Habitat Restoration and Conservation Plan for Anadromous Salmonid Habitat in Selected Tributaries of the Russian River Basin

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TABLE OF CONTENTS

EXECUTIVE SUMMARY [TO BE COMPLETED]

INTRODUCTION

The salmon and steelhead runs in California's Russian River have been listed as threatened or endangered under the Federal Endangered Species Act (ESA). The Federal agency responsible for recovering these species is the National Oceanic and Atmospheric Administration's (NOAA) National Marine Fisheries Service (NMFS). This agency routinely provides guidance and consults with diverse entities on ways to minimize impacts from development on salmonid species. However, the actual recovery of these species will necessitate the collaboration and cooperation of Federal, state, and municipal agencies, non-governmental organizations, and private entities including landowners and business enterprises that affect critical habitat supporting these species. This report is the product of one such collaborative effort.

The Russian River, a 1,485 square mile watershed in Mendocino and Sonoma County, historically supported large runs of salmon and steelhead. Citing 19th century records of the U.S. Bureau of Fish and Fisheries, Steiner Environmental Consulting (SEC 1996) reports that coho salmon (*Oncorhynchus kisutch*) were once so prevalent in the Russian River that they supported a commercial fishery. In 1888, 183,597 pounds of fish were caught near Duncan Mills for cannery and personal use. The river also supported the third largest runs of steelhead (*O. mykiss*) in California; only the Sacramento and Klamath Rivers had larger steelhead runs in the state (SEC 1996). Today, however, widespread habitat degradation has reduced numbers of coho salmon to the point where they are difficult to detect, and steelhead abundance has declined to less than 15 percent of historic levels (SEC 1996). In general, the Russian River has historically supported relatively low numbers of Chinook salmon (*O. tshawytscha*).

The salmon and steelhead runs in the Russian River belong to larger distinct population segments that are substantially reproductively isolated from other population units. For purpose of conservation, NMFS manages and, as necessary, lists these distinct population segments as threatened or endangered under the ESA. Coho salmon in the Russian River are a component of the Central California Coast (CCC) coho salmon Evolutionarily Significant Unit that was initially listed as *threatened* in 1996, and then listed as *endangered* in 2005 (70 Federal Register (FR) 37160, June 28, 2005). The CCC coho salmon includes coastal populations in rivers entering the ocean along the coasts of Mendocino, Sonoma, Marin, San Mateo and Santa Cruz Counties. Russian River steelhead are part of the CCC steelhead Distinct Population Segment, which has been listed as threatened since 1997 (62 FR 43937, August 18, 1997). The CCC steelhead includes populations ranging from those in the Russian River south to streams in Santa Cruz counties, plus populations in streams entering San Francisco Bay (*e.g.*, Sonoma Creek and the Napa River). The Russian River's Chinook salmon runs belong to the California Coastal (CC) Chinook salmon Evolutionarily Significant Unit that was listed as threatened in 1999 (64 FR 50394, September 16, 1999). CC Chinook salmon include populations of this species in coastal streams ranging from the Russian River north to Humboldt County's Redwood Creek.

In 2005, NMFS designated critical habitat for the listed threatened and endangered populations of steelhead and Chinook salmon in California (70 FR 52488, September 2, 2005). In response to these designations, the Russian River Watershed Salmonid Coalition ('Salmon Coalition') formed for the purpose of opening a dialogue with NMFS to address landowner and other private sector concerns. Initially comprised of representatives of the viticulture and winemaking industry, instream gravel miners, the Sonoma County Water Agency, Northern California Homebuilders Association, Russian River Property Owners Association, and municipal interests, the Salmon Coalition had concerns over the regulatory implications of critical habitat designations for private landowners. To address its concerns, the Salmon Coalition sought the development of a collaborative strategy for conserving habitat for federally listed threatened and endangered salmonid species in several streams designated as critical habitat in Sonoma County. Specifically, their stated mission is to protect and enhance existing habitat, restore historic habitat, and promote the recovery and maintenance of salmonid populations in the Alexander, Dry Creek and Knights Valleys of the Russian River Watershed while balancing the need to provide for regional economic viability and regulatory certainty. The group's mission statement states that it seeks to create sustainable partnerships, both public and private, that allow property owners, public agencies and conservation groups to achieve its mission.

NMFS recognized the value of working cooperatively with the Salmon Coalition to identify necessary measures to recover listed species in sub-watersheds within the Russian River Basin. NMFS also recognizes the value of previous habitat restoration projects to population recovery in several watersheds in the Russian River Basin. To these ends, NMFS developed a strategy for completing a plan for conserving habitat in selected streams within Dry Creek, Alexander, and Knights Valleys that were designated as critical habitat for steelhead. The streams chosen for this effort were not listed as critical habitat for Chinook salmon, a species that generally spawns and rears in larger rivers such as Dry Creek and the Russian River mainstem. However, critical habitat for CCC coho salmon (*O. kisutch*) was designated in these streams under a separate rule (64 FR 24049, May 5, 1999). Therefore, this planning effort, if implemented, should benefit both steelhead and coho salmon. The specific scope for this conservation plan initially included 16 streams; however, logistical considerations necessitated reducing the scope to 12 streams, including four tributaries to Dry Creek (Dutcher, Wine, Grape, and Crane Creeks), four tributaries to the mainstem Russian River in Alexander Valley (Crocker, Gill, Miller, Gird Creeks) and four streams in the Maacama sub-basin in Knights Valley, (Maacama, Franz, Redwood, and Foote Creeks, see Figure 1). This effort entailed: 1) the review of existing habitat data obtained by the California Department of Fish and Game (CDFG), Sotoyome Resource Conservation District (SRCD), North Coast Regional Water Quality Control Board (NCRWQCB), and municipal agencies during the past 15 years, 2) follow-up field surveys that ground-truthed historical habitat data, 3) the development of a conservation plan for restoring degraded habitat and 4) reviewing and recommending beneficial management practices (BMPs) to protect those habitat elements that have not been degraded. This report provides the results of this conservation planning effort.

Land use in these valleys is dominated by viticulture but also includes cattle ranching. Therefore, this plan considers approaches for minimizing impacts to anadromous salmonid habitat that primarily stem from agriculture. Approaches for addressing other habitat concerns are covered elsewhere (*e.g.*, gravel mining, NMFS 2004). Because the life cycle of anadromous fish includes both a freshwater component and marine component, anadromous populations are influenced by habitat features of both environments. While recognizing this is important to consider when setting population recovery goals, our intention in this document is to create a guide for future efforts to restore and protect anadromous salmonid habitat in freshwater and, specifically, the watersheds listed above. The process we undertook to arrive at these recommendations was scientifically-based, objective, collaborative and transparent so that anyone can clearly follow the pathway leading to a particular habitat assessment result, recommendation for a beneficial management practice (BMP), or watershed improvement project. Although the measures we suggest for habitat restoration are focused on recovering anadromous salmonid populations, implementing these recommendations will also benefit other species that rely on healthy aquatic habitat and riparian function.

This plan is founded on assessments of current habitat conditions for anadromous salmonids in the above listed streams. Assessments are mainly from existing CDFG habitat surveys (1996-2001) and field work conducted in 2007 but include data from other sources as well. The initial scope for this work included the Russian River mainstem, Sausal Creek, Kellogg Creek, Yellowjacket Creek as well as the 12 streams listed above. However, because of insufficient resources to conduct field assessments on the Russian River mainstem and insufficient landowner access on Sausal, Kellogg, and Yellowjacket, our assessments were limited to only 12 streams that we hereafter refer to as the 'project streams' (Figure 1).

Document organization

This document consists of two parts. Part I summarizes current habitat conditions and habitat restoration priorities in the project streams. Part II considers BMPs for protecting instream habitat for anadromous salmonids.

Part I begins by outlining the habitat factors that are fundamental for the persistence of anadromous salmonid populations in freshwater. In the Methods Section, we present the approaches and data we used for assessing those habitat factors. The Results Section summarizes habitat conditions in each of the 12 project streams. Existing data (*e.g.*, from CDFG) and additional field surveys conducted during spring 2007 were useful for examining existing conditions related to four principal aspects of stream habitat (channel complexity, substrate quality, riparian quality and the presence of artificial barriers to movement). Data for two other principal habitat factors, water quality and water quantity, were limited and the collection of new data pertaining to these two habitat factors was well beyond the scope of this project. Therefore, rather than providing stream specific analyses of water quality or water quantity, we have provided a general review of these issues for the all project streams, collectively, in Results Sections 3.2 and 3.3. After reviewing the physical habitat conditions in each stream (*i.e.*, channel complexity, substrate quality, riparian conditions and artificial barriers), we present a prioritized list of habitat-focused restoration actions that should serve as a guide to improving habitat conditions in each stream. In the Discussion Section, we present some common land use activities that have contributed to degraded habitat conditions. Additionally, we provide an overview of information gaps and recommendations for addressing those gaps. Finally, we present a framework for recommending an overall priority list of habitat restoration actions for all project streams.

Part II…**[TO BE COMPLETED]**

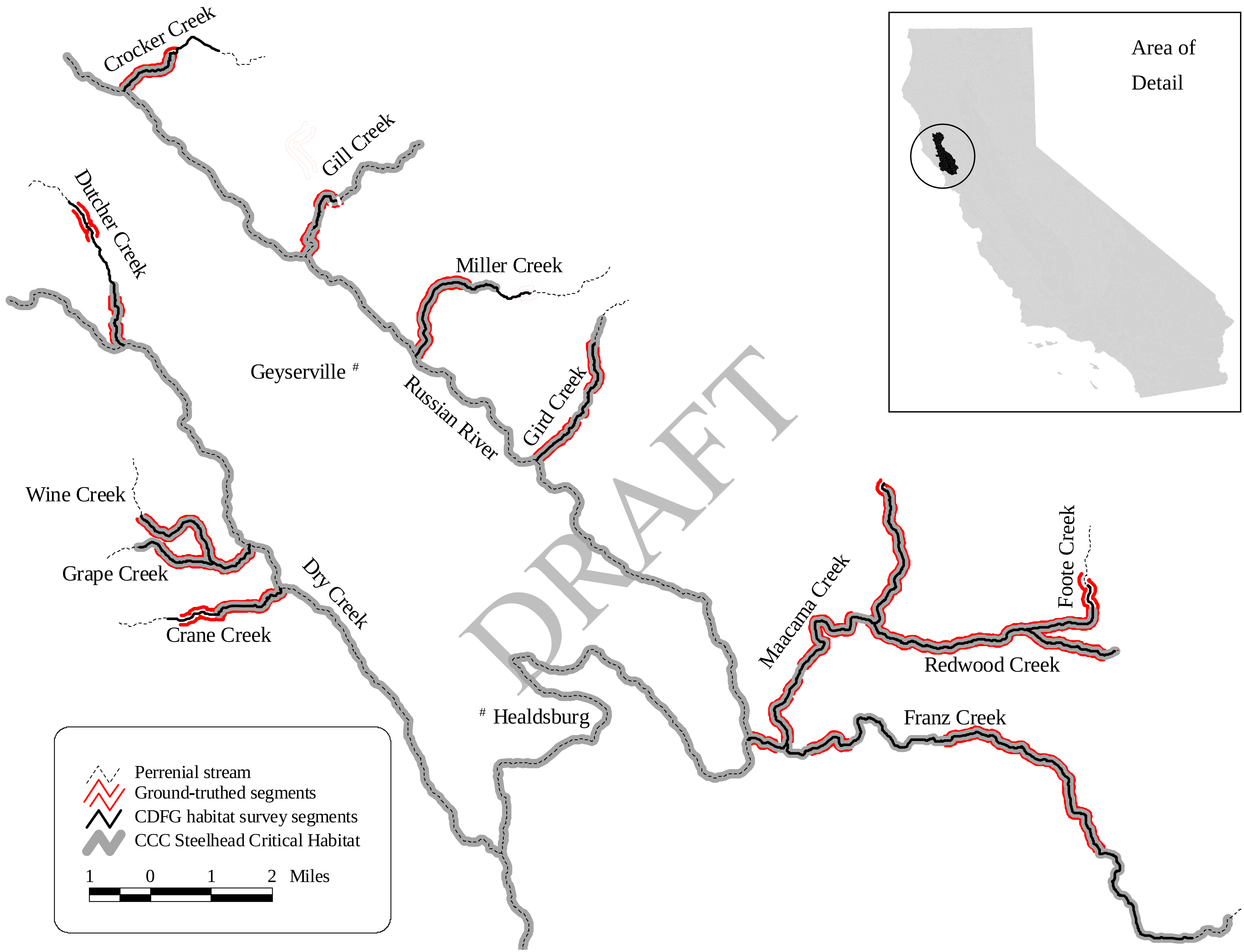

Figure 1. Overview of stream sections in the Warm Springs and Geyserville sub-basins that were assessed for the current condition of salmonid habitat (note that additional CCC steelhead critical habitat in other tributaries of these sub-basins is not shown).

PART I. ASSESSMENT OF CURRENT HABITAT CONDITIONS AND HABITAT RESTORATION PRIORITIES

1.0 Introduction

There is a wealth of published literature that describes the importance and function of various elements of freshwater habitat for the completion of the anadromous salmonid life cycle. We do not attempt to review the available literature here (see Meehan (1991) and Quinn (2005) for excellent reviews); instead, we highlight those habitat characteristics that have demonstrated meaningful relationships with some aspect of one or more life stages of anadromous salmonids (Table 1) and then link those land and water use activities that are likely to have an impact on those habitat characteristics (Table 2). In addition to these somewhat subtle relationships, artificial passage barriers (structures that block access to movement by one or more life stages of fish) can have more dramatic consequences for salmonid populations and, if present, can diminish the value of efforts to protect and restore upstream habitat.

Based on this, we identified six habitat factors that are considered fundamental to salmonid population persistence in freshwater (Fundamental Habitat Factors, FHFs):

1. Channel complexity (*e.g.*, amount of pool habitat, pool quality, pool shelter)
2. Substrate quality
3. Riparian quality
4. Unimpeded access to historic habitat (*i.e.*, absence of artificial passage barriers)
5. Water quality
6. Water quantity.

Our approach involved first identifying the appropriate data for rating. In cases where data were already available, the data were 'ground-truthed' to see if conditions had changed since the time of data collection. In cases where existing data were not representative or where data were lacking, we were able to collect new data relating to some (but not all) of the six FHFs. The protocols and rating criteria we used were from a combination of sources based on work in this part of California (*e.g.*, CDFG, Flosi et al. (2004), Coey et al. (2002), NCRWQCB (2006)) and, in some case, from the primary literature (see Appendix 1).

A paucity of data limited our ability to ground-truth some of the FHFs. We were further constrained by resources available to collect new data. Thus, our assessments are limited to only four of the six FHFs listed above:

1. Channel complexity (*e.g.*, pool habitat amount, pool quality, pool shelter)
2. Substrate quality
3. Riparian quality
4. Unimpeded access to historic habitat (*i.e.*, artificial passage barriers).

For water quality, we were able to collect some water temperature data on three streams in 2007. We present those data along with a few data collected in recent years by other entities; however, those data are temporally and spatially limited. Data on water quantity are even more limited.

Table 1. Partial list of habitat characteristics and their function in maintaining anadromous salmonid populations in freshwater.

Habitat	Characteristic	Function
Pools and riffles	Cover material (*e.g.*, large woody debris, boulders), depth, gradient	• Flow refugia • Shelter from predators • Sediment traps and substrate sorting • Nutrient reservoirs • Macroinvertebrate production • Spawning • Oxygenation
Substrate quality	Sedimentation, substrate size	• Spawning • Incubation • Macroinvertebrate production
Riparian corridor	Canopy, vegetation type, vegetation amount	• Water temperature (shade) • Nutrient sources (invertebrate production) • Source of large woody debris • Filter for sediment and chemical pollution from adjacent land
Water quality	Temperature, dissolved oxygen, conductivity, chemical pollution	• Mortality • Growth • Toxicity/sub-lethal effects
Water quantity	Low flow, high velocity	• Mortality • Competition • Predation • Interactions with water quality

Table 2. Potential influences of various activities associated with land use in the Warm Springs and Geyserville sub-basins of the Russian River Watershed and their potential consequences for salmonids. Whenever growth consequences are listed, the potential for change in age at smolting and therefore survival and production also exist. Adapted from Hicks et al. (1991).

Activity	**Potential Change in Physical Stream Environment**	**Potential Change in Salmonid Habitat Quality**	**Potential Consequences for Salmonids**
Removal, alteration of riparian vegetation	Increased solar radiation	Increased stream temperature; higher light levels; increased autotrophic production; decreased dissolved oxygen	Reduced growth efficiency; increased disease; increased growth; change in growth; decreased swimming performance
	Decreased supply of large woody debris	Reduced cover; loss of pools; reduced protection from peak flows; reduced organic matter; reduced invertebrate production; reduced storage of gravel; reduced trapping of fine sediment; loss of channel complexity	Increased vulnerability to predation; lower winter survival; reduced carrying capacity; less spawning gravel; reduced food; reduced growth
	Accelerated erosion of stream banks	Increased channel width; decreased stream depth; change in invertebrate abundance and species composition	Increased vulnerability to predation; change in habitat suitability by life stage
		Increased fine sediment in spawning gravel and food production areas; increased turbidity	Reduced quality of spawning gravel; reduced embryo survival and emergence; reduced intra-gravel oxygen; reduced gas exchange during incubation; interruption of migration; feeding impairment
	Increase in peak high flow events	Lack of pools and interruption of pool forming processes; Channel incisement; channelization; loss of substrate complexity; change in invertebrate abundance and species composition	Fish passage; reduced embryo survival; reduced carrying capacity of earlier life stages; reduced growth

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Activity	Potential Change in Physical Stream Environment	Potential Change in Salmonid Habitat Quality	Potential Consequences for Salmonids
Water withdrawals	Reduction in wetted area	Dewatering; loss of cover; passage barriers	Reduced embryo survival; reduced carrying capacity; reduced growth; increased vulnerability to predation; suffocation; reduction in swimming performance; reduced growth efficiency; interruption of movement
		Reduced invertebrate production; increased temperature; reduced dissolved oxygen	Reduced growth; reduced swimming performance; reduced growth efficiency; interruption of movement
Water releases (returns)	Altered streamflow regime	Increase in streamflow during summer; change in invertebrate abundance and species composition; velocity barriers	Increased habitat in summer but decreased habitat in winter; reduced growth
Artificial passage barriers	Inaccessibility to habitat; increased velocities; scour; erosion	Impoundments; water velocity barriers; increase in predator and/or non-native species habitat	Unable to complete life cycle; spawn or rear in marginal habitat leading to reduced growth and/or survival; reduction in carrying capacity; increased vulnerability to predation/competition
Chan-nelization and flood control	Channel straightening, increased velocities, disconnection from flood plain	Lack of pools and interruption of pool forming processes; increased erosion; channel incisement; increased sediment transport; change in invertebrate abundance and species composition	Fish passage; sedimentation of spawning gravel; change in spawning suitability; decreased invertebrate production; change in growth
Pesticide, fertilizer application	NA	Acute and chronic toxicity to invertebrates; change in invertebrate abundance and species composition; change in primary productivity	Acute and chronic toxicity; altered food abundance; change in growth; deformities; hormonal changes; reproductive impairments

2.0 Methods

Each of the four FHF (Fundamental Habitat Factors) we have data for consists of multiple habitat components. For habitat components relating to channel complexity, substrate quality, and riparian quality, we identified an indicator variable for each component. We then developed criteria to score each indicator (Table 3). We made no attempt to score either unimpeded access to historic habitat (absence of artificial passage barriers) or point erosion sites; however we do present specific characteristics of barriers and point erosion sites that we identified.

