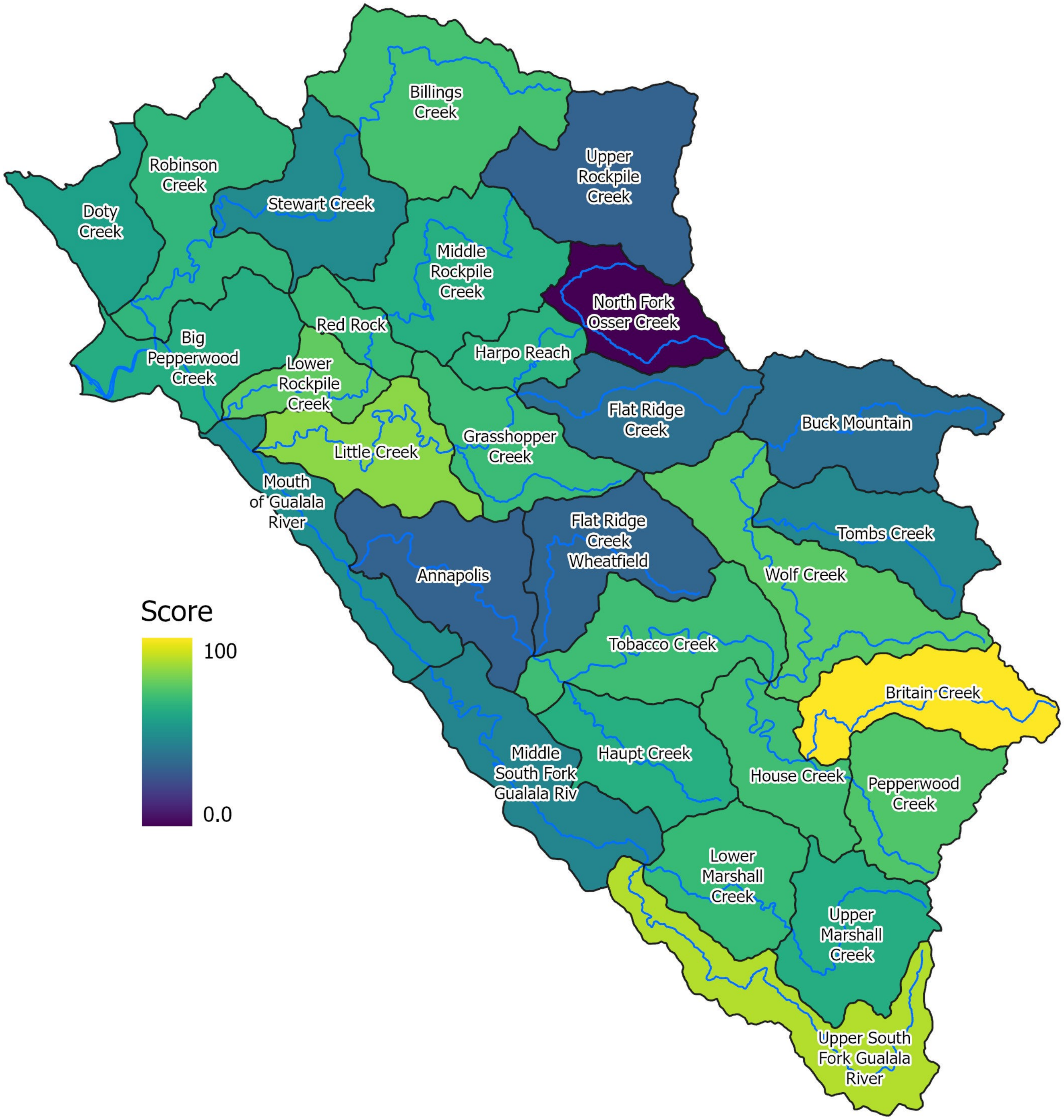

Figure 11. Map showing total scores by subwatersheds.

Table 3. Metrics and final score values for each subwatershed.