Data were combined within stream reaches of variable length and rated to arrive at a single score for each indicator and reach. Reaches were adopted from existing CDFG stream surveys conducted between 1996 and 2001. CDFG stream reaches were defined on the basis of the Rosgen Classification of Natural Rivers (Rosgen 1994) and represent an objective, geomorphological classification that is important to consider when planning habitat improvement projects (Flosi et al. 2004) and evaluating habitat conditions.

During ground-truthing, multiple observations were made within each reach for each indicator variable listed in Table 3. To account for differences in stream length that each observation applied to, the weighted average of each indicator was calculated for the reach by using the length of the stream segment as a weighting factor. To illustrate, if reach *r* was divided into *n* segments and *n* measures of canopy closure and stream length were collected for each segment *s*, the weighted average was calculated as:

$$\text{Weighted mean canopy} = \frac{\sum_{s}^{n}(\text{Canopy}_s * \text{Length}_s)}{\sum_{s}^{n}(\text{Length}_s)}.$$

The weighted average for each indicator was then scored using the appropriate rating criteria (Table 3). The range of possible rating scores for each indicator was 1 to 5 for all habitat components scored. We also scored each habitat component based on the previously collected CDFG data.

Table 3. Fundamental habitat factors, habitat components, indicators, ranges of values, and scores used to rate existing or new habitat data (see Appendix 1 for development of rating criteria). Artificial passage barriers and erosion sites were not scored; instead individual characteristics are tabulated in the Results Section for each site.

Fundamental Habitat Factor	Habitat Component	Indicator variable	Lower bound	Upper bound	Score
Channel complexity	Amount of pool habitat	Pool to riffle ratio	0	20	1
			20	40	2
			70	100	3
			40	50	4
			50	70	5
	Depth of pools	Percent primary[1] pools (residual depth[2] criteria for primary pool depends on stream order[3])	0	20	1
			20	30	2
			30	40	3
			40	50	4
			50	100	5
	Amount of shelter in pools	Percent of substrate in pools covered with material large enough to shelter a fish <6"	0	10	1
			10	20	2
			20	30	3
			30	40	4
			40	100	5
	Complexity of shelter material in pools	Percent of pools with a shelter complexity[4] of 2 or 3	0	20	1
			20	40	2
			40	60	3
			60	80	4
			80	100	5
	Composite shelter quality in pools	Shelter rating[5] in pools	0	70	1
			70	80	2
			80	90	3
			90	100	4
			100	300	5

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[1] To be considered a primary pool, the residual depth of the pool depends on stream order: 1) for stream order 1-2, the residual depth must be ≥2 feet; 2) for stream order 3-4, the residual depth must be ≥3 feet (Flosi at al. 2004).
[2] Residual depth applies to pools: residual depth = maximum depth - depth at the pool tail crest (Flosi at al. 2004).
[3] Stream order- Based on Strahler stream order classification system (Strahler 1957).
[4] Shelter complexity- See Flosi et al. (2004) for descriptions.
[5] Shelter rating is calculated for each pool as the product of shelter amount and shelter complexity (Flosi at al. 2004).

Fundamental Habitat Factor	Habitat Component	Indicator variable	Lower bound	Upper bound	Score
Substrate quality	Fine sediment in spawning substrate	Percent of pool tail-outs with embeddedness[6] <25%	0	20	1
			20	40	2
			40	60	3
			60	80	4
			80	100	5
Riparian quality	Canopy	Percent canopy closure[7]	0	5	1
			5	25	2
			25	50	3
			50	80	4
			80	100	5
	Amount of riparian vegetation cover	Percent of stream bank covered with vegetation	0	15	1
			15	35	2
			35	50	3
			50	70	4
			70	100	5
	Riparian vegetation type	Dominant riparian vegetation type	No vegetation		1
			Grass/Invasive/Moss		2
			Brush		3
			Hardwood trees		4
			Coniferous trees		5

[6] Protocol used was the average percentage that 5 cobbles from each pool tail-out is buried in sediment (Flosi at al. 2004).
[7] Canopy closure is the area of the sky over the selected stream channel that is bracketed by vegetation. Closure tends to be more constant throughout the season than density.

2.1 Data sources

CDFG data

We relied heavily on data collected by CDFG during the period 1996 to 2001. These data were collected using a standard set of protocols (Flosi et al. 2004). The data have been summarized by CDFG stream reach and geo-referenced making them available for use in a geographical information system (GIS). The data have been useful for prioritizing and implementing habitat restoration projects in the past; however, because in some cases the data are several years old, their accuracy in representing current habitat conditions needed to be verified before we used them.

Other data and resources

Other data that were indirectly useful included water rights data provided by the California Department of Water Resources (DWR). These data were used to gather general impressions about the severity of impacts from human-related impacts on water quantity.

We gathered GIS coverages from various sources for analysis and mapping purposes and, when necessary, re-projected coverages to UTM Zone 10 NAD 83. All data were standardized to a 1:24,000 scale routed stream hydrography layer produced by the California Department of Forestry and Fire Protection (CDF) and the United States Forest Service (USFS) (see References). This same layer was used to depict the stream courses in all maps in this document. GIS coverages of critical habitat for CCC steelhead and Chinook were produced by NMFS (see References). CDFG reaches are depicted from a GIS coverage maintained by CDFG (version 05/01/2007). The layer representing points of diversion (POD) within the Russian River Watershed are for appropriative water rights permits and permit applications. The POD information is part of a larger database of permit application information called the Water Rights Information Management System (WRIMS).

Ground-truthing

The only data we attempted to verify was the CDFG habitat survey data. To accomplish this, we received assistance from personnel from the SRCD and CDFG. The protocols we implemented were as similar as possible to those used by CDFG. In some cases, we had interest in assessing habitat components that were not formally assessed by CDFG or where data sets were incomplete or potentially outdated. Two such cases were the number of erosion sites and the number of potential artificial barriers. In these cases our efforts were directed at collecting new data rather than verifying existing data. Whether ground-truthing existing data or collecting new data, protocol implementation required us to walk as many of the CDFG reaches as possible. Because the vast majority of project stream lengths were on private land, we had to first secure landowner permission.

We are confident in the repeatability of protocols for assessing three of the four FHFs on all stream reaches. However, in the case of protocols for assessing substrate quality (embeddedness, Table 3) we have less confidence for some of the assessment reaches. This is mainly due to unavoidable biases among observers (*e.g.*, which cobbles are selected for measurements) and subjectivity regarding where in the stream channel cobbles are selected for measurement. These issues were more problematic in lower gradient portions of larger streams that had characteristically long pool tail-outs with few cobbles (*e.g.*, Maacama Creek) and pools in steeper gradient channels where larger sediments are highly mobile. Despite these possible limitations, we are confident, in most cases, that the embeddedness values we report are reflective of fine sediment conditions in spawning substrate.

Stream lengths were generated from start/end locations collected while ground-truthing. We used a Garmin ETrex® non-differentially corrected global positioning satellite receiver for this purpose. Slight offsets (errors) in point locations relative to the 1:24,000 scale base layer were corrected in Arcview by snapping the points to the nearest location along the relevant stream course.

3.0 Results

Because of data limitations and constraints on resources available to collect new data, we only evaluated current habitat conditions pertaining to four of the six FHFs on the 12 project streams. Those four 'physical' FHFs are: channel complexity, substrate quality, riparian quality, and unimpeded access to historic habitat. In the results that follow, we first present our assessment for the physical FHFs specific to each stream (Section 3.1). Then we present a review of habitat concerns relating to water quality (Section 3.2) and water quantity (Section 3.3). Because data to evaluate water quality and water quantity are limited, Sections 3.2 and 3.3 present an overview of those land use activities in the watersheds project streams that we are most concerned with.

3.1 Physical habitat conditions

This section consists of a reach-by-reach habitat assessment for each of the CDFG reaches that we surveyed. Streams are grouped by those that flow directly into the mainstem Russian River (Alexander Valley), mainstem Dry Creek (Dry Creek Valley), or are part of the Maacama Creek system (Knights Valley). Each stream section begins with a general description of current habitat conditions and dominant land use activities adjacent to the stream channel in each reach for four of the six FHFs. A spatial representation of scores for each habitat indicator for each stream reach is also presented in Appendix 2. Following the reach-by-reach treatment for each stream, a prioritized list of recommendations is provided that, if implemented, will benefit anadromous salmonid habitat.

A long-range vision of watershed protection is necessary to achieve lasting conservation for listed salmonids. However, without shorter-term measures to address immediate habitat impairments, longer-term measures may be too slow to avoid continued trends of anadromous salmonid population decline. Therefore, we present short term habitat restoration recommendations (*e.g.*, artificial barrier removal, native vegetation planting) in the context of longer term watershed-level changes in land use practices (*e.g.*, reducing land use impacts on the riparian zone, reconnecting streams to their floodplain). This will ultimately ensure the most cost-effective, efficient, and lasting protection for salmonid habitat in the project streams.

Length of streams ground-truthed

The length of stream actually ground-truthed was strongly influenced by the amount of landowner access granted. Of the approximately 247 parcels adjacent to segments of the project streams we were interested in assessing, landowner access was granted for 178 parcels.

Prevailing conditions during habitat assessments

Weekly stream flows between 10/1/2006 and 6/30/2007 were generally well below the long term mean except during February and early March. As an illustration of this, we analyzed stream flow statistics from the United States Geological Survey (USGS) stream flow gauge on Austin Creek in Cazadero (no such data were available for any of the project streams). The low stream flows observed in 2007 were explained by the below average rainfall during the same period (Figure 2) which resulted in relatively dry channel conditions. Stream segments that did not have contiguous stream flow were not assessed for channel complexity or substrate quality (Table 3).

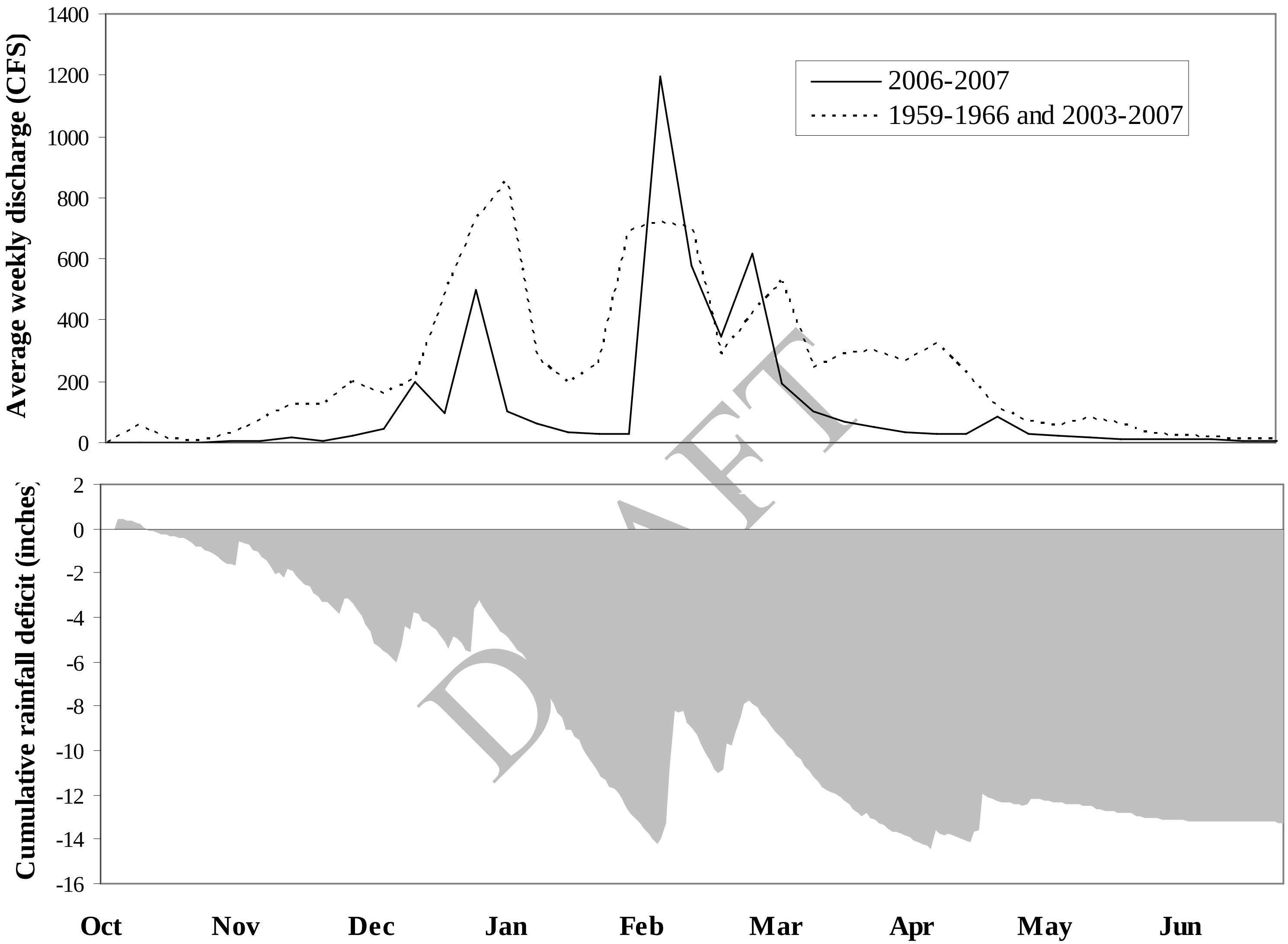

Figure 2. Mean weekly stream discharge (2006 to 2007) and the long term weekly stream discharge for Austin Creek (top panel) and cumulative rainfall deficit from the long term mean, Healdsburg (bottom panel). Both data sets encompass the same period. Flow data are from the USGS stream gauge site in Cazadero and the rainfall data are from the University of California Statewide Integrated Pest Management Program online weather database.

3.1.1 Alexander Valley

For the four project streams in Alexander Valley, NMFS ground-truthed habitat conditions for 67% of the stream length previously surveyed by CDFG (Table 4). This represents 68% of the critical habitat for CCC steelhead in these streams. We evaluated all of the critical habitat in Crocker Creek, the majority of critical habitat in Gird Creek (78%) and Miller Creek (83%), and 32% of the critical habitat in Gill Creek.

Through visual observation, we documented the presence of steelhead in all four Alexander Valley project streams in 2007. There are no historic accounts of coho in any of these streams. This is probably due to water temperatures that are above the thermal tolerance of coho (see Appendix 1 and citations therein for relationships between coho populations and temperature). Very little historic temperature data exist for the project streams in Alexander Valley; however, there is often a strong relationship between water temperature and air temperature (Essig 1998). Because of this relationship, we analyzed a long term weather data set (University of California Statewide Integrated Pest Management Program online weather database) and found that maximum daily summer air temperature in Alexander Valley (Cloverdale weather station) is an average of 2.1°F warmer than Dry Creek Valley (Healdsburg weather station). From this analysis and in combination with the lack of historical accounts of coho in these streams, we conclude that it is unlikely that the project streams in Alexander Valley historically supported independent[1] populations of coho. A metapopulation analysis by Bjorkstedt et al. (2005) supports this conclusion.

[1] 'Independent' populations are those with a high likelihood of persisting over 100-year time scales (Bjorkstedt et al. 2005).

Table 4. Lengths of Alexander Valley project streams surveyed by CDFG, CCC steelhead critical habitat, ground-truthed by NMFS, and percentage ground-truthed.

Stream	CDFG reach	Stream length (miles)			Ground-truthed as a percentage of:	
		CDFG Reach	CCC steelhead critical habitat	Ground-truthed	CDFG Reach	CCC steelhead critical habitat
Crocker Creek	1	0.45	0.45	0.45	100%	100%
	2	0.54	0.54	0.54	100%	100%
	3	0.12	0.09	0.12	100%	100%
	4	0.14	0	0.11	79%	No critical habitat
	5	0.89	0	0	0%	No critical habitat
	Total	***2.14***	***1.08***	***1.22***	***57%***	***100%***
Gill Creek	Downstream[1]	0	0.62	0.62	NA	100%
	1	0.42	0.42	0	0	0
	2	0.12	0.12	0.12	100%	100%
	3	0.36	0.36	0.35	97%	97%
	Upstream[2]	0	1.84	0	NA	0%
	Total	***0.90***	***3.36***	***1.09***[3]	***52%***	***32%***
Gird Creek	1	2.25	2.25	1.71	76%	76%
	2	0.17	0.17	0.17	100%	100%
	Total	***2.42***	***2.42***	***1.88***	***78%***	***78%***
Miller Creek	1	3.04	2.36	1.96	65%	83%
	Total	***3.04***	***2.36***	***1.96***	***65%***	***83%***
Alexander Valley totals:		**8.5**	**9.2**	**6.2**[3]	**65%**[4]	**67%**

[1] CDFG survey began 0.62 miles upstream from the mouth of Gill Creek.
[2] CCC steelhead critical habitat extends upstream of the CDFG survey extent on Gill Creek.
[3] Includes 0.62 miles in Gill Creek that was not surveyed by CDFG but is critical habitat for CCC steelhead.
[4] Does not include 0.62 miles in Gill Creek that was not surveyed by CDFG but is critical habitat for CCC steelhead.

A. Crocker Creek

In 1998 CDFG surveyed approximately 2.1 miles of the 3.1 miles of perennial stream length in Crocker Creek (CDFG 2006a). Their survey delineated five reaches. Beginning at the mouth of the stream, NMFS ground-truthed approximately 1.2 miles of contiguous stream length in four of these reaches on June 14, 2007 (Table 4). Stream flow was discontinuous in the lower 0.4 miles and mostly continuous throughout the upstream 0.8 miles except near the upstream extent of our assessment segment. We observed juvenile steelhead distributed throughout all but the very upstream end of the assessment segment. Habitat restoration efforts in the vicinity of a failed dam site are still evident and functioning well to provide both fish passage and stream bank stabilization. Crocker Creek does not have any artificial passage barriers in the segment assessed by NMFS.

Summary of habitat impairments (Tables A-1, A-2)

<u>Reach 1.</u> Land use adjacent to the reach is primarily rural residential but all homes are restricted to the immediate area just downstream of the River Road crossing. Riparian vegetation in the lower reach is in fair condition except for segments that have been cleared for house lots. Other than some rip-rapping to hold the stream banks near the River Road crossing, there is little evidence of artificial channel confinement. Upstream of the River Road crossing, riparian encroachment from current land use activities is non-existent. In this part of the reach, canopy closure and riparian vegetation cover are both high and comprised mostly of shrubs and immature hardwoods. Stream gradient and natural channel confinement increase with distance upstream.

The principal habitat degradation in the reach has been caused by the failure of a 100 foot wide by 30 foot high dam beginning in 1995. The dam was located very near the downstream end of Reach 2. Although the remnants of the dam were removed in 2001 and the site in the immediate vicinity of the dam restored, a huge sediment load that had been trapped behind the dam moved downstream. In some places, the sediment has accumulated to a depth of 1.5 feet on the stream banks and evidence of sediment from the event in the form of a severely aggraded stream channel is still visible all of the way to the stream mouth nearly 0.5 miles downstream. Combined with the lack of instream cover, fish passage may be a challenge at high flows. Stream channel conditions also probably narrow the adult upstream migration period as the stream flow becomes more easily disconnected between winter rain events. These factors also appear to eliminate summer rearing potential in at least the downstream-most 0.4 miles of the stream. Local residents living in the vicinity of the River Road crossing confirmed that the aggraded channel condition and associated accumulation of sediment just upstream of the road crossing has resulted in flooding during winter storms.

<u>Reach 2.</u> Most of Reach 2 has experienced major erosion and collapsing banks associated with the loss of the dam that acted as a major grade control structure. Efforts to reshape, plant native vegetation, and stabilize stream banks have been helpful; however, the scale of the erosion was so great and the channel widened so much that canopy is virtually non-existent for two long segments of the reach. Even if the canopy was more mature, its effect in shading the stream would be negligible. Other land use impacts are not evident.

<u>Reach 3.</u> There is no sign that the effect of the dam extended as far upstream as Reach 3. Most of this reach is in a canyon and the stream gradient increases with distance upstream. Riparian vegetation cover and canopy closure are high and dominated by mature trees. Near the upstream end of the reach, the substrate is dominated by large boulders and a series of 6 foot high vertical

drops with very shallow pools for upstream migrants to jump from. These boulder cascades are not passable to upstream migrants at most or perhaps all flows; therefore, the upstream end of Reach 3 probably represents the natural limit to anadromy.

Watershed and habitat restoration recommendations

Watershed restoration

Removing the dam in Reach 2 has been highly beneficial to anadromous salmonid populations in Crocker Creek by allowing access to more than twice the length of stream available to them before the dam was removed. Despite the benefits, however, most of the problems in the stream segment we assessed are related to high levels of sediment that were released after the dam began to fail in 1995. Efforts to remove sediment from the stream channel should be undertaken (see habitat restoration and protection priorities below) and land use activities that lead to disturbance of the riparian zone or further sediment entering the stream should be avoided.

Habitat restoration and protection- priority 1

- *Address the accumulation of sediment in Reach 1*
  - ✓ Remove sediment from the stream channel in the immediate vicinity of the River Road crossing.
  - ✓ Consider replacing the River Road crossing with a larger culvert or free span bridge that would not limit the passing of sediment.
- *Design and build pools for juvenile rearing*
  - ✓ Construct pools in low gradient stream segments.
  - ✓ Enhance cover in newly constructed pools by adding large wood structures.

Habitat restoration and protection- priority 2

- *Enhance cover in existing pools*
  - ✓ Add large wood structures to pools in lower gradient portions of the stream.
- *Address fish passage conditions in the lower portion of the stream*
  - ✓ Structures should be designed and placed in the channel so that adults are afforded ample low velocity sites to use as rest stops during migration.
  - ✓ Consider designing a low water channel in the downstream-most portion of the stream that would facilitate a longer temporal window for adult upstream migration.

Habitat restoration and protection- priority 3

- *Evaluate sediment sources*
  - ✓ The erosion sites upstream of the old dam site that were caused by the former impoundment are still probably delivering sediment to the stream; however, an evaluation of whether or not this constitutes a significant problem should be conducted before further actions are taken.

Table A-1. Scores for nine habitat components in Crocker Creek based on the CDFG habitat survey (1998) and NMFS ground-truthing (June 14, 2007). Scores range from least desirable (1) to most desirable (5). Differences indicate a possible change in the habitat factor since the CDFG survey in 1998 ('+' for better and '-' for worse). No assessment is indicated by 'na'.

CDFG Reach	Fundamental habitat factor	Habitat component	Score (sample size)		
			CDFG based	Ground-truth based	Difference
1	***Channel complexity***	Amount of pool habitat	4 (9)	4 (4)	0
		Depth of pools	1 (9)	3 (4)	+2
		Amount of shelter in pools	1 (9)	2 (4)	+1
		Complexity of shelter material in pools	2 (9)	2 (4)	0
		Composite shelter quality in pools	1 (9)	1 (4)	0
	Substrate quality	Fine sediment in spawning substrate	2 (9)	1 (4)	-1
	Riparian quality	Canopy	3	4	+1
		Amount of riparian vegetation cover	3	4	+1
		Riparian vegetation type	4	4	0
2	***Channel complexity***	Amount of pool habitat	5 (13)	2 (10)	-3
		Depth of pools	1 (11)	3 (10)	+2
		Amount of shelter in pools	2 (13)	1 (10)	-1
		Complexity of shelter material in pools	3 (13)	2 (10)	-1
		Composite shelter quality in pools	1 (13)	1 (10)	0
	Substrate quality	Fine sediment in spawning substrate	2 (11)	3 (10)	+1
	Riparian quality	Canopy	2	4	+2
		Amount of riparian vegetation cover	4	5	+1
		Riparian vegetation type	4	4	0
3	***Channel complexity***	Amount of pool habitat	5 (6)	5 (15)	0
		Depth of pools	1 (6)	5 (15)	+4
		Amount of shelter in pools	2 (6)	2 (15)	0
		Complexity of shelter material in pools	5 (6)	3 (15)	-2
		Composite shelter quality in pools	1 (6)	1 (15)	0
	Substrate quality	Fine sediment in spawning substrate	4 (6)	4 (10)	0
	Riparian quality	Canopy	4	5	+1
		Amount of riparian vegetation cover	5	5	0
		Riparian vegetation type	4	4	0
4	***Channel complexity***	Amount of pool habitat	3 (3)	na	na
		Depth of pools	1 (2)	na	na
		Amount of shelter in pools	4 (3)	na	na
		Complexity of shelter material in pools	5 (3)	na	na
		Composite shelter quality in pools	4 (3)	na	na
	Substrate quality	Fine sediment in spawning substrate	1 (2)	na	na
	Riparian quality	Canopy	5	5	0
		Amount of riparian vegetation cover	4	5	+1
		Riparian vegetation type	4	na	na

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CDFG Reach	Fundamental habitat factor	Habitat component	Score (sample size)		
			CDFG based	Ground-truth based	Difference
5	***Channel complexity***	Amount of pool habitat	5 (31)	na	na
		Depth of pools	2 (28)	na	na
		Amount of shelter in pools	2 (30)	na	na
		Complexity of shelter material in pools	3 (30)	na	na
		Composite shelter quality in pools	1 (30)	na	na
	Substrate quality	Fine sediment in spawning substrate	3 (29)	na	na
	Riparian quality	Canopy	4	na	na
		Amount of riparian vegetation cover	4	na	na
		Riparian vegetation type	4	na	na

Table A-2. Anthropogenic point erosion sites on Crocker Creek. RB (Right Bank), LB (Left Bank) and BB (Both Banks) refer to the stream bank when looking downstream.

Site number	Description and size	Cause	Comment
Multiple	RB; all are immediately upstream of old dam site	Former impoundment from old dam	Evaluate whether or not these sites constitutes a significant enough problem to warrant restorative actions

B. Gill Creek

In 1998 CDFG surveyed approximately 0.9 miles of the 3.4 miles of perennial stream length in Gill Creek (CDFG 2006e). Their survey delineated three reaches. The downstream extent of the CDFG survey was the River Road crossing; therefore, the 0.6 mile long segment between the mouth and River Road is not represented in the CDFG survey. NMFS ground-truthed approximately 0.5 miles of non-contiguous stream length in the three CDFG reaches on June 5, 2007 plus an additional 0.6 miles downstream of Reach 1 on June 4, 2007; the furthest upstream we assessed was approximately 1.5 miles from the mouth (Table 4). Our assessment was discontinuous and the upstream extent limited because of lack of landowner access. Because only a very small portion of Reach 1 was ground-truthed (<10%), those results are not reported. Stream flow was discontinuous in the lower 0.6 miles and continuous throughout the remainder of the assessment segment. We observed juvenile steelhead distributed throughout the entire assessment segment. We also observed two adult steelhead in an unnamed tributary to the stream.

Summary of habitat impairments (Tables B-1, B-2, B-3)

<u>Downstream of Reach 1.</u> Land use adjacent to the reach is primarily viticulture. The lower one-half of the reach is closely bordered by vineyards and includes farm roads near the top of the stream bank. The stream is artificially channelized with levies and revetments on both banks. The result is a wide active channel with little connectivity to its flood plain. Because of the lack of instream cover and the very straight channel, fish passage may be a challenge at high flows. Channel conditions have probably also narrowed the adult upstream migration period as the stream channel becomes more easily disconnected between winter rain events. These conditions also appear to eliminate summer rearing potential in at least the downstream-most 0.6 miles of the stream. Canopy closure is low and the riparian zone is narrow and in poor condition. We noted invasive plant species adjacent to the channel including water primrose (*Ludwigia spp.*). Just downstream of the River Road crossing there is a severe impediment to fish passage caused by the remains of the previous River Road crossing. Material consists of broken concrete, wooden posts and twisted pieces of metal.

<u>Reach 1.</u> Not assessed by NMFS.

<u>Reach 2.</u> The stream is naturally confined on both sides and land use encroachment of the riparian zone is low. The riparian vegetation is intact and dominated by mature hardwoods; canopy closure is very high. The amount of fine sediment in the channel is high and there are a moderate number of pools with adequate depth.

<u>Reach 3.</u> Natural confinement in this reach is lower than Reach 2. Gradient is higher and the substrate is boulder dominated. The zone of riparian vegetation is narrow and surrounded by oak grassland; this is probably a natural condition. There is an especially high amount of fine sediment in the stream near the upstream end of the reach that is likely due to sediment delivery from a road crossing. Two tributaries enter the reach, one on each bank. Both were surveyed by CDFG and although we ground-truthed the right bank tributary (unnamed tributary), we do not report the results.

<u>Upstream of Reach 3.</u> Although we did not assess habitat upstream of Reach 3, this portion of Gill Creek is being impacted by cattle (Bob Coey CDFG, personal communication 2007).

Watershed and habitat restoration recommendations

Watershed restoration

Most of the problems in the segment of Gill Creek that we assessed are related to channelization and encroachment of the riparian zone by agriculture. Downstream of the River Road crossing, the riparian zone needs to be better protected and allowed to widen and diversify by transitioning land use activities further away from the stream channel. The stream should be allowed to reconnect to its floodplain by removing levies and other unnatural confinement structures downstream of River Road.

Habitat restoration and protection- priority 1

- *Enhance cover in existing pools*
  - ✓ Add large wood structures to pools in lower gradient portions of the stream.
- *Assess habitat upstream of Reach 3*

Habitat restoration and protection- priority 2

- *Address fish passage conditions in the lower portion of the stream*
  - ✓ Remove the remnants of the old River Road crossing (just downstream of the current crossing).
  - ✓ Structures should be designed and placed in the channel so that adults are afforded ample low velocity sites to use as rest stops during migration.
  - ✓ Consider designing a low water channel in the downstream-most portion of the stream that would facilitate a longer temporal window for adult upstream migration.
- *Identify and reduce fine sediment input to the stream*
  - ✓ Conduct an assessment of roads in the watershed.
  - ✓ Address the sediment coming from the road crossing at the upstream end of Reach 3.

Habitat restoration and protection- priority 3

- *Identify and reduce impacts from cattle (as appropriate) in the stream segment upstream of Reach 3*

Table B-1. Scores for nine indicator variables in Gill Creek based on the CDFG habitat survey (1998) and NMFS ground-truthing (June 4 and 5, 2007). Scores range from least desirable (1) to most desirable (5). Differences indicate a possible change in the habitat factor since the CDFG survey in 1998 ('+' for better and '-' for worse).

CDFG Reach	Fundamental habitat factor	Habitat component	Score (sample size)		
			CDFG based	Ground-truth based	Difference
1	***Channel complexity***	Amount of pool habitat	3 (9)	5 (2)	+2
		Depth of pools	3 (9)	1 (2)	-2
		Amount of shelter in pools	1 (4)	1 (2)	0
		Complexity of shelter material in pools	2 (4)	1 (2)	-1
		Composite shelter quality in pools	1 (4)	1 (2)	0
	Substrate quality	Fine sediment in spawning substrate	2 (9)	1 (2)	-1
	Riparian quality	Canopy	4	2	-2
		Amount of riparian vegetation cover	5	4	-1
		Riparian vegetation type	4	2	-2
2	***Channel complexity***	Amount of pool habitat	5 (2)	4 (3)	-1
		Depth of pools	1 (2)	4 (3)	+3
		Amount of shelter in pools	3 (1)	1 (3)	-2
		Complexity of shelter material in pools	5 (1)	4 (3)	-1
		Composite shelter quality in pools	1 (1)	1 (3)	0
	Substrate quality	Fine sediment in spawning substrate	1 (2)	1 (2)	0
	Riparian quality	Canopy	5	5	0
		Amount of riparian vegetation cover	5	4	-1
		Riparian vegetation type	4	4	0
3	***Channel complexity***	Amount of pool habitat	4 (5)	5 (13)	+1
		Depth of pools	4 (5)	5 (13)	+1
		Amount of shelter in pools	1 (3)	1 (13)	0
		Complexity of shelter material in pools	2 (3)	1 (13)	-1
		Composite shelter quality in pools	1 (3)	1 (13)	0
	Substrate quality	Fine sediment in spawning substrate	2 (5)	4 (8)	+2
	Riparian quality	Canopy	4	4	0
		Amount of riparian vegetation cover	5	4	-1
		Riparian vegetation type	4	4	0

Table B-2. Anthropogenic point erosion sites on Gill Creek. RB (Right Bank), LB (Left Bank) and BB (Both Banks) refer to the stream bank when looking downstream. Site numbers are sorted from downstream to upstream.

Site number	Description and size	Cause	Comment
1	RB; size not noted	Land use encroachment into the riparian zone	Existing erosion control measures are inadequate
2	RB; 150'w, 10'h	Land use encroachment into the riparian zone	None

Table B-3. Potential partial and complete passage barriers for life stages of anadromous salmonids in Gill Creek. Also shown is length of stream segment with critical habitat for CCC steelhead that is upstream of barrier. '% of total' is the percent of either critical habitat or the CDFG survey that is upstream of the barrier (A=Adult, S=Smolt, J=Juvenile).

			Upstream		Downstream	Length upstream				
						Critical habitat		CDFG Survey		
Barrier number	**CDFG Reach**	**Type**	**Partial**	**Complete**	**Partial**	**Miles**	**% of total**	**Miles**	**% of total**	**Description**
1[*]	1	Bridge	A	J	A S J	2.85	82	0.29	32	Jumble of concrete and old wooden posts on downstream side of River Road crossing (old River Road crossing) makes for an obstacle course and debris catcher

[*] Priority 1 habitat restoration recommendation.

C. Gird Creek

In 2001 CDFG surveyed approximately 2.4 miles of the 3.6 miles of perennial stream length in Gird Creek (CDFG 2006f). Their survey delineated two reaches. Beginning at the mouth of the stream, NMFS ground-truthed approximately 1.9 miles of contiguous stream length in both reaches on May 22 and 23, 2007; the furthest upstream we assessed was approximately 2.4 miles from the mouth (Table 4). Stream flow was discontinuous in the lower 0.7 miles and continuous throughout the remainder of the assessment segment. We observed juvenile steelhead distributed throughout the entire assessment segment. Gird Creek does not have any artificial passage barriers in the segments assessed by NMFS.

Summary of habitat impairments (Tables C-1, C-2)

<u>Reach 1.</u> Land use adjacent to the downstream-most 0.5 miles of the stream (primarily downstream of the highway 128 crossing) is primarily viticulture with extensive bank revetment work to stabilize stream banks adjacent to private dwellings. In this area, the stream has been artificially channelized and straightened and has nearly vertical stream banks. Riparian vegetation is poor and canopy is nearly non-existent. Almost the entire length of the downstream-most 0.5 miles of the reach is armored with rip-rap. As a result, the channel is deeply incised. There was no evidence of pool forms and no instream structure for migrating fish to use as rest stops; therefore, adult migration through this segment is almost certainly impaired at high flows. Channel conditions have probably also narrowed the adult upstream migration period as stream flow becomes more easily disconnected between winter rain events. The channel's straight, incised morphology also helps to eliminate summer rearing potential in at least the downstream-most 0.7 miles of the stream.

Immediately upstream of the Highway 128 crossing, land use adjacent to the channel transitions to rural residential with some cattle ranching. Riparian and canopy conditions are markedly improved and the stream is no longer channelized. However, in the approximately 1.2 miles between highway 128 and Bennett Road, there are 11 stream crossings (driveways, roads and wet crossings). We classified one of these crossings as a partial, artificial barrier to migration. Along with a few point sources of erosion, these crossings probably account for a large input of sediment.

Riparian and instream habitat conditions continue to improve upstream of the Geysers Road crossing with progressively less land use encroaching into the riparian zone; riparian encroachment from land use is almost non-existent upstream of Bennett Road. In this area, gradient is steeper and natural channel confinement and substrate size both increase with distance upstream.

<u>Reach 2.</u> This reach is very short, has a steep gradient with boulder-dominated substrate and a high level of natural confinement. We did not detect any land use impacts in the reach. The CDFG survey and the reach end at a 20 foot high waterfall that is totally impassable to migrating steelhead. We also ended our assessment at this point.

Watershed and habitat restoration recommendations

<u>Watershed restoration</u>

The extreme channelization and riparian encroachment that have severely degraded stream channel conditions in Gird Creek downstream of Highway 128 should be alleviated in order to restore this portion of the stream as a migration corridor. The riparian zone should be widened and protected by transitioning land use activities further away from the stream channel. The stream should also be allowed to reconnect to its floodplain by removing or reducing levies and other unnatural confinement structures downstream of Highway 128. The feasibility of a bioengineered, multi-stage stream channel downstream of Highway 128 should be considered.

<u>Habitat restoration and protection- priority 1</u>

- *Address fish passage conditions in the lower portion of the stream*
  - ✓ Structures should be designed and placed in the channel so that adults are afforded ample low velocity sites to use as rest stops during migration.
  - ✓ Consider designing a low water channel in the downstream-most portion of the stream that would facilitate a longer temporal window for adult upstream migration.

<u>Habitat restoration and protection- priority 2</u>

- *Enhance cover in existing pools*
  - ✓ Add large wood structures to pools in lower gradient portions of the stream.

<u>Habitat restoration and protection- priority 3</u>

- *Reduce fine sediment input to the stream*
  - ✓ Much of the sediment input is the result of over-steepened stream banks because of channelization and hydrogeomorphic processes related to activities in the Russian River (see Discussion).

Table C-1. Scores for nine habitat components in Gird Creek based on the CDFG habitat survey (2001) and NMFS ground-truthing (May 22 and 23, 2007). Scores range from least desirable (1) to most desirable (5). Differences indicate a possible change in the habitat factor since the CDFG survey in 2001 ('+' for better and '-' for worse). No assessment is indicated by 'na'.