Region	Subwatershed	Coho	Steelhead	RUSLE	Landslide Potential	Diversions	Score (weighted)	Score (scaled)
Wheatfield Fork	Britain Creek	0.92	0.98	1.00	0.57	0.22	9.98	100.00
Gualala	Upper South Fork Gualala River	1.00	0.82	0.34	0.74	0.32	8.94	88.62
Buckeye Creek	Little Creek	0.94	0.84	0.17	0.84	0.10	8.40	82.71
Rockpile Creek	Lower Rockpile Creek	0.74	0.86	0.22	0.84	0.10	7.76	75.71
Wheatfield Fork	Wolf Creek	0.70	0.87	0.68	0.43	0.00	7.63	74.29
Wheatfield Fork	Pepperwood Creek	0.58	0.73	0.80	0.62	0.09	7.44	72.21
North Fork	Billings Creek	0.78	0.74	0.46	0.44	0.17	7.31	70.79
Wheatfield Fork	House Creek	0.54	0.80	0.46	0.61	0.50	7.20	69.58
Wheatfield Fork	Tobacco Creek	0.60	0.82	0.36	0.71	0.15	7.15	69.04
Buckeye Creek	Grasshopper Creek	0.70	0.94	0.17	0.54	0.00	7.04	67.83
Gualala	Lower Marshall Creek	0.66	0.84	0.46	0.40	0.10	6.98	67.18
Rockpile Creek	Red Rock	0.69	0.48	0.56	0.85	0.00	7.02	67.61
North Fork	Robinson Creek	0.51	0.52	0.53	0.91	0.37	6.85	65.75
Buckeye Creek	Harpo Reach	0.76	0.74	0.34	0.37	0.00	6.68	63.89
Rockpile Creek	Middle Rockpile Creek	0.63	0.73	0.52	0.38	0.00	6.51	62.04
Wheatfield Fork	Haupt Creek	0.45	0.78	0.34	0.82	0.05	6.51	62.04
Gualala	Big Pepperwood Creek	0.40	1.00	0.15	0.62	0.36	6.50	61.93
Gualala	Upper Marshall Creek	0.23	0.98	0.55	0.74	0.09	6.53	62.25
North Fork	Doty Creek	0.45	0.63	0.25	0.78	0.25	6.00	56.46
Gualala	Mouth of Gualala River	0.56	0.32	0.00	0.60	1.00	5.40	49.89
North Fork	Stewart Creek	0.26	0.31	0.59	1.00	0.04	5.19	47.59
Wheatfield Fork	Tombs Creek	0.22	0.32	0.79	0.82	0.00	5.06	46.17
Gualala	Middle South Fork Gualala Riv	0.42	0.36	0.20	0.81	0.19	4.97	45.19
Wheatfield Fork	Buck Mountain	0.27	0.28	0.56	0.56	0.00	4.16	36.32
Buckeye Creek	Flat Ridge Creek	0.36	0.49	0.37	0.26	0.00	4.17	36.43
Wheatfield Fork	Flat Ridge Creek Wheatfield	0.29	0.39	0.26	0.26	0.46	3.83	32.71
Wheatfield Fork	Annapolis	0.28	0.33	0.12	0.62	0.16	3.75	31.84
Rockpile Creek	Upper Rockpile Creek	0.22	0.21	0.52	0.58	0.00	3.71	31.40
Buckeye Creek	North Fork Osser Creek	0.00	0.00	0.42	0.00	0.00	0.84	0.00

Cumulative Geographic Consideration:

The final score for each of the 29 subwatersheds provides a cumulative metric that will help inform and guide the prioritization of road assessments for landowners in the watershed. A further step in analysis could be to geographically consider neighboring watersheds, especially if a high-scoring watershed is hydrologically connected to a medium or lower scoring watershed. To create the most impact for reducing sediment, it could be beneficial to group subwatersheds that have aquatic connectivity and thereby cumulative impacts on downstream water quality when considering prioritization, even if a subwatershed on its own is not a top ranked watershed for sediment loading. A weighted average based on the adjacent watershed's total score and acreage could be one form for adjusting based on aquatic connectivity.

An example of this consideration could be applied to Middle South Fork Gulala River which scored relatively low with a 45.22 cumulative score. However, the Upper South Fork Gulala River is directly upstream and scored second with a 88.46. The impacts from the Upper South Fork could elevate the water quality concerns in the Middle Fork and prioritizing road assessments in the Middle Fork could help mitigate sedimentation of the watershed. A second example is Big Pepperwood Creek which scored relatively low (62.10) as an isolated watershed, but receives runoff from Little Creek and Lower Rockpile Creek upstream which scored 82.68 and 75.76 respectively, thereby contributing to the deterioration of water quality within Big Pepperwood.

<u>Conclusion</u>

The Prioritization Assessment Results are meant to serve as a tool for landowners and other decision makers in the watershed and may help guide how state-supported contract funds are directed to support on-the-ground road assessments as part of the Gualala Total Maximum Daily Load (TMDL) Action Plan Implementation Program. The results identify specific subwatersheds where road assessments and associated improvements are likely to provide the greatest benefit to water quality and aquatic habitat. These findings support more strategic allocation of resources and more effective implementation of the Gualala TMDL Action Plan.

A number of variations and datasets were explored as part of this assessment, and the methodology and results were reviewed for accuracy by the Technical Advisory Committee (TAC) that was developed to provide expert review of the development of this work. Future refinements may incorporate additional data, adjustments to metric weights, and how watersheds are geographically grouped. Additionally, prior studies could be considered for prioritization of road assessment.

A fourth report, Evaluation Methodology Report, is being developed in parallel to define the field-based methods for conducting road assessments. SRCD is conducting outreach to stakeholders to identify potential landowners interested in voluntary assessments. Available funding is unlikely to support assessments of all roads in the watershed and the prioritization results will play a key role in determining where efforts are focused to achieve the greatest overall benefit to water quality and aquatic habitat.