CDFG Reach	**Fundamental habitat factor**	**Habitat component**	**Score (sample size)**		
			CDFG based	**Ground-truth based**	**Difference**
1	***Channel complexity***	Amount of pool habitat	2 (3)	4 (44)	+2
		Depth of pools	5 (3)	4 (44)	-1
		Amount of shelter in pools	2 (3)	1 (43)	-1
		Complexity of shelter material in pools	5 (3)	2 (43)	-3
		Composite shelter quality in pools	1 (3)	1 (43)	0
	Substrate quality	Fine sediment in spawning substrate	5 (3)	3 (13)	-2
	Riparian quality	Canopy	5	4	-1
		Amount of riparian vegetation cover	4	5	+1
		Riparian vegetation type	4	4	0
2	***Channel complexity***	Amount of pool habitat	2 (1)	4 (11)	+2
		Depth of pools	5 (1)	4 (11)	-1
		Amount of shelter in pools	1 (1)	1 (11)	0
		Complexity of shelter material in pools	5 (1)	2 (11)	-3
		Composite shelter quality in pools	1 (1)	1 (11)	0
	Substrate quality	Fine sediment in spawning substrate	5 (1)	2 (3)	-3
	Riparian quality	Canopy	na	5	na
		Amount of riparian vegetation cover	na	4	na
		Riparian vegetation type	na	4	na

Table C-2. Anthropogenic point erosion sites on Gird Creek. RB (Right Bank), LB (Left Bank) and BB (Both Banks) refer to the stream bank when looking downstream. Site numbers are sorted from downstream to upstream.

Site number	Description and size	Cause	Comment
1	LB; size not noted	Land use encroachment into the riparian zone	Rip-rap and bank revetment work is beginning to fail; no riparian vegetation
2	BB; 5’w, height not noted	Cattle crossing creek	Pasture on both sides of stream
3	LB; 15’w, 5’h	Land use encroachment into the riparian zone	Broken concrete has been used for rip-rap; no riparian vegetation
4	LB; width not noted, 10’h	Pasture?	Bank is over-steep; evaluate cause and reshape/plant with native vegetation
5	BB; size not noted	Cattle crossing creek	Evidence of cattle in stream just upstream as well

D. Miller Creek

In 2001 CDFG surveyed approximately 3.0 miles of the 4.6 miles of perennial stream length in Miller Creek (CDFG 2005). Their survey delineated one reach. Beginning at the mouth of the stream, NMFS ground-truthed approximately 2.0 miles of contiguous stream length in this reach on April 27, 2007 (Table 4). The results of our assessment for a 1,200 foot stream segment beginning 2.9 miles upstream of the mouth are not included because it was upstream of a 14 foot high natural waterfall that represents the natural limit to anadromy. Stream flow was discontinuous in the lower 0.6 miles and continuous throughout the upstream 1.4 miles. We observed juvenile steelhead distributed throughout the entire assessment segment. Recent habitat restoration projects including levee removal and native vegetation plantings are evident upstream of the midpoint of the assessment segment. No anthropogenic point sources of erosion were noted, and Miller Creek does not have any artificial passage barriers in the segment assessed by NMFS.

Summary of habitat impairments (Table D-1)

Reach 1. Land use adjacent to the reach is primarily viticulture. The lower one-half of this 3.0 mile long reach is closely bordered by vineyards especially in the first 0.75 miles. The lower one-half is also artificially channelized, although channel confinement gradually decreases as distance upstream increases. Canopy closure is moderate in most places and generally consists of shrubs or immature hardwoods. Stream bank vegetation cover generally scored high but there are patches of invasive species (including an isolated clump of *Arundo spp.* and Tamarisk).

We identified three stream crossings in this reach of Miller Creek but none act as artificial passage barriers. However, because of a lack of structure to use as rest stops, fish passage may be a challenge to upstream migrating adults at high flows. This is particularly true in the lower one-half of reach the reach where the channel is very straight for long segments and the active channel width is approximately five times the wetted width. The wide channel serves to disperse flow throughout the active channel width which, in turn, results in shallow water depths and a diminished ability for the stream to form and maintain scour pools. In combination with the naturally low summer flow conditions in this reach, these factors probably narrow the adult upstream migration period as stream flow becomes easily disconnected between winter rain events. Existing channel conditions also appear to eliminate summer rearing potential in at least the downstream-most 0.6 miles of Miller Creek.

The channelized conditions in Miller Creek result in other habitat impairments as well. Over-steepened banks that do not hold vegetation are most common in the middle portion of the reach. Such conditions result in non-point sources of fine sediment that erode into the stream as stream banks continually collapse. In the lower portion of the reach, this problem is exacerbated by the poor condition of the riparian zone and associated vegetation to hold the stream banks. Farm roads on top of both stream banks compound the problem by reducing the functional width of the riparian zone. The low number of pools in the reach is a significant impairment to salmonid habitat that is likely due to channelization.

Watershed and habitat restoration recommendations

Watershed restoration

The main problem in the segment of Miller Creek that we assessed is largely the result of channelization and land use encroachment into the riparian zone. Downstream of the Highway 128 crossing, the riparian zone needs to be better protected and vegetation should be allowed to widen and diversify by transitioning land use activities further away from the stream channel. Although some levies have been removed in the recent past, this work should continue so that the stream can reconnect to its floodplain. The feasibility of a bioengineered, multi-stage stream channel downstream of River Road should be considered.

Habitat restoration and protection- priority 1

- *Design and build pools for juvenile rearing*
  - ✓ Pools should be constructed in middle and upstream portions of Reach 1.
  - ✓ Enhance cover in newly constructed pools by adding large wood structures.

Habitat restoration and protection- priority 2

- *Address fish passage conditions in the lower portion of the stream*
  - ✓ Structures should be designed and placed in the channel so that adults are afforded ample low velocity sites to use as rest stops during migration.
  - ✓ Consider designing a low water channel in the downstream-most portion of the stream that would facilitate a longer temporal window for adult upstream migration.

Habitat restoration and protection- priority 3

- *Reduce fine sediment input to the stream*
  - ✓ Much of the sediment inputs result from over-steepened stream banks that are from channelization and hydrogeomorphic processes related to activities in the mainstem Russian River (see Discussion).
  - ✓ Conduct an assessment of roads in the watershed.

Table D-1. Scores for nine indicator variables in Miller Creek based on the CDFG habitat survey (2001) and NMFS ground-truthing (April 27, 2007). Scores range from least desirable (1) to most desirable (5). Differences indicate a possible change in the habitat factor since the CDFG survey in 2001 ('+' for better and '-' for worse).

CDFG Reach	Fundamental habitat factor	Habitat component	Score (sample size)		
			CDFG based	Ground-truth based	Difference
1	***Channel complexity***	Amount of pool habitat	1 (1)	1 (6)	0
		Depth of pools	1 (1)	1 (2)	0
		Amount of shelter in pools	1 (1)	1 (2)	0
		Complexity of shelter material in pools	1 (1)	1 (2)	0
		Composite shelter quality in pools	1 (1)	1 (2)	0
	Substrate quality	Fine sediment in spawning substrate	5 (1)	2 (2)	-3
	Riparian quality	Canopy	2	3	+1
		Amount of riparian vegetation cover	4	5	+1
		Riparian vegetation type	4	3	-1

3.1.2 Dry Creek Valley

For the four project streams in Dry Creek Valley, NMFS ground-truthed habitat conditions for 78% of the stream length previously surveyed by CDFG (Table 5). This represents 94% of the critical habitat for CCC steelhead in these streams. We did not evaluate all of the critical habitat in Dutcher Creek (66%) or Grape Creek (83%), but we did evaluate 100% of the critical habitat in Crane and Wine Creeks.

Through visual observation, we documented steelhead in all four Dry Creek Valley project streams in 2007. A metapopulation analysis by Bjorkstedt et al. (2005) indicates that the Dry Creek watershed historically supported its own independent[1] population of steelhead. Bjorkstedt et al. (2005) also suggests that tributaries to the lower and middle Russian River collectively supported one large independent population of coho salmon. Grape, Wine, and Crane Creeks likely supported populations of coho salmon and may contain current populations as well. This is supported by several lines of evidence. In 1998, CDFG documented the presence of coho in the Grape/Wine system (CDFG 2006j) and in Pena Creek (CDFG, unpublished data), a tributary of Dry Creek entering upstream of Grape Creek). Since 2004, coho have been stocked into Mill Creek (a tributary of Dry Creek entering approximately 6 miles downstream of Crane Creek). This effort could result in a source population of coho to disperse into nearby streams including Crane, Grape, and Wine. As part of their coho monitoring program, the University of California Cooperative Extension (UCCE) documented natural-origin coho in nearby Felta Creek in both 2005 and 2006 (Conrad et al. 2006; Mariska Obedzinski UCCE, personal communication, 2007).

[1] 'Independent' populations are those with a high likelihood of persisting over 100-year time scales (Bjorkstedt et al. 2005).

Table 5. Lengths of Dry Creek Valley project streams surveyed by CDFG, CCC steelhead critical habitat, ground-truthed by NMFS, and percentage ground-truthed.

Stream	CDFG reach	Stream length (miles)			Ground-truthed as a percentage of:		Comment
		CDFG Reach	**CCC steelhead critical habitat**	**Ground-truthed**	**CDFG Reach**	**CCC steelhead critical habitat**	
Crane Creek	1	1.81	1.32	1.81	100%	100%	
	2	0.15	0	0.15	100%	No critical habitat	Assessments for Reaches 2 and 3 are combined
	3	0.3	0	0.08	27%	No critical habitat	
	Total	***2.26***	***1.32***	***2.04***	***90%***	***100%***	
Dutcher Creek	1	2.86	1.16	1.39	49%	66%	Pools only counted (not surveyed) for part of reach
	Total	***2.86***	***1.16***	***1.39***	***49%***	***66%***	
Grape Creek	1	1.82	1.82	1.82	100%	100%	
	2	0.12	0.12	0.08	67%	67%	Surveyed erosion sites only
	3	0.23	0.23	0	0%	0%	
	4	0.1	0.13	0	0%	0%	
	Total	***2.27***	***2.30***	***1.90***	***84%***	***83%***	
Wine Creek	1	0.55	0.55	0.55	100%	100%	
	2	0.14	0.14	0.14	100%	100%	
	3	0.27	0.27	0.27	100%	100%	
	4	0.07	0.06	0.07	100%	100%	
	5	0.05	0.05	0.05	100%	100%	
	6	0.3	0.3	0.3	100%	100%	Surveyed erosion sites only
	7	0.15	0.15	0.15	100%	100%	
	8	0.36	0.28	0.36	100%	100%	
	Total	***1.89***	***1.80***	***1.89***	***100%***	***100%***	
Dry Creek Valley totals:		9.3	6.6	7.2	78%	94%	

E. Crane Creek

In 1999 CDFG surveyed approximately 2.3 miles of the 3.1 miles of perennial stream length in Crane Creek (CDFG 2005). That survey delineated three reaches. Beginning at the mouth of the stream, NMFS ground-truthed approximately 2.0 miles of contiguous stream length in all three of these reaches on April 3 and 4, 2007 (Table 5). Stream flow was continuous throughout the assessment segment. We observed juvenile steelhead distributed throughout all but the upstream-most 0.1 mile of the assessment segment.

Summary of habitat impairments (Tables E-1, E-2, E-3)

Reach 1. Overall, land use encroachment of the riparian zone is relatively low throughout the reach as compared to other streams assessed. However, the downstream-most 0.3 miles of Crane Creek is closely bordered by vineyards as evidenced by a narrow riparian corridor consisting of extremely dense shrub growth mixed with few mature trees. Upstream of West Dry Creek Road, the dominant riparian vegetation is mature hardwoods and conifers, except for short segments consisting of shrubs and young hardwoods. The extreme lower portion of the reach is severely incised due to activities in Dry Creek (see Discussion). The most severe evidence of down-cutting is in the downstream-most 100 yards of the stream up to the point of a head-cut that presents a partial or complete barrier to salmonids depending on flows, species, and life stage. We identified five stream crossings in the reach. Along with one other point source, two of these showed evidence that they are a source of sediment to the stream. Except for these point sources, there is no clear evidence that the gravel road which parallels most of the reach length is delivering much sediment to the stream. The upstream-most crossing we encountered acts as a partial barrier to fish passage. Additionally, there is a flashboard dam present just upstream of this crossing that, depending on operation schedule and flow, may act as a partial barrier to some life stages. Pool frequency is high and includes a moderate to high number of pools with adequate depth; however, pool shelter is low. The amount of fine sediment in the stream is low as evidenced by low embeddedness in pool tail-outs.

Reaches 2 and 3. Land use encroachment of the riparian zone is minimal and the canopy is mature and dominated by redwoods. Stream gradient is high as are accumulations of woody debris and large boulders in places. We doubt that anadromous salmonids inhabit reaches upstream of where we ended our assessment. Similar to Reach 1, pool frequency is high and pool shelter is low. There is one active erosion site from an old logging road that crosses (without a culvert) an unnamed, ephemeral tributary to Crane Creek.

Watershed and habitat restoration recommendations

Watershed restoration

Although there is generally low encroachment of land use into the riparian zone, the few places where land use has impacted Crane Creek should be restored (see habitat restoration priorities below). In those same places, land use should be moved away from the stream channel.

Habitat restoration and protection- priority 1

- *Address artificial passage barrier near the mouth of the stream*

- ✓ The head-cut near the mouth of the stream should be addressed by evaluating the channel for placement of grade control structures and/or modifications to the head-cut itself.

Habitat restoration and protection- priority 2

- *Enhance cover in existing pools*
  - ✓ Add large wood structures to pools in lower gradient portions of the stream.

Habitat restoration and protection- priority 3

- *Repair human-related point sources of sediment throughout the stream*
  - ✓ Two road/driveway crossings and other human-related point sources of sediment throughout the stream.
- *Address artificial passage barriers located in upstream stream segments*
  - ✓ The upstream-most road crossing.
  - ✓ One flashboard dam.

Table E-1. Scores for nine indicator variables in Crane Creek based on the CDFG habitat survey (1999) and NMFS ground-truthing (April 3 and 4, 2007). Scores range from least desirable (1) to most desirable (5). Differences indicate a possible change in the habitat factor since the CDFG survey in 1998 ('+' for better and '-' for worse). No assessment is indicated by 'na'.

			Score (sample size)		
CDFG Reach	**Fundamental habitat factor**	**Habitat component**	**CDFG based**	**Ground-truth based**	**Difference**
1	***Channel complexity***	Amount of pool habitat	5 (86)	4 (86)	-1
		Depth of pools	3 (79)	3 (85)	0
		Amount of shelter in pools	2 (86)	2 (83)	0
		Complexity of shelter material in pools	4 (86)	3 (83)	-1
		Composite shelter quality in pools	1 (86)	1 (83)	0
	Substrate quality	Fine sediment in spawning substrate	4 (76)	5 (70)	+1
	Riparian quality	Canopy	5	4	-1
		Amount of riparian vegetation cover	4	5	+1
		Riparian vegetation type	4	4	0
2[1]	***Channel complexity***	Amount of pool habitat	5 (9)	4 (3)	-1
		Depth of pools	2 (9)	4 (3)	+2
		Amount of shelter in pools	2 (9)	1 (3)	-1
		Complexity of shelter material in pools	2 (9)	1 (3)	-1
		Composite shelter quality in pools	1 (9)	1 (3)	0
	Substrate quality	Fine sediment in spawning substrate	3 (9)	1 (1)	-2
	Riparian quality	Canopy	5	5	0
		Amount of riparian vegetation cover	4	4	0
		Riparian vegetation type	5	5	0
3[1]	***Channel complexity***	Amount of pool habitat	4 (15)	na	na
		Depth of pools	1 (15)	na	na
		Amount of shelter in pools	2 (15)	na	na
		Complexity of shelter material in pools	4 (15)	na	na
		Composite shelter quality in pools	1 (15)	na	na
	Substrate quality	Fine sediment in spawning substrate	3 (14)	na	na
	Riparian quality	Canopy	5	na	na
		Amount of riparian vegetation cover	4	na	na
		Riparian vegetation type	4	na	na

[1] 2007 assessments were combined for reaches 2 and 3.

Table E-2. Anthropogenic point erosion sites on Crane Creek. RB (Right Bank), LB (Left Bank) and BB (Both Banks) refer to the stream bank when looking downstream. Site numbers are sorted from downstream to upstream.

Site number	Description and size	Cause	Comment
1	LB; 30’w, 5’h	Foundation for building near stream bank	Bank revetment work is inadequate
2	LB; size not noted	Private driveway crossing	Crossing itself is in poor condition
3	BB; only in vicinity of crossing	Private road crossing	Erosion is threatening to wash out road
4	RB; 10’w gully	Failed woods road that crosses ephemeral stream but has no culvert	Near the probable, existing, upstream limit of anadromy

Table E-3. Potential partial and complete passage barriers for life stages of anadromous salmonids in Crane Creek. Also shown is length of stream segment with critical habitat for CCC steelhead that is upstream of barrier. '% of total' is the percent of either critical habitat or the CDFG survey that is upstream of the barrier (A=Adult, S=Smolt, J=Juvenile). Site numbers are sorted from downstream to upstream.

						Length upstream				
			Upstream		Downstream	Critical habitat		CDFG Survey		
Barrier number	**CDFG Reach**	**Type**	**Partial**	**Complete**	**Partial**	**Miles**	**% of total**	**Miles**	**% of total**	**Description**
1[*]	1	Headcut	A J		A J	1.32	100	2.26	100	Incision and headcut due to artificially high flows in Dry Creek.
2	1	Culvert	A J		A J	0	0	0.57	25	Low flow barrier.
3	1	Flashboard dam	A J		A S J	0	0	0.56	25	Impacts depend on when and if flashboards are in.

[*] Priority 1 habitat restoration recommendation.

F. Dutcher Creek

In 1998 CDFG surveyed approximately 2.9 miles of the 3.7 miles of perennial stream length in Dutcher Creek (CDFG 2006b). That survey delineated one reach. Beginning at the mouth of the stream, NMFS ground-truthed approximately 1.4 miles of non-contiguous stream length in this reach on May 11 and 18, 2007; the furthest upstream we assessed was approximately 2.0 miles from the mouth (Table 5). Our assessment was non-contiguous because of limited landowner access. Stream flow was discontinuous in the lower 0.5 miles and upper 0.7 miles of the assessment segment. We observed juvenile steelhead distributed throughout the lower 0.9 miles of the stream. Habitat restoration projects were implemented in the lower 0.4 mile of the stream by CDFG and most appear to be functioning as intended.

Summary of habitat impairments (Tables F-1, F-2, F-3)

Reach 1. Land use adjacent to Dutcher Creek consists of viticulture and private homes. The downstream-most 0.5 miles of stream has low gradient and is bordered by vineyards and buildings associated with wineries and wine tasting rooms. In this downstream-most segment, the stream has been channelized relative to more upstream segments and therefore has few pool forms. The riparian vegetation in this area consists of some mature trees and is generally more diverse on one stream bank than the other. Upstream of the Dry Creek Road crossing, the riparian vegetation is consistently more mature and the riparian zone is less encroached by land use except for the many stream crossings. The stream has not been channelized here and the stream gradient is higher than downstream of Dry Creek Road. In the upstream-most 0.7 miles of the segment that we assessed, the channel is very narrow with almost no water, and there is extremely dense vegetation in the channel and on both banks.

The principal impairment of anadromous salmonid habitat in Dutcher Creek is six artificial passage barriers (including 5 stream crossings). Taylor et al. (2003) prioritized 78 stream crossings that should be addressed in order to improve fish passage in the Sonoma County portion of the Russian River Basin. Of the top 11 priorities they identified, four were on Dutcher Creek. The most severe problems are presented by two of the Dutcher Creek Road crossings. However, a private driveway just upstream of the downstream-most Dutcher Creek Road crossing is also a significant impediment to passage. The Dry Creek Road crossing is probably rarely a problem for adults during migration flows, but it undoubtedly restricts the movement of juveniles at even moderately low flows. Three of the six barriers are located in a 0.1 mile segment within 0.5 miles of the stream mouth. Collectively, they restrict access to over one-half of the stream length designated as critical habitat for CCC steelhead.

Besides barriers, impacts to anadromous fish come from both point and non-point sediment sources that are probably from adjacent land use. The effects of these sediment inputs are not necessarily reflected in our single metric of substrate conditions (embeddedness in pool tail-outs) because of the nature of these sediments. Riparian and canopy conditions are generally favorable except for the high densities of invasive plant species in some places (predominantly *Vinca spp.*) and the point erosion sites mentioned above.

Watershed and habitat restoration recommendations

The generally healthy riparian zone in Dutcher Creek should be protected and enhanced with native vegetation planting where it has been degraded. Land use activities that lead to disturbance of the riparian zone or further sediment entering the stream should be avoided.

Habitat restoration and protection- priority 1

- *Address artificial passage barriers located in downstream stream segments* [1]
  - ✓ Dry Creek Road crossing.
  - ✓ Dutcher Creek Road crossing.
  - ✓ Private driveway crossing.

Habitat restoration and protection- priority 2

- *Address artificial passage barriers located in upstream segments*

Habitat restoration and protection- priority 3

- *Enhance cover in existing pools*
  - ✓ Add large wood structures to pools in lower gradient portions of the stream.
- *Repair human-related point sources of sediment throughout the stream*

[1] Because of their close proximity to one another, these barriers should be addressed as a group. Failure to do so will only restore access to a very small amount of stream length.

Table F-1. Scores for nine indicator variables in Dutcher Creek based on the CDFG habitat survey (1998) and NMFS ground-truthing (May 11, 18, 2007). Scores range from least desirable (1) to most desirable (5). Differences indicate a possible change in the habitat factor since the CDFG survey in 1998 ('+' for better and '-' for worse).

CDFG Reach	Fundamental habitat factor	Habitat component	Score (sample size)		
			CDFG based	Ground-truth based	Difference
1	***Channel complexity***	Amount of pool habitat	3 (48)	5 (31)	+2
		Depth of pools	4 (48)	2 (30)	-2
		Amount of shelter in pools	2 (7)	1 (31)	-1
		Complexity of shelter material in pools	3 (7)	1 (31)	-2
		Composite shelter quality in pools	1 (7)	1 (31)	0
	Substrate quality	Fine sediment in spawning substrate	3 (48)	3 (28)	0
	Riparian quality	Canopy	5	4	-1
		Amount of riparian vegetation cover	5	5	0
		Riparian vegetation type	4	3	-1

Table F-2. Anthropogenic point erosion sites on Dutcher Creek. RB (Right Bank), LB (Left Bank) and BB (Both Banks) refer to the stream bank when looking downstream. Site numbers are sorted from downstream to upstream.

Site number	Description and size	Cause	Comment
1	BB; size not noted	County road crossing	The active channel is very wide downstream of here because of the erosion
2	BB; 10'w, 20'h	Wet crossing	Vicinity has been rip-rapped here but the rip-rap is not very effective at holding the bank
3	RB; width not noted, 9'h	Private driveway crossing	There is much bare soil on both banks in the vicinity of the crossing
4	BB; size not noted	County road crossing	LB erosion is more severe than the RB; has already been heavily rip-rapped
5	RB; 50'w, 20'h	Land use encroachment into the riparian zone	None

Table F-3. Potential partial and complete passage barriers for life stages of anadromous salmonids in Dutcher Creek. Also shown is length of stream segment with critical habitat for CCC steelhead that is upstream of barrier. '% of total' is the percent of either critical habitat or the CDFG survey that is upstream of the barrier (A=Adult, S=Smolt, J=Juvenile). Site numbers are sorted from downstream to upstream.

			Upstream		Downstream	Length upstream				
						Critical habitat		CDFG Survey		
Barrier number	**CDFG Reach**	**Type**	**Partial**	**Complete**	**Partial**	**Miles**	**% of total**	**Miles**	**% of total**	**Description**
1*	1	Culvert	A J		A J	0.71	62	2.42	85	Dry Creek Road. Would be passable at higher flows than we observed.
2*	1	Culvert		A J	A S J	0.63	54	2.33	82	Concrete apron is undercut and a dead end for upstream movement.
3*	1	Culvert	A	J	A S J	0.63	54	2.33	82	Crossing consists of 3 circular pipes.
4	1	Culvert	A	J	A S J	0	0	1.63	57	Low flow barrier for sure but even at higher flows may be impassable.
5	1	Fence	A		A	0	0	1.45	51	Wooden slat fence at upstream end of culvert.
6	1	Dam	A J		A S J	0	0	1.45	51	Dam made of concrete. Unknown purpose.

* Priority 1 habitat restoration recommendation.

G. Grape Creek

In 1998 CDFG surveyed approximately 2.3 miles of the 2.9 miles of perennial stream length in Grape Creek (CDFG 2006g). That survey delineated four reaches. Beginning at the mouth of the stream, NMFS ground-truthed approximately 1.9 miles of contiguous stream in two of those reaches on March 16, 19, and 26, 2007 (Table 5). Because we ground-truthed less than 10% of Reach 2, results for that reach are not reported. Stream flow was continuous throughout the assessment segment during our survey. We observed juvenile steelhead distributed throughout the downstream-most 1.5 miles of the stream. We also observed a live adult steelhead approximately 0.3 miles upstream from the mouth and a dead adult steelhead approximately 1 mile upstream from the mouth. In addition, we observed steelhead redds in the lower 1 mile of Grape Creek. Habitat restoration projects have been implemented in the past and are still evident in downstream segments of Reach 1. These include stream bank stabilization measures, reshaping over-steepened banks, native vegetation planting, and grade control structures (boulder and log weirs).

Summary of habitat impairments (Tables G-1, G-2, G-3)

<u>Reach 1.</u> Land use adjacent to the reach consists of viticulture, private homes, outbuildings, clearings, wet crossings, foot bridges, public and private roads, and livestock. Downstream of West Dry Creek Road, land use activities have been shifted away from the stream bank and ongoing restoration efforts have improved habitat conditions. With this exception, land use encroachment of the riparian zone tends to decrease with distance upstream in the reach. This leads to slightly higher, but still impaired, riparian vegetation quality in the upper part of the reach. Except for two notable, short stretches dominated by mature hardwoods and conifers, most of the stream canopy is provided by shrubs and young hardwood trees. The riparian corridor also includes high densities of invasive plant species.

We identified five artificial structures that are passage barriers for one or more life stages of anadromous salmonids. Taylor et al. (2003) prioritized 78 stream crossings that should be addressed to improve fish passage in the Sonoma County portion of the Russian River Basin. The West Dry Creek Road crossing was ranked 14. Some of the grade control structures installed to address fish passage at this crossing may also impede fish passage at moderately low flows. Depending on their operation schedule, three flashboard dams may also be at least seasonal barriers to fish passage.

Sediment is being delivered from several point sources of erosion as well as from many of the collapsing stream banks that are the result of the highly entrenched stream channel (~10 foot high vertical stream banks). Overall, the reach has low gradient, and fine sediments have accumulated in pool tail-outs resulting in habitat scores indicating deleteriously high levels of embeddedness (*i.e*., substrate quality score of 2) .

There is an on-stream storage pond upstream of a flashboard dam that is freely accessible to livestock in the upper part of the reach. Although located upstream of the majority of salmonid rearing habitat, the effects of this reservoir and the livestock that use it probably include elevated water temperatures (due to the impoundment and impairment of riparian vegetation) and nutrient inputs (from animal waste) that may have effects reaching downstream into nearby salmonid rearing habitat.

Watershed and habitat restoration recommendations

Watershed restoration

Where possible, channel encroachment from bordering land use activities (mostly viticulture) and artificial confinement should be alleviated to allow Grape Creek's channel to reconnect to its floodplain. Combined with remediation efforts (see habitat restoration priorities below) this would help in addressing artificial passage barriers and reduce the input of fine sediment.

Habitat restoration and protection- priority 1

- *Address artificial passage barriers located in downstream stream segments*
  - ✓ West Dry Creek Road crossing.
  - ✓ Further evaluate the impacts and effects of operation schedule of lower reach, on-stream storage dams on fish movement.

Habitat restoration and protection- priority 2

- *Reduce fine sediment input*
  - ✓ Reshape and plant (with native vegetation) over-steepened stream banks that are the result of artificial confinement and channel incisement. This is an important step towards reconnecting the stream to its flood plain while simultaneously filtering fine sediment from stream runoff.
  - ✓ Repair human-related point sources of sediment throughout the stream.
- *Livestock management*
  - ✓ Livestock access to the stream should be carefully managed.
  - ✓ Develop and implement a water quality monitoring plan focused on assessing the impacts of livestock access to the creek.
  - ✓ Livestock fence across the stream should be evaluated for need and removed and/or replaced with alternative types of fencing (*e.g.*, floating fence) as needed.
- *Enhance cover in existing pools*
  - ✓ Add large wood structures to pools in lower gradient portions of Reach 1.

Habitat restoration and protection- priority 3

- *Address fish passage issues caused by grade control structures*
  - ✓ Boulder weirs to address fish passage at the West Dry Creek Road crossing should be adjusted to facilitate movement of all salmonid life stages over a broader range of flows. These structures should then be periodically inspected and readjusted to maximize fish passage. Ideally, a properly designed and implemented solution to the West Dry Creek Road crossing would obviate the need for these grade control structures altogether.

Table G-1. Scores for nine indicator variables in Grape Creek based on the CDFG habitat survey (1998) and NMFS ground-truthing (March 16, 19, and 26, 2007). Scores range from least desirable (1) to most desirable (5). Differences indicate a possible change in the habitat factor since the CDFG survey in 1998 ('+' for better and '-' for worse). No assessment is indicated by 'na'.

CDFG Reach	**Fundamental habitat factor**	**Habitat component**	**Score (sample size)**		
			CDFG based	**Ground-truth based**	**Difference**
1	***Channel complexity***	Amount of pool habitat	3 (85)	5 (103)	+2
		Depth of pools	1 (78)	5 (102)	+4
		Amount of shelter in pools	2 (81)	3 (103)	+1
		Complexity of shelter material in pools	5 (81)	3 (103)	-2
		Composite shelter quality in pools	1 (81)	1 (103)	0
	Substrate quality	Fine sediment in spawning substrate	2 (80)	2 (37)	0
	Riparian quality	Canopy	5	4	-1
		Amount of riparian vegetation cover	4	4	0
		Riparian vegetation type	4	3	-1
2	***Channel complexity***	Amount of pool habitat	3 (8)	na	na
		Depth of pools	3 (6)	na	na
		Amount of shelter in pools	3 (7)	na	na
		Complexity of shelter material in pools	4 (7)	na	na
		Composite shelter quality in pools	1 (7)	na	na
	Substrate quality	Fine sediment in spawning substrate	3 (8)	na	na
	Riparian quality	Canopy	5	na	na
		Amount of riparian vegetation cover	3	na	na
		Riparian vegetation type	4	na	na
3	***Channel complexity***	Amount of pool habitat	4 (7)	na	na
		Depth of pools	1 (7)	na	na
		Amount of shelter in pools	3 (7)	na	na
		Complexity of shelter material in pools	3 (7)	na	na
		Composite shelter quality in pools	1 (7)	na	na
	Substrate quality	Fine sediment in spawning substrate	1 (7)	na	na
	Riparian quality	Canopy	5	na	na
		Amount of riparian vegetation cover	2	na	na
		Riparian vegetation type	4	na	na
4	***Channel complexity***	Amount of pool habitat	3 (8)	na	na
		Depth of pools	3 (8)	na	na
		Amount of shelter in pools	3 (7)	na	na
		Complexity of shelter material in pools	5 (7)	na	na
		Composite shelter quality in pools	1 (7)	na	na
	Substrate quality	Fine sediment in spawning substrate	1 (8)	na	na
	Riparian quality	Canopy	5	na	na
		Amount of riparian vegetation cover	3	na	na
		Riparian vegetation type	4	na	na

Table G-2. Anthropogenic point erosion sites on Grape Creek. RB (Right Bank), LB (Left Bank) and BB (Both Banks) refer to the stream bank when looking downstream. Site numbers are sorted from downstream to upstream.

Site number	Description and size	Cause	Comment
1	LB; 10'w, 20'h	Drainage culvert through gravel parking lot	Also livestock paddock here
2	LB; 30'w, 15'h	Burn pile and slash pushed into stream	Ash pile actually in stream (quite recent); landowner outreach is needed
3	RB; size not noted	Stumps thrown in stream	Old willow wall failing here too
4	RB; size not noted	"Shotgun[1]" drainage culvert	None
5	BB; only in vicinity of crossing	Private driveway bridge crossing stream	None
6	RB; 10'w, 20'h	"Shotgun" drainage culvert	Sediment from erosion extends downstream to site number 5; landowner outreach is needed
7	BB (mostly on RB); size not noted	Extensive vegetation clearing	Sediment from erosion extends downstream to site number 5; landowner outreach is needed
8	BB (mostly on RB); size not noted	Extensive livestock grazing and access to creek	Site is just upstream of an on-stream storage (summer) dam; upstream of the probable natural limit to anadromy

[1] A "shotgun" culvert refers to a culvert with the downstream end suspended above the ground.

Table G-3. Potential partial and complete passage barriers for life stages of anadromous salmonids in Grape Creek. Also shown is length of stream segment with critical habitat for CCC steelhead that is upstream of barrier. '% of total' is the percent of either critical habitat or the CDFG survey that is upstream of the barrier (A=Adult, S=Smolt, J=Juvenile). Site numbers are sorted from downstream to upstream.

						Length upstream				
			Upstream		**Downstream**	**Critical habitat**		**CDFG Survey**		
Barrier number	**CDFG Reach**	**Type**	**Partial**	**Complete**	**Partial**	**Miles**	**% of total**	**Miles**	**% of total**	**Description**
1	1	Flashboard dam	A J			2.11	92	2.09	92	Low flow barrier. Unclear if dam is still being used.
2	1	Grade control	A J		A S J	2.10	91	2.08	91	Multiple boulder weirs for grade control downstream of West Dry Creek Road
3[*]	1	Culvert	A J		A S J	1.98	86	1.95	86	West Dry Creek Road. Just wet concrete under road and therefore impassable at time of assessment.
4	1	Flashboard dam	A J		A S J	1.94	84	1.91	84	Probably not a barrier without flashboards. However, flashboards were in at time of assessment.
5	1	Culvert	A J		A S J	1.07	47	1.04	46	Depth in structure was too low for passage at time of assessment.
6	1	Fence	A		A	not calculated		not calculated		Could be a debris catcher and/or low flow barrier.

[*] Priority 1 habitat restoration recommendation.

H. Wine Creek

In 1998 CDFG surveyed approximately 1.9 miles of the 2.9 miles of perennial stream length in Wine Creek (CDFG 2006j). That survey delineated eight reaches. Beginning at the mouth of the stream, NMFS ground-truthed approximately 1.9 miles of contiguous stream length on March 19 and 23, 2007 (Table 5). At that time, stream flow was continuous throughout the assessment segment. We observed juvenile steelhead and steelhead redds distributed throughout the lower 1 mile of Wine Creek. Habitat restoration projects have been implemented in the past in Reaches 1-3 including stream bank stabilization, native vegetation planting, and grade control structures (boulder and log weirs).

Summary of habitat impairments (Tables H-1, H-2, H-3)

Reach 1. The major land use adjacent to this reach of Wine Creek is viticulture but there are also a few private homes visible from the stream channel including driveways, farm roads, and outbuildings. There is one road crossing (a culvert). In some cases, human encroachment (including roads) is less than 10 feet from the top of the stream bank. The stream channel is entrenched (~10 foot high banks) with some over-steepened and collapsing stream banks. The riparian corridor is characterized by high amounts of invasive plant species (including *Vinca spp*). Although canopy closure is fairly high, most of it consists of shrubs and young hardwood trees.

There is a high amount of silt in the stream channel particularly in the upper part of the reach. Sediment entering upstream of the reach may be settling out in this part of the reach due to its low gradient; however, sediment may also be entering the channel from roads adjacent to the channel. In combination with point sources of erosion, the incised channel and near-vertical stream banks are probably also contributing sediment. This is reflected in the deleteriously high embeddedness levels for this reach.

The boulder and log weirs that were installed in the reach to either act as grade control structures downstream of the Koch Road culvert or address sediment issues have been largely successful at improving habitat conditions. However, in some cases, even at moderately low stream flows, the structures themselves are acting as partial barriers to adult migration and juvenile movement.

Reach 2. Reach 2 has a somewhat higher gradient than Reach 1. The major land use adjacent to the stream channel is a few private homes, and Koch Road that parallels the stream channel for the entire length of the reach. In some cases there is high encroachment of private dwellings including a rock wall stream bank revetment, a network of foot paths and associated foot bridges, riparian vegetation clearing, and extensive invasive plant species on both stream banks. The stream channel is incised although somewhat less than Reach 1. Overall, the riparian corridor is characterized by fewer invasive plants than Reach 1, and most of the excellent stream canopy is provided by mature hardwoods and conifers. Koch Road on the right bank is close to the stream channel in most places and is very likely contributing sediment to the stream.

Reaches 3 and 4. Land use adjacent to these reaches appears to be restricted to Koch Road which continues to parallel the stream channel on the right bank for the entire length of both reaches. A second road near the downstream end of Reach 3 joins Koch Road very close to a stream crossing that was recently replaced by CDFG. The presence of these two roads and the associated steep hillsides act to concentrate sediment and direct fine sediment into the stream. The high canopy closure provided by mature hardwoods and coniferous trees continues in these reaches. Despite the apparent source of large woody debris from the mature riparian corridor, cover quality in pools is generally low and may be a reflection of past efforts to remove wood from the stream channel. Grade control structures near the downstream end of Reach 3 that were installed as part of the CDFG bridge replacement project are creating at least partial passage barriers to salmonids even under moderately low flow.

Reach 5. Land use adjacent to this reach appears to be restricted to Koch Road which continues to parallel the stream channel for the entire length of the reach and eventually crossing the stream at the top of the reach where a culvert forms a partial fish passage barrier. This is a short reach with high gradient consisting almost entirely of bedrock cascades. These cascades probably present a natural, complete barrier to migration for adults in most years. Landowners upstream of this reach reported that they have never seen adult steelhead above these cascades. The mature riparian vegetation and canopy continues in this reach.

Reaches 6 and 7. The major land use adjacent to the stream channel is private homes and associated encroachment including a summer dam, road crossings, and foot bridges. Good canopy continues in these reaches except around some of the private homes where the natural riparian vegetation has been disturbed and invasive plant species are dominating the riparian zone.

Reach 8 and upstream of reach 8. There is no evidence of land use encroachment in this segment of Wine Creek except near the extreme upper portion of Reach 8 where there has been some recent forestry activity. However, upstream of Reach 8, a failed project to develop a roads network on extremely steep slopes still shows signs of delivering fine sediment to the stream. The severe channel incisement in the upper portion of Reach 8 may be due to this project. Remediation efforts immediately following the failure of the project included the installation of silt fencing to prevent additional sediment from reaching the stream. Unfortunately, the fence is beginning to deteriorate and natural vegetation is probably not substantial enough to stabilize the slope and keep sediment out of the channel. Accounts from fisheries professionals and landowners indicate that during the winter of 2001 and again in 2002, a huge amount of sediment moved into the channel and settled out as far downstream as Reach 1. The high canopy closure over the stream continues in Reach 8 except around some of the forest clearing in the upper reach.

Watershed and habitat restoration recommendations

Watershed restoration

Because of Wine Creek's acute sedimentation problems, immediate identification of the sources and steps to reduce fine sediment input is paramount. This would necessitate a coordinated, watershed-wide effort that addresses roads, past and present impacts from land use, repair of human-related erosion sites, and alleviation of channelization and riparian encroachment.

Habitat restoration and protection- priority 1

- *Reduce fine sediment input*
  - ✓ Immediate steps should be taken to reduce the likelihood of a second large sedimentation event associated with the failed roads project upstream of Reach 8.
  - ✓ Identify non-point sources of fine sediment inputs including a general roads assessment in the watershed that pays careful attention to the sediment contribution of

Koch Road. For road segments that can not be re-aligned, ways to divert sediment (*e.g.*, water bars, diversion ditches) before it enters the stream channel should be identified and implemented.

- ✓ Implement projects to reshape and plant (with native vegetation) over-steep stream banks that result from the unnaturally confined and entrenched stream channel in Reach 1.
- ✓ Repair human-related erosion sites throughout the stream.

<u>Habitat restoration and protection- priority 2</u>

- *Enhance cover in existing pools*
  - ✓ Add large wood structures to pools in lower gradient portions of Reaches 1-4.
- *Design and build pools for juvenile rearing*
  - ✓ Construct pools in Reaches 1-4.
  - ✓ Enhance cover in newly constructed pools by adding large wood structures.
- *Address fish passage issues caused by grade control structures*
  - ✓ Boulder and log weirs in downstream reaches should be adjusted to facilitate movement of all salmonid life stages over a broader range of flows. These structures should then be periodically inspected and readjusted to maximize fish passage.

<u>Habitat restoration and protection- priority 3</u>

- *Address artificial passage barrier located in upstream stream segment*
  - ✓ The culvert associated with the road crossing at the top of Reach 5 presents a partial barrier to fish passage. However, given the presence of the natural barrier (bedrock cascades) immediately downstream of the road crossing, measures to address this artificial barrier should be given low priority within the watershed.

Table H-1. Scores for nine indicator variables in Wine Creek based on the CDFG habitat survey (1998) and NMFS ground-truthing (March 19 and 23, 2007). Scores range from least desirable (1) to most desirable (5). Differences indicate a possible change in the habitat factor since the CDFG survey in 1998 ('+' for better and '-' for worse). No stream assessment is indicated by 'na'.

			Score (sample size)		
CDFG Reach	**Fundamental habitat factor**	**Habitat component**	**CDFG based**	**Ground-truth based**	**Difference**
1	***Channel complexity***	Amount of pool habitat	5 (21)	2 (16)	-3
		Depth of pools	2 (19)	3 (16)	+1
		Amount of shelter in pools	1 (20)	2 (16)	+1
		Complexity of shelter material in pools	2 (20)	1 (16)	-1
		Composite shelter quality in pools	1 (20)	1 (16)	0
	Substrate quality	Fine sediment in spawning substrate	2 (19)	1 (15)	-1
	Riparian quality	Canopy	4	4	0
		Amount of riparian vegetation cover	5	3	-2
		Riparian vegetation type	3	2	-1
2	***Channel complexity***	Amount of pool habitat	3 (8)	2 (7)	-1
		Depth of pools	4 (7)	3 (7)	-1
		Amount of shelter in pools	2 (7)	1 (7)	-1
		Complexity of shelter material in pools	5 (7)	1 (7)	-4
		Composite shelter quality in pools	1 (7)	1 (7)	0
	Substrate quality	Fine sediment in spawning substrate	2 (8)	1 (6)	-1
	Riparian quality	Canopy	5	5	0
		Amount of riparian vegetation cover	4	4	0
		Riparian vegetation type	4	5	+1
3	***Channel complexity***	Amount of pool habitat	3 (15)	2 (15)	-1
		Depth of pools	1 (12)	3 (15)	+2
		Amount of shelter in pools	2 (14)	2 (15)	0
		Complexity of shelter material in pools	4 (14)	2 (15)	-2
		Composite shelter quality in pools	1 (14)	1 (15)	0
	Substrate quality	Fine sediment in spawning substrate	1 (12)	3 (12)	+2
	Riparian quality	Canopy	5	5	0
		Amount of riparian vegetation cover	4	2	-2
		Riparian vegetation type	4	2	-2
4	***Channel complexity***	Amount of pool habitat	5 (2)	2 (4)	-3
		Depth of pools	5 (2)	3 (4)	-2
		Amount of shelter in pools	3 (2)	2 (4)	-1
		Complexity of shelter material in pools	3 (2)	2 (4)	-1
		Composite shelter quality in pools	1 (2)	1 (4)	0
	Substrate quality	Fine sediment in spawning substrate	1 (2)	4 (3)	+3
	Riparian quality	Canopy	5	5	0
		Amount of riparian vegetation cover	5	3	-2
		Riparian vegetation type	4	4	0

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CDFG Reach	Fundamental habitat factor	Habitat component	Score (sample size)		
			CDFG based	Ground-truth based	Difference
5	***Channel complexity***	Amount of pool habitat	5 (1)	5 (3)	0
		Depth of pools	1 (1)	5 (3)	+4
		Amount of shelter in pools	1 (1)	1 (3)	0
		Complexity of shelter material in pools	1 (1)	1 (3)	0
		Composite shelter quality in pools	1 (1)	1 (3)	0
	Substrate quality	Fine sediment in spawning substrate	1 (1)	1 (1)	0
	Riparian quality	Canopy	5	5	0
		Amount of riparian vegetation cover	5	3	-2
		Riparian vegetation type	4	4	0
6	***Channel complexity***	Amount of pool habitat	5 (23)	na	na
		Depth of pools	2 (21)	na	na
		Amount of shelter in pools	3 (22)	na	na
		Complexity of shelter material in pools	5 (22)	na	na
		Composite shelter quality in pools	1 (22)	na	na
	Substrate quality	Fine sediment in spawning substrate	1 (22)	na	na
	Riparian quality	Canopy	5	na	na
		Amount of riparian vegetation cover	5	na	na
		Riparian vegetation type	4	na	na
7	***Channel complexity***	Amount of pool habitat	3 (8)	na	na
		Depth of pools	3 (8)	na	na
		Amount of shelter in pools	3 (8)	na	na
		Complexity of shelter material in pools	5 (8)	na	na
		Composite shelter quality in pools	1 (8)	na	na
	Substrate quality	Fine sediment in spawning substrate	1 (8)	na	na
	Riparian quality	Canopy	4	na	na
		Amount of riparian vegetation cover	4	na	na
		Riparian vegetation type	4	na	na
8	***Channel complexity***	Amount of pool habitat	3 (21)	na	na
		Depth of pools	3 (19)	na	na
		Amount of shelter in pools	3 (21)	na	na
		Complexity of shelter material in pools	5 (21)	na	na
		Composite shelter quality in pools	1 (21)	na	na
	Substrate quality	Fine sediment in spawning substrate	1 (19)	na	na
	Riparian quality	Canopy	5	na	na
		Amount of riparian vegetation cover	4	na	na
		Riparian vegetation type	4	na	na

Table H-2. Anthropogenic point erosion sites on Wine Creek. RB (Right Bank), LB (Left Bank) and BB (Both Banks) refer to the stream bank when looking downstream. Site numbers are sorted from downstream to upstream.

Site number	Description and size	Cause	Comment
1	LB; 75'w, 6'h	Old woods road	Upstream of the probable upstream limit of anadromy
2	RB; 15'w, 15'h	Eroding drainage culvert for private driveway	Upstream of the probable upstream limit of anadromy
3	LB; 150'w, 20'h	Private roads and deforestation	Silt fence is in place but it is beginning to fail; need a plan for restoring the entire hillside; Upstream of the probable upstream limit of anadromy
4[*]	BB; 100'w, 30'h	Private roads and deforestation	Silt fence is in place but it is beginning to fail; need a plan for restoring the entire hillside; Upstream of the probable upstream limit of anadromy

[*] Priority 1 habitat restoration recommendation.

Table H-3. Potential partial and complete passage barriers for life stages of anadromous salmonids in Wine Creek. Also shown is length of stream segment with critical habitat for CCC steelhead that is upstream of barrier. '% of total' is the percent of either critical habitat or the CDFG survey that is upstream of the barrier (A=Adult, S=Smolt, J=Juvenile). Site numbers are sorted from downstream to upstream.

						Length upstream				
			Upstream		Downstream	Critical habitat		CDFG Survey		
Barrier number	**CDFG Reach**	**Type**	**Partial**	**Complete**	**Partial**	**Miles**	**% of total**	**Miles**	**% of total**	**Description**
1	1	Grade control	A J		A S J	1.38	76	1.45	77	Seven boulder and log weirs in a 0.1 mile segment.
2	3	Grade control	A J		A S J	1.13	62	1.20	63	Grade control structures in the vicinity of a newly replaced bridge.
3	6	Culvert	A J		A S J	0.72	40	0.79	42	Low flow barrier. Bottom of culvert is rusting through
4	6	Culvert	A J		A S J	0.64	35	0.71	38	Low flow barrier. There is concrete in the culvert.
5	6	Flashboard dam	A J		A S J	0.42	23	0.49	26	Landowner says it is a "summer" dam.

3.1.3 Knights Valley

For the four project streams in Knights Valley, NMFS ground-truthed habitat conditions for 73% of the stream length previously surveyed by CDFG (Table 6). This represents 70% of the critical habitat for CCC steelhead in these streams. We evaluated all of the critical habitat on Foote Creek, the majority of critical habitat on Maacama Creek (92%) and Redwood Creek (96%), and 42% of the critical habitat on Franz Creek.

Through visual observation, we documented steelhead in all four Knights Valley project streams in 2007. In 2001, coho salmon were found in Redwood Creek about one-half of the way up the mainstem (CDFG 2006i). In 1993, coho were also found in the mainstem of Redwood just downstream of its confluence with Kellogg and Yellowjacket Creeks (Merritt Smith Consulting 2003). Based on these accounts, we conclude that Redwood Creek or other streams in the Maacama system may currently support or have the potential to support coho salmon populations.

Table 6. Lengths of Knights Valley project streams surveyed by CDFG, CCC steelhead critical habitat, ground-truthed by NMFS, and percentage ground-truthed.

		Stream length (miles)			Ground-truthed as a percentage of:	
Stream	**CDFG reach**	**CDFG Reach**	**CCC steelhead critical habitat**	**Ground-truthed**	**CDFG Reach**	**CCC steelhead critical habitat**
Foote Creek	1	1.35	1.28	1.35	100%	100%
	2	0.42	0	0.42	100%	100%
	Total	***1.77***	***1.28***	***1.77***	***100%***	***100%***
Franz Creek	1	3.11	3.11	0.82	26%	26%
	2	0.37	0.37	0	0%	0%
	3	0.96	0.96	0.75	78%	78%
	4	0.73	0.73	0.73	100%	100%
	5	2.36	2.36	2.36	100%	100%
	6	0.53	0.53	0	0%	0%
	7	0.63	0.63	0	0%	0%
	8	0.16	0.16	0	0%	0%
	9	0.49	0.49	0	0%	0%
	Upstream	0	0.71	0	No CDFG survey	0%
	Total	***10.34***	***11.05***	***4.66***	***45%***	***42%***
Maacama Creek	1	3.76	3.76	3.46	92%	92%
	2	0.35	0.35	0.34	97%	97%
	3	1.50	1.50	1.23	82%	82%
	4	1.58	1.58	1.58	100%	100%
	Total	***7.19***	***7.19***	***6.61***	***92%***	***92%***

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Stream	CDFG reach	Stream length (miles)			Ground-truthed as a percentage of:	
		CDFG Reach	CCC steelhead critical habitat	Ground-truthed	CDFG Reach	CCC steelhead critical habitat
Redwood Creek	1	1.84	1.84	1.84	100%	100%
	2	2.61	2.61	2.44	93%	93%
	Total	***4.45***	***4.45***	***4.28***	96%	96%
Knights Valley totals:		**24.0**	**24.0**	**17.3**[1]	**72%**	**70%**

DRAFT

[1] Includes 0.42 miles on Foote Creek that is upstream of the extent of critical habitat for CCC steelhead.

I. Foote Creek

In 1997 CDFG surveyed approximately 1.8 miles of the 2.8 miles of perennial stream length in Foote Creek (CDFG 2006c). Their survey delineated two reaches. Beginning at the mouth of the stream, NMFS ground-truthed the same stream length in both reaches on April 3 and 6, 2007 (Table 6). During this survey, stream flow was continuous throughout the assessment segment. We observed juvenile steelhead distributed throughout the lower 1.4 miles of the assessment segment.

Summary of habitat impairments (Tables I-1, I-2, I-3)

Reach 1. Land use is primarily viticulture in the downstream-most 0.75 mile of the stream. In this lower segment, the stream is artificially channelized with levies and rip-rap. There is a private road on the top of the stream bank. The channel is incised and contributing sediment from the over-steep banks. This is particularly true in the vicinity of the Highway 128 crossing. Canopy closure is moderate and, along with stream bank vegetation, consists mostly of young hardwoods and shrubs. The pools are infrequent and have low amounts of cover.

Land use adjacent to the upper 0.6 mile of the reach is dominated by cattle ranching. This portion is characterized by low canopy closure and stream bank vegetation consisting mostly of grass. The channel is unconfined and stream banks are generally stable except in a few cases where erosion is occurring from cattle access to the stream. Pools are relatively more frequent in this segment, though they still have low scores for depth and cover. Filamentous green algae are prevalent on the stream substrate throughout most of the reach suggesting excessive nutrient inputs. There are two artificial passage barriers that impact fish passage at low flows; one is a flashboard dam and the other is a head cut resulting from efforts to stabilize a wet crossing.

Reach 2. Reach 2 is an artificially created stream channel associated with an off-stream reservoir. Currently, the artificial stream channel extends upstream of the reservoir for a few hundred yards. At the upstream end of the reservoir the channel was dammed to create the reservoir; therefore, at this point the stream becomes impassable to all life stages of salmonids. The stream channel adjacent to the reservoir is severely incised and includes a concrete structure that may have been constructed as a grade control for a nearby wet crossing. That structure is at least partially impassable to all life stages of salmonids during low stream flows. Canopy closure is high and pool frequency and depths are greater than in Reach 1. Shelter values for pools remain low.

Watershed and habitat restoration recommendations

Watershed restoration

Sediment inputs to Foote Creek could be significantly reduced by reducing riparian encroachment from viticulture and cattle ranching. Along with remediation measures (see habitat restoration priorities below), alleviating stream channelization in the vicinity of Highway 128 would help allow the stream to reconnect to its floodplain.

Habitat restoration and protection- priority 1

- *Address artificial passage barriers in Reach 1*

- ✓ The artificial passage barrier caused by the flashboard dam should be addressed by modifying or removing it if it is no longer used.
- ✓ Seek an alternative to the wet crossing and address the head-cut it created.

- *Livestock management*
  - ✓ Develop and implement a water quality monitoring plan focused on assessing the impacts of livestock access to the stream.
  - ✓ The riparian zone needs to be better protected and allowed to widen and diversify by restricting or managing cattle access to the stream.
- *Riparian enhancement*
  - ✓ Native vegetation should be planted in the upstream portion of Reach 1 to replace the current vegetation which provides very little canopy closure or large woody debris for instream cover.

<u>Habitat restoration and protection- priority 2</u>

- *Reduce fine sediment input to the stream*
  - ✓ Reshape and plant (with native vegetation) over-steep banks in the lower portion of Reach 1.
  - ✓ Repair human-related point sources of sediment.
  - ✓ Manage livestock access and wet crossings
- *Design and build pools for juvenile rearing*
  - ✓ Construct pools in low gradient stream segments.
  - ✓ Enhance cover in newly constructed pools by adding large wood structures.

<u>Habitat restoration and protection- priority 3</u>

- *Address artificial passage barriers in Reach 2*
  - ✓ Review operation of the reservoir dam to minimize impacts to the downstream channel.
- *Enhance cover in existing pools*
  - ✓ Add large wood structures to pools in lower gradient portions of the stream.

Table I-1. Scores for nine indicator variables in Foote Creek based on the CDFG habitat survey (1997) and NMFS ground-truthing (April 3 and 6, 2007). Scores range from least desirable (1) to most desirable (5). Differences indicate a possible change in the habitat factor since the CDFG survey in 2001 ('+' for better and '-' for worse). No stream assessment is indicated by 'na'.

CDFG Reach	Fundamental habitat factor	Habitat component	Score (sample size)		
			CDFG based	Ground-truth based	Difference
1	***Channel complexity***	Amount of pool habitat	3 (6)	2 (24)	-1
		Depth of pools	1 (5)	3 (24)	+2
		Amount of shelter in pools	2 (6)	1 (24)	-1
		Complexity of shelter material in pools	3 (6)	1 (24)	-2
		Composite shelter quality in pools	1 (6)	1 (24)	0
	Substrate quality	Fine sediment in spawning substrate	3 (6)	2 (22)	-1
	Riparian quality	Canopy	3	3	0
		Amount of riparian vegetation cover	4	na	na
		Riparian vegetation type	3	2	-1
2	***Channel complexity***	Amount of pool habitat	5 (6)	5 (11)	0
		Depth of pools	1 (3)	5 (11)	+4
		Amount of shelter in pools	1 (5)	2 (10)	+1
		Complexity of shelter material in pools	5 (5)	2 (10)	-3
		Composite shelter quality in pools	1 (5)	1 (10)	0
	Substrate quality	Fine sediment in spawning substrate	5 (6)	5 (10)	0
	Riparian quality	Canopy	4	4	0
		Amount of riparian vegetation cover	3	na	na
		Riparian vegetation type	4	4	0

Table I-2. Anthropogenic point erosion sites on Foote Creek. RB (Right Bank), LB (Left Bank) and BB (Both Banks) refer to the stream bank when looking downstream.

Site number	Description and size	Cause	Comment
1	LB; 50’w, 6’h	Cattle access to stream	Willow sprigs and wall have only been somewhat effective in stabilizing bank

Table I-3. Potential partial and complete passage barriers for life stages of anadromous salmonids in Foote Creek. Also shown is length of stream segment with critical habitat for CCC steelhead that is upstream of barrier. '% of total' is the percent of either critical habitat or the CDFG survey that is upstream of the barrier (A=Adult, S=Smolt, J=Juvenile). Site numbers are sorted from downstream to upstream.

						Length upstream				
			Upstream		Downstream	Critical habitat		CDFG Survey		
Barrier number	**CDFG Reach**	**Type**	**Partial**	**Complete**	**Partial**	**Miles**	**% of total**	**Miles**	**% of total**	**Description**
1	1	Flashboard dam	J		J	0.4	33	0.9	52	Concrete footer is all that remains; dam could not be functional again without rebuilding
2	1	Wet crossing and head-cut	A	J	A J S	0.1	6	0.6	32	Concrete and boulders were used to contain a wet crossing and have resulted in a head-cut with a jump height for upstream migration of ~5 feet
3	1	Wet crossing and head-cut	A	J	A J S	0	0	0.4	22	Boulders were used to contain a wet crossing and have resulted in a head-cut with a jump height for upstream migration of ~5 feet
4	2	Dam		A J	A S J	0	0	0.2	12	Dam is related to the creation of an off-stream reservoir- impassable to upstream passage of all life stages of salmonids

J. Franz Creek

In 1997 CDFG surveyed approximately 10.3 miles of the 14.1 miles of perennial stream length in Franz Creek (CDFG 2006d). Their survey delineated nine reaches. Beginning at the mouth of the stream, NMFS ground-truthed 4.7 miles of non-contiguous stream length in five of the reaches on June 12, 13, and 15, 2007; the furthest downstream we assessed was approximately 0.6 miles from the mouth and the furthest upstream we assessed was approximately 7.5 miles from the mouth (Table 6). Our assessment was non-contiguous because of limited landowner access. During the survey, stream flow was discontinuous throughout the lower 0.6 miles of the assessment segment but continuous throughout the remainder. We observed juvenile steelhead distributed throughout the upper 6.9 miles of the assessment segment.

Summary of habitat impairments (Tables J-1, J-2, J-3)

Reach 1. For the 0.8 miles (26%) of the reach that we ground-truthed, adjacent land use is viticulture and rural residential. The riparian zone does not seem to be encroached by these activities except for a farm road that is on top of a stream bank near the top of the assessment reach. Gradient is low, there are few pools and the active channel is relatively wide and unconfined. Riparian vegetation is diverse and mature and the canopy is dominated by hardwoods.

Reach 2. Not assessed by NMFS.

Reach 3. Cattle ranching is the predominant land use adjacent to the reach. There is evidence of cattle accessing the creek in the lower portion of this reach. The channel in the middle portion of the assessment segment is naturally confined, and the lower and upper portions are unconfined. The riparian quality and canopy closure are moderate to high.

Reach 4. The stream channel is quite sinuous in this reach and has frequently moved back and forth across the floodplain as evidenced by unstable cobble bars and old stream channels with exposed substrate that lack established vegetation. Natural channel confinement alternates between stream banks along the reach. Riparian quality and canopy closure are both high and hardwood dominated. Near the top of the reach, there are two wet crossings and more evidence of cattle; both the crossings and cattle may be contributing minor amounts of sediment to the reach. Pools are infrequent and their depths and shelter ratings scored low.

Reach 5. In the lower one-half of the reach, the only signs of land use impacts are from an abandoned farm road on the right bank and one small segment where Franz Valley Road is close to the stream and has washed out a portion of the stream bank (the stream bank has been repaired with rock rip-rap). Stream gradient in the lower one-half is fairly steep and dominated by larger substrate than either Reach 3 or 4. Canopy closure and riparian quality are also higher in the lower one-half of the reach. Stream gradient is quite low in the upper one-half.

Because embeddedness values are averaged over the reach, our overall embeddedness values do not reflect the high amount of fine sediment we observed in some portions of the reach. We suspect the fine sediment is from the higher encroachment into the riparian zone from land use activities in the upper one-half of the reach. Most of this land use is rural residential with some small vineyards. The riparian vegetation is dense and canopy closure is still relatively high but they are both from low growing shrubs. Road crossings are more numerous but we can not rule out the possibility of sediment sources coming from sources upstream of this reach as well.

Reaches 6, 7, 8 and 9. Not assessed by NMFS.

Watershed and habitat restoration recommendations

Watershed restoration

Most of the problems we observed in Franz Creek were related to sediment deposition and some points of erosion along the narrow riparian zone in Reach 5. A more complete assessment of sediment sources is warranted, but we suspect that much of it is from roads and cumulative land use impacts in the upper portion of Reach 5.

Habitat restoration and protection- priority 1

- *Identify and reduce fine sediment input to the stream*
  - ✓ Assess sediment delivery to Reach 5 from road crossings and upslope road network.
  - ✓ Repair human-related erosion sites.

Habitat restoration and protection- priority 2

- *Enhance cover in existing pools*
  - ✓ Add large wood structures to pools in lower gradient portions of the stream.
- *Design and build pools for juvenile rearing*
  - ✓ Construct pools in Reaches 3- 5.
  - ✓ Enhance cover in newly constructed pools by adding large wood structures.

Habitat restoration and protection- priority 3

- *Livestock management*
  - ✓ Manage livestock access to the stream in Reach 4.
- *Evaluate the need and remove artificial structures that are acting as barriers*

Table J-1. Scores for nine indicator variables in Franz Creek based on the CDFG habitat survey (1997) and NMFS ground-truthing (June 12, 13, and 15, 2007). Scores range from least desirable (1) to most desirable (5). Differences indicate a possible change in the habitat factor since the CDFG survey in 2001 ('+' for better and '-' for worse). No stream assessment is indicated by 'na'.

CDFG Reach	Fundamental habitat factor	Habitat component	Score (sample size) CDFG based	Score (sample size) Ground-truth based	Score (sample size) Difference
1	***Channel complexity***	Amount of pool habitat	3 (38)	5 (13)	+2
		Depth of pools	2 (38)	5 (13)	+3
		Amount of shelter in pools	2 (34)	2 (13)	0
		Complexity of shelter material in pools	4 (34)	4 (13)	0
		Composite shelter quality in pools	1 (34)	1 (13)	0
	Substrate quality	Fine sediment in spawning substrate	2 (38)	4 (10)	+2
	Riparian quality	Canopy	4	4	0
		Amount of riparian vegetation cover	3	5	+2
		Riparian vegetation type	4	4	0
2	***Channel complexity***	Amount of pool habitat	3 (10)	na	na
		Depth of pools	5 (10)	na	na
		Amount of shelter in pools	3 (10)	na	na
		Complexity of shelter material in pools	4 (10)	na	na
		Composite shelter quality in pools	1 (10)	na	na
	Substrate quality	Fine sediment in spawning substrate	2 (10)	na	na
	Riparian quality	Canopy	4	na	na
		Amount of riparian vegetation cover	3	na	na
		Riparian vegetation type	4	na	na
3	***Channel complexity***	Amount of pool habitat	3 (20)	2 (8)	-1
		Depth of pools	4 (20)	3 (8)	-1
		Amount of shelter in pools	1 (20)	1 (8)	0
		Complexity of shelter material in pools	4 (20)	2 (8)	-2
		Composite shelter quality in pools	1 (20)	1 (8)	0
	Substrate quality	Fine sediment in spawning substrate	2 (20)	2 (1)	0
	Riparian quality	Canopy	4	3	-1
		Amount of riparian vegetation cover	4	5	+1
		Riparian vegetation type	4	4	0
4	***Channel complexity***	Amount of pool habitat	3 (15)	1 (5)	-2
		Depth of pools	3 (15)	1 (5)	-2
		Amount of shelter in pools	2 (15)	1 (5)	-1
		Complexity of shelter material in pools	5 (15)	5 (5)	0
		Composite shelter quality in pools	1 (15)	1 (5)	0
	Substrate quality	Fine sediment in spawning substrate	2 (15)	5 (3)	+3
	Riparian quality	Canopy	5	4	-1
		Amount of riparian vegetation cover	4	5	+1
		Riparian vegetation type	4	4	0

Continued next page

CDFG Reach	Fundamental habitat factor	Habitat component	Score (sample size)		
			CDFG based	Ground-truth based	Difference
5	***Channel complexity***	Amount of pool habitat	3 (50)	2 (42)	-1
		Depth of pools	2 (49)	3 (42)	+1
		Amount of shelter in pools	2 (50)	2 (41)	0
		Complexity of shelter material in pools	4 (50)	3 (41)	-1
		Composite shelter quality in pools	1 (50)	1 (41)	0
	Substrate quality	Fine sediment in spawning substrate	3 (49)	3 (27)	0
	Riparian quality	Canopy	4	5	+1
		Amount of riparian vegetation cover	5	5	0
		Riparian vegetation type	4	3	-1
6	***Channel complexity***	Amount of pool habitat	3 (37)	na	na
		Depth of pools	5 (37)	na	na
		Amount of shelter in pools	2 (37)	na	na
		Complexity of shelter material in pools	5 (37)	na	na
		Composite shelter quality in pools	1 (37)	na	na
	Substrate quality	Fine sediment in spawning substrate	2 (37)	na	na
	Riparian quality	Canopy	4	na	na
		Amount of riparian vegetation cover	3	na	na
		Riparian vegetation type	4	na	na
7	***Channel complexity***	Amount of pool habitat	3 (6)	na	na
		Depth of pools	5 (6)	na	na
		Amount of shelter in pools	2 (6)	na	na
		Complexity of shelter material in pools	5 (6)	na	na
		Composite shelter quality in pools	1 (6)	na	na
	Substrate quality	Fine sediment in spawning substrate	2 (6)	na	na
	Riparian quality	Canopy	5	na	na
		Amount of riparian vegetation cover	3	na	na
		Riparian vegetation type	4	na	na
8	***Channel complexity***	Amount of pool habitat	3 (9)	na	na
		Depth of pools	5 (8)	na	na
		Amount of shelter in pools	2 (9)	na	na
		Complexity of shelter material in pools	4 (9)	na	na
		Composite shelter quality in pools	1 (9)	na	na
	Substrate quality	Fine sediment in spawning substrate	4 (8)	na	na
	Riparian quality	Canopy	5	na	na
		Amount of riparian vegetation cover	4	na	na
		Riparian vegetation type	4	na	na
9	***Channel complexity***	Amount of pool habitat	3 (41)	na	na
		Depth of pools	3 (40)	na	na
		Amount of shelter in pools	1 (40)	na	na
		Complexity of shelter material in pools	5 (40)	na	na
		Composite shelter quality in pools	1 (40)	na	na
	Substrate quality	Fine sediment in spawning substrate	3 (40)	na	na
	Riparian quality	Canopy	5	na	na
		Amount of riparian vegetation cover	5	na	na
		Riparian vegetation type	4	na	na

Table J-2. Anthropogenic point erosion sites on Franz Creek. RB (Right Bank), LB (Left Bank) and BB (Both Banks) refer to the stream bank when looking downstream. Site numbers are sorted from downstream to upstream.

Site number	Description and size	Cause	Comment
1	RB; 75’w, 40’h	Cattle access to stream	Very little, if any, sediment currently being delivered to stream
2	RB; 150’w, 10’h	Farm road	Very little, if any, sediment currently being delivered to stream
3	RB; 50’w, 10’h	Cattle access to stream	None
4	BB; size not noted	Wet crossing	None
5	RB; 50’w, 10’h	Unknown	Could be natural
6	BB; size not noted	Wet crossing	Probably an ATV crossing
7	RB; 100’w, 10’h	Land use encroachment into the riparian zone	None
8	RB; 75’w, 10’h	Land use encroachment into the riparian zone	None

Table J-3. Potential partial and complete passage barriers for life stages of anadromous salmonids in Franz Creek. Also shown is length of stream segment with critical habitat for CCC steelhead that is upstream of barrier. '% of total' is the percent of either critical habitat or the CDFG survey that is upstream of the barrier (A=Adult, S=Smolt, J=Juvenile). Site numbers are sorted from downstream to upstream.

						Length upstream				
			Upstream		Downstream	Critical habitat		CDFG Survey		
Barrier number	**CDFG Reach**	**Type**	**Partial**	**Complete**	**Partial**	**Miles**	**% of total**	**Miles**	**% of total**	**Description**
1	1	Wet crossing and head-cut	A J		A S J	Not calculated				Boulders were used to contain a wet crossing and have resulted in a head-cut that is acting as a low flow barrier
2	5	Bridge	A J		A S J	3.6	33	2.9	28	Concrete foundation is creating a low flow barrier

K. Maacama Creek

In 1996 CDFG surveyed the entire 7.2 miles of the perennial stream length in Maacama Creek (CDFG 2006h). Their survey delineated four reaches. Beginning at the mouth of the stream, NMFS ground-truthed 6.6 miles of non-contiguous stream length in all four reaches on May 8, 9, 10, and 16, 2007 (Table 6). Our assessment was non-contiguous because of limited landowner access. During this survey, stream flow was continuous throughout the assessment segment. We observed juvenile steelhead distributed throughout most of the assessment segment; we also observed occasional steelhead redds and one adult steelhead approximately 3 miles upstream from the mouth.

Summary of habitat impairments (Tables K-1, K-2, K-3)

<u>Reach 1.</u> In the downstream two-thirds of the reach where the active channel is widest, there is low canopy closure over the active channel. The riparian vegetation buffer is generally wide and dense but has significant patches of invasive vegetation on both stream banks. The pools also have very low amounts of cover; this is not surprising given the presumably high flows that occur in this large stream. Human encroachment into the riparian zone is generally low, but where present, is usually from private homes. One notable segment is just upstream of the Chalk Hill Road bridge where there are several homes very near the top of the left stream bank. The stream bank in this stretch is very steep and high and has failed in a few spots as evidenced by efforts to contain the slippage with bank revetment work. There are a few other natural erosion sites that are acting as sediment sources as well. During the 10 year period from 1993-2002, Merritt Smith Consulting (2003) noted what they termed a “major loss” of habitat for juvenile salmonids in the lower portion of Reach 1 that they attributed to pools being filled in by sediment deposition from erosion.

Approximately 0.25 miles upstream of the Chalk Hill Road crossing, land use transitions to viticulture for a short distance before transitioning yet again to cattle and hay farming. Throughout the upstream one-third of the reach, the gradient increases slightly. The stream channel is quite sinuous here and has frequently moved back and forth across the floodplain as evidenced by unstable cobble bars and old stream channels with exposed substrate that lack established vegetation. Near the extreme upstream end of the reach, Highway 128 is very close to the right bank.

<u>Reach 2.</u> Highway 128 follows Maacama Creek close to the right stream bank for the entire length of this short reach. Long stretches of rip-rap have been placed to keep the bank and road from collapsing. As a consequence, the riparian vegetation on the right bank is somewhat sparse. Confinement, stream gradient, and substrate size (including some bedrock outcrops) all increase with distance upstream in the reach. The left stream bank is delivering sediment from several large natural erosion sites. There is a dam in the reach that is a partial barrier to juvenile movement even when the flashboards are not in.

<u>Reach 3.</u> Highway 128 continues very close to the top of the right bank before crossing the stream and then continues to follow the stream near the top of its left bank. Stream gradient increases even more in this lower part of this reach with several ledge outcrops. Eventually, Highway 128 moves away from the stream, both gradient and confinement decrease, substrate becomes more alluvial resembling the upper portion of Reach 1. The quality of the riparian

vegetation and canopy are both good throughout the reach. Pools are relatively infrequent and are rated as having low depth and poor cover quality.

Reach 4. Aquatic habitat in this reach has clearly benefitted from conservation efforts on private lands. The watershed is more dominated by oak grassland in this part of the watershed and, consequently, the riparian buffer is not as densely vegetated. Nevertheless, canopy closure remains high. The stream gradient is lower relative to Reach 3. Pool frequency and cover are higher than downstream reaches, but cover remains low and dominated by boulders. The reach has an artificial passage barrier that may be a low flow impediment to juvenile movement.

Watershed and habitat restoration recommendations

Watershed restoration

Because riparian encroachment is generally low and human-related point sources of erosion are few in Maacama Creek, the most significant reduction of fine sediment input will be through BMPs.

Habitat restoration and protection- priority 1

- *Reduce non-point sediment sources*
  - ✓ Assess and treat road systems in the watershed.

Habitat restoration and protection- priority 2

- *Enhance cover in existing pools*
  - ✓ Add large wood structures to pools in lower gradient portions of the stream

Habitat restoration and protection- priority 3

- *Livestock management*
  - ✓ Manage livestock access to the stream in Reach 2.
- *Evaluate the need and remove artificial structures that are acting as barriers*

Table K-1. Scores for nine indicator variables in Maacama Creek based on the CDFG habitat survey (1996) and NMFS ground-truthing (May 8, 9, 10, and 16, 2007). Scores range from least desirable (1) to most desirable (5). Differences indicate a possible change in the habitat factor since the CDFG survey in 1996 ('+' for better and '-' for worse). No stream assessment is indicated by 'na'.

CDFG Reach	Fundamental habitat factor	Habitat component	Score (sample size)		
			CDFG based	**Ground-truth based**	**Difference**
1	***Channel complexity***	Amount of pool habitat	3 (42)	4 (54)	+1
		Depth of pools	na	na	na
		Amount of shelter in pools	2 (42)	2 (53)	0
		Complexity of shelter material in pools	5 (42)	3 (53)	-2
		Composite shelter quality in pools	1 (42)	1 (53)	0
	Substrate quality	Fine sediment in spawning substrate	2 (41)	2 (49)	0
	Riparian quality	Canopy	3	3	0
		Amount of riparian vegetation cover	5	5	0
		Riparian vegetation type	4	4	0
2	***Channel complexity***	Amount of pool habitat	3 (5)	5 (5)	+2
		Depth of pools	na	na	na
		Amount of shelter in pools	1 (5)	1 (5)	0
		Complexity of shelter material in pools	4 (5)	1 (5)	-3
		Composite shelter quality in pools	1 (5)	1 (5)	0
	Substrate quality	Fine sediment in spawning substrate	1 (5)	2 (3)	+1
	Riparian quality	Canopy	3	4	+1
		Amount of riparian vegetation cover	3	4	+1
		Riparian vegetation type	4	4	0
3	***Channel complexity***	Amount of pool habitat	5 (32)	4 (22)	-1
		Depth of pools	1 (32)	4 (22)	+3
		Amount of shelter in pools	2 (31)	1 (18)	-1
		Complexity of shelter material in pools	5 (31)	1 (18)	-4
		Composite shelter quality in pools	1 (31)	1 (18)	0
	Substrate quality	Fine sediment in spawning substrate	4 (31)	5 (15)	+1
	Riparian quality	Canopy	4	4	0
		Amount of riparian vegetation cover	3	5	+2
		Riparian vegetation type	4	4	0
4	***Channel complexity***	Amount of pool habitat	5 (28)	5 (28)	0
		Depth of pools	4 (27)	5 (28)	+1
		Amount of shelter in pools	1 (28)	1 (20)	0
		Complexity of shelter material in pools	5 (28)	2 (20)	-3
		Composite shelter quality in pools	1 (28)	1 (20)	0
	Substrate quality	Fine sediment in spawning substrate	5 (27)	3 (20)	-2
	Riparian quality	Canopy	3	4	+1
		Amount of riparian vegetation cover	5	5	0
		Riparian vegetation type	4	4	0

Table K-2. Anthropogenic point erosion sites on Maacama Creek. RB (Right Bank), LB (Left Bank) and BB (Both Banks) refer to the stream bank when looking downstream. Site numbers are sorted from downstream to upstream.

Site number	Description and size	Cause	Comment
1	LB; 100’w, 20’h	Land use encroachment into the riparian zone	Repair with rip-rap has been ineffective
2	LB; 900’w, 20’h	Cattle pasture	None
3	RB; 100’w, 25’h	Highway 128 very close to top of stream bank	None
4	RB; 50’w, 15’h	Unknown	Could be natural

Table K-3. Potential partial and complete passage barriers for life stages of anadromous salmonids in Maacama Creek. Also shown is length of stream segment with critical habitat for CCC steelhead that is upstream of barrier. '% of total' is the percent of either critical habitat or the CDFG survey that is upstream of the barrier (A=Adult, S=Smolt, J=Juvenile). Site numbers are sorted from downstream to upstream.

			Upstream		Downstream	Length upstream				
						Critical habitat		CDFG Survey		
Barrier number	CDFG Reach	Type	Partial	Complete	Partial	Miles	% of total	Miles	% of total	Description
1	2	Dam	J		J	2.5	38	2.5	38	Could be a flashboard dam- low flow barrier only except if flashboards are in
2	4	Wet crossing	A J		A S J	0.8	12	0.8	12	Crossing is on top of a ledge outcrop and is very stable. Ledge may have been a partial barrier even without the crossing

L. Redwood Creek

In 2001 CDFG surveyed the entire 4.5 miles of the perennial stream length in Redwood Creek (CDFG 2006i). Their survey delineated two reaches. Beginning at the mouth of the stream, NMFS ground-truthed 4.3 miles of stream length in both reaches on March 29, April 1 and 3, 2007 (Table 6). Stream flow was continuous throughout the assessment segment. Juvenile steelhead and steelhead redds were distributed throughout the downstream-most 3.4 miles of the assessment segment. There is still evidence of some past habitat restoration measures in Reach 2 including boulder weirs, boulder deflectors, and native vegetation plantings along the stream banks; however, some seem to be no longer functioning as intended probably because of the severity of impacts to the stream channel. Some of the recent habitat restoration-related plantings are providing the only substantial riparian vegetation for long stretches in Reach 2.

Summary of habitat impairments (Tables L-1, L-2, L-3)

<u>Reach 1.</u> The lower one-half of this reach is distinctly different than the upper one-half. It can be characterized as having a moderately steep gradient as it passes through a very steep-sided canyon. Although there are some eroding banks in this segment, the erosion is natural and is not contributing much sediment to the stream as evidenced by the low embeddedness values. There is no land use encroachment into the riparian zone in the lower reach and very good canopy closure comprised of a mix of mature hardwoods and coniferous trees (mostly redwoods). In the upper one-half of the reach, the substrate is more highly embedded in fine material and canopy closure and stream gradient are slightly lower. Cattle pastures adjacent to the upper one-half of the reach are contributing sediment from failing stream banks because of cattle access to the stream. There are numerous pools of good depth throughout the reach but they lack cover.

<u>Reach 2.</u> The lower portion of the reach is similar to the upper one-half of Reach 1 with cattle pastures adjacent to the stream (including cattle in the stream). The segment has moderate canopy closure consisting mainly of hardwoods. Upstream of this, the active channel widens considerably and land use transitions to viticulture. The channel in this segment is straight, channelized with levies, and deeply incised. The middle two-thirds of the reach has an active channel width that is 8-10 times wider than the wetted width and shows the effects of extremely high flows. Some of the observed conditions are the result of natural factors including topography in the watershed upstream of the reach and naturally erodible soils. Because instream structure and pools are practically non-existent in this portion of the reach, high water velocities most likely impede adult upstream migration during high flows while shallow depths limit passage at low flows. During low flow periods, this segment is narrow, shallow and braided (the channel was already dry during our assessment in late March). This eliminates a significant segment of the reach as juvenile summer rearing habitat. Along with the almost non-existent riparian buffer throughout the majority of the reach, there is very little shelter in the few pools that are present. Most of the reach length is dominated by grass or other low growing riparian vegetation. The channel is severely incised (including over-steep banks) and canopy closure is near zero for long stretches. Upstream of its confluence with Foote Creek, green filamentous algae covering much of the stream substrate suggests excessive nutrient inputs to the stream. Land use in the upstream portion of the reach transitions back to cattle ranching for nearly the entire remainder of the stream where riparian and channel conditions are somewhat improved relative to the majority of the lower portion of the reach.

There are head-cuts associated with two wet crossings that are at least partial passage barriers to all life stages of salmonids; one of the head cuts was approximately 11 feet high on the day of our assessment. Other potential artificial passage barriers in the reach include two points where livestock fencing crosses the stream.

Watershed and habitat restoration recommendations

The stream channel in Reach 2 of Redwood Creek could be improved with intensive remediation efforts (see habitat restoration priorities below) that are part of a broader plan to reduce riparian encroachment and stream channelization.

Habitat restoration and protection- priority 1

- *Address artificial passage barriers in Reach 2*
  - ✓ Seek an alternative to the two wet crossings and address/repair the head-cuts they created.
- *Address fish passage conditions in the middle portion of Reach 2*
  - ✓ Consider designing a low flow channel in the middle two-thirds of the reach that would facilitate a longer temporal window for adult upstream migration.

Habitat restoration and protection- priority 2

- *Enhance cover in existing pools*
  - ✓ Add large wood structures to pools in lower gradient portions of the stream.
- *Livestock management*
  - ✓ Restrict/ manage cattle access to the stream and consider alternatives to fencing across the stream.
  - ✓ Reshape and plant (with native vegetation) over-steep banks in portions of both reaches that have been impacted by cattle accessing the stream.

Habitat restoration and protection- priority 3

- *Develop and implement a water quality monitoring plan*
  - ✓ Plan should focus on the impacts of livestock access to the creek.

Table L-1. Scores for nine indicator variables in Redwood Creek based on the CDFG habitat survey (2001) and NMFS ground-truthing (March 29, April 1 and 3, 2007). Scores range from least desirable (1) to most desirable (5). Differences indicate a possible change in the habitat factor since the CDFG survey in 2001 ('+' for better and '-' for worse). No stream assessment is indicated by 'na'.

CDFG Reach	Fundamental habitat factor	Habitat component	Score (sample size)		
			CDFG based	Ground-truth based	Difference
1	*Channel complexity*	Amount of pool habitat	4 (29)	4 (47)	0
		Depth of pools	2 (28)	4 (47)	+2
		Amount of shelter in pools	2 (26)	2 (47)	0
		Complexity of shelter material in pools	5 (26)	3 (47)	-2
		Composite shelter quality in pools	1 (26)	1 (47)	0
	Substrate quality	Fine sediment in spawning substrate	4 (28)	5 (47)	+1
	Riparian quality	Canopy	4	4	0
		Amount of riparian vegetation cover	4	4	0
		Riparian vegetation type	na	5	na
2	*Channel complexity*	Amount of pool habitat	2 (9)	2 (27)	0
		Depth of pools	2 (9)	2 (27)	0
		Amount of shelter in pools	3 (8)	1 (27)	-2
		Complexity of shelter material in pools	5 (8)	2 (27)	-3
		Composite shelter quality in pools	2 (8)	1 (27)	-1
	Substrate quality	Fine sediment in spawning substrate	4 (9)	4 (27)	0
	Riparian quality	Canopy	4	2	-2
		Amount of riparian vegetation cover	5	3	-2
		Riparian vegetation type	3	3	0

Table L-2. Anthropogenic point erosion sites on Redwood Creek. RB (Right Bank), LB (Left Bank) and BB (Both Banks) refer to the stream bank when looking downstream. Site numbers are sorted from downstream to upstream.

Site number	Description and size	Cause	Comment
1	RB; 50'w, 75'h	Cattle access to stream	Pasture on both sides of stream
2	LB; 75'w, 10'h	Old bridge site	Bridge is gone
3	LB; 100'w, 10'h	Cattle access to stream	Pasture on both sides of stream
4	LB; 60'w, 15'h	Cattle access to stream	A lot of fine sediment just downstream
5	BB; size not noted	Channelization	Unstable and over-steep stream banks

Table L-3. Potential partial and complete passage barriers for life stages of anadromous salmonids in Redwood Creek. Also shown is length of stream segment with critical habitat for CCC steelhead that is upstream of barrier. '% of total' is the percent of either critical habitat or the CDFG survey that is upstream of the barrier (A=Adult, S=Smolt, J=Juvenile). Site numbers are sorted from downstream to upstream.

			Upstream				Downstream			Length upstream				
										Critical habitat		CDFG Survey		
Barrier number	**CDFG Reach**	**Type**	**Partial**		**Complete**		**Partial**			**Miles**	**% of total**	**Miles**	**% of total**	**Description**
1*	2	Wet crossing and head-cut	A	J			A	S	J	1.8	39	1.8	39	Concrete and boulders were used to contain a wet crossing and have resulted in a head-cut with a jump height for upstream migration of ~11 feet
2*	2	Wet crossing and head-cut	A	J			A	S	J	1.1	+25	1.1	24	Concrete and boulders were used to contain a wet crossing and have resulted in a head-cut with a jump height for upstream migration of ~3 feet

* Priority 1 habitat restoration recommendation.

3.2 Water quality

Numerous studies have demonstrated the importance of water quality to salmonid survival and growth (*e.g.*, Meehan 1991 and references therein). In particular, water temperature, turbidity and dissolved oxygen are three water quality parameters that have been demonstrated to limit populations in watersheds with a high level of disturbance due to cultivation and/or rural residential devlopment. Despite the importance of water quality data in assessing the current habitat conditions of project streams, very little such data exist (see Discussion Section 4.2). An exception is water temperature data on some streams in some years.

3.2.1 Water temperature

Many researchers have noted the associations between salmonid biology and water temperature. Despite this, there is a lack of consensus on the best metric or set of metrics to use to evaluate water temperature suitability. Even when there is agreement between researchers on the best water temperature metrics to use, there is often disagreement on preference or suitability thresholds. This is mainly due to differences by species and life stage. Regardless of this lack of consensus, it is generally agreed that preferred temperatures are lower for coho as compared to steelhead (Sullivan et al. 2000). Further, Welsh et al. (2001) showed a strong relationship between coho presence and both maximum weekly average temperature (MWAT[1]) and maximum weekly maximum temperature (MWMT[2]). This makes a strong case for why these particular temperature metrics are suitable for at least an initial evaluation of water temperature in the project streams.

Based on the work of Sullivan et al. (2000), MWAT values in excess of 63°F (for steelhead) and 58°F (for coho) can have sub-lethal effects. Welsh et al. (2001) only found coho in streams with MWAT values less than about 62°F. In the Russian River Basin, survival of juvenile coho has been adversely impacted in some streams by MWAT values in excess of 66°F (Conrad et al. 2006).

Unfortunately, the availability of water temperature data is both spatially and temporally limited for the project streams. Based on these limited data, however, water temperatures for coho appear to be most suitable in Crane Creek, Gird Creek and, perhaps, Redwood Creek in some years (Table 7). Temperatures are probably suitable for steelhead in all of the project streams where data are available; however, water temperatures in Reach 1 of Maacama Creek are probably unsuitably high in at least some years.

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[1] MWAT is the highest average of mean daily temperatures over any 7 day sampling period.
[2] MWMT is the highest average of maximum daily temperatures over any 7 day sampling period.

Table 7. Maximum weekly average water temperature (MWAT) and maximum weekly maximum water temperature (MWMT) for sites where water temperature was continuously monitored during the summer. Values are in degrees Fahrenheit. See text and Welsh et al. (2001) for definitions of MWAT, MWMT and justification for selection of these water temperature metrics.

Stream	CDFG Reach	Year	Agency	Period	Metric	
					MWAT	MWMT
Crane Creek	1	2007	SRCD	6/13-9/12	63.9	67.6
Gird Creek	1	2001	CDFG	7/4-8/30	64.2	67.6
Miller Creek	1	2001	CDFG	7/4-8/14	69.8	77.4
Maacama Creek	1	2007	SRCD	6/8-9/12	67.1	71.6
		2006	SRCD	5/18-11/08	73.4	78.1
		2005	SRCD	6/12-10/19	72.1	77.4
Redwood Creek	1	2007	SRCD	6/14-8/16	66.0	70.5
	1	2006	UC Berkeley	6/23-10/13	71.1	73.4

3.2.2 Pesticides

Pesticide contact with surface water can also have serious consequences for many physiologic functions of salmonids including acute and chronic effects (Environmental Protection Agency, EPA 2004). Exposure may affect salmonids directly (*e.g.*, mortality, injury, exclusion from affected habitat) or indirectly (*e.g.*, reduced growth due to depressed aquatic macroinvertebrate populations). The easiest and most efficient means of preventing these impacts is to prevent exposure of the waterway to pesticide applications. This is often a labeling requirement for the pesticide as well.

Impacts to salmonids from pesticides are not noted for the Russian River watershed, however there seems to be a distinct lack of data and monitoring. The USGS study in 2003 and 2004 (Anders et al. 2006) screened for selected constituents in the lower mainstem river and selected tributaries. Unfortunately, these data are not of sufficient scope to make assumptions across the entire watershed nor do they appear to have screened for pesticides associated with land uses common in the project watersheds (*i.e.*, viticulture). An older study conducted by the California Department of Pesticide Regulation (Ganapathy et al. 1987) detected pesticides in only two of fifty-two samples taken near the highway 116 bridge in Guerneville. One detection was for diazinon which had some use in wine grapes at the time but much heavier use in residential applications. A second detection was for dimethoate which is still used in some vineyards.

These two studies are insufficient to make statements concerning the exposure of salmonids to pesticides in the project streams. Although the main land use in the project watersheds (viticulture) generally uses fewer pesticides than other agricultural systems, the compromised condition of the riparian corridors and the close proximity of planting to the streams increase the risk for drift of sprayed pesticides into nearby streams. A more detailed effort to correlate pesticide application timing with salmonid presence and life stage, along with sampling designed to capture potential exposure scenarios, would be helpful in revealing potential pesticide impacts. It is important to remember, however, that pesticide applications change with shifting pest pressures and that the best defense is careful application and healthy riparian corridors that can serve as barriers to drift and filter run-off.

3.3 Water quantity

Stream dewatering and loss of habitat due to water diversions is a contributing factor in the decline of several populations of steelhead and coho salmon in central and southern California coastal streams (Busby et al. 1996, Titus et al. 1999, CDFG 2002). In the Russian River watershed alone, many hundreds of small water diversion projects were constructed without environmental review, permits, or operational constraints to protect aquatic life. The State Water Resources Control Board (SWRCB 1997) states that there are over 1,300 recorded water rights within the Russian River watershed, and extensive water development projects substantially affect flow in the Russian River and its tributaries. The SWRCB has designated seven tributaries of the Russian River in Sonoma County as “Fully Appropriated” during the drier portions of the year, which means that all available supplies of water are being used and that no water is available for appropriation during the specified season (Table 8). Moreover, SWRCB (1997) states that based on their analysis, there is a sufficient basis for SWRCB to declare the entire Russian River watershed a fully appropriated stream and that their staff “recommend[s] that all tributaries within the entire Russian River watershed be added to the list of Fully Appropriated Streams from April 1 through December 14."

Table 8. Fully Appropriated Streams in Sonoma County as reported in SWRCB (1997).

Sonoma County Stream System	**Related Decision or Order**	**Fully Appropriated Season**	**Critical Reach**
Mark West Creek	D-0302	05/01-10/31	Mark West Creek where it crosses Hwy 101 upstream
Green Valley Creek	D-0663	06/15-10/31	From point of diversion downstream approx. 6 miles
Atascadero Creek	D-0709	06/15-10/31	From the confluence of Green Valley Creek upstream
Laguna de Santa Rosa	D-0852 D-0691	06//01-10/31	From Laguna de Santa Rosa and north of Molino Rd upstream
Santa Rosa Creek	D-1038	06//01-10/31	From Santa Rosa Creek located at the point within section 18,T7N, R8W upstream
Unnamed stream SW1/4, SW1/4 SEC5,T9N, R8W	D-1537	06//01-10/31	From the point of diversion immediately downstream and upstream
Unnamed trib to Gill Creek	D-1608	06//01-09/30	From the confluence of Gill Creek and the unnamed stream located within projected section 1, T10N, R10W, upstream

The SWRCB has limited regulatory capacity to address the issue of fisheries impacts caused by excessive water diversions. State water right laws and related regulations administered by the SWRCB provide a regulatory process for appropriating water to storage or to lands not adjacent to the diverted stream (*i.e.*, the permitting of appropriative rights). However, direct diversions to parcels of land adjacent to streams are termed riparian rights and these are essentially unregulated and unrestricted. Use of percolated groundwater is also largely unregulated, and wells set adjacent to streams often elicit claims of rights to non-jurisdictional groundwater pumping.

In practice, the protection of public trust resources (including fish and wildlife resources) is accomplished through a process of dispute resolution in which advocates for the environment (citizens, environmental groups, and natural resource agencies) request hearings to address complaints, and/or formally "protest" applications for water rights that pose risks to fisheries or other natural resource values. State water law acknowledges the need to protect public trust and avoid "*waste*" and "*unreasonable use*". However, without routine intervention by environmental proponents, protective permit terms for fisheries may not be included in appropriative water rights, and streams can become fully appropriated for agriculture and water supply, with resulting impacts to fish populations. Redressing environmental impacts from riparian diversions require physical proof of that impact within the context of complex watershed hydrology and ecology, demonstration that the diversion is “unreasonable”, and costly, contentious public hearings.

Unlike issues of habitat degradation through loss of pool quality, fish passage barriers, stream bank erosion, and sedimentation, land use impacts on stream flow can not be assessed or easily documented using one or two days of field survey. Stream flows in the project streams are highly dynamic and dependent upon the timing and magnitude of precipitation, stream geology, evapotranspiration of riparian vegetation, aquifer and groundwater elevations, as well as the timing and extent of water extraction by landowners (*i.e.*, surface diversions and pumping of subterranean flow from wells adjacent to the stream). Environmental organizations and natural resource agencies have routinely intervened as protestants in the water right permitting process for water diversion projects in the Russian River because of concerns that ongoing diversions and continued development that diminish surface flows pose a significant threat to habitats for fish and other aquatic resources. These concerns have been raised because 1) many streams have already been listed as fully allocated because of competing landowner claims to water with little or no consideration for fisheries and other public trust resources, 2) resource agencies have received numerous, isolated public complaints of significant alterations of stream flow and stream dewatering by water diversion practices, 3) numerous, unauthorized water diversion projects have been constructed in the Russian River basin without benefit of permit terms to conserve even minimal flow or protect public trust resources, 4) there is general concern about the effects to stream habitats of unrestricted and unregulated diversion practices associated with claims of riparian water rights, and 5) it is recognized that, except for the highly regulated flow in the Russian mainstem and Dry Creek, streams in this watershed typically have flows less than 2 or 3 cfs (often less than 0.5 cfs) for most of the year, and even seemingly modest rates of diversion have the cumulative capacity to dewater stream reaches, and many stream reaches do go dry during spring, summer, and fall.

Concern over the limited availability of water and impacts of water diversions on fisheries resources is not a new issue in the Russian River basin. For example in 1950, several residents in the Green Valley Creek watershed protested a proposed diversion totaling only 225 gallons per minute (0.5 cfs) from three points of diversion during the period May 15 to September 15 on the grounds that new diversions would injure their own agricultural water needs. Following investigation and a hearing, the SWRCB rejected the new water right application on the basis that agricultural interests had already fully appropriated water from the stream during that summer period (SWRCB D-663). In 1980, the CDFG protested an application for a water right to divert and store 245 acre-feet in two unnamed tributaries to Gill Creek, one of the project streams in this study. The SWRCB upheld CDFG’s protest that the proposed year round diversion of 0.25 cfs would “*have a serious detrimental impact on steelhead nursery areas in Gill Creek*”. As a result, SWRCB set a 0.4 cfs minimum flow for that diversion in order to effectively limit diversions to periods with elevated seasonal flows (SWRCB D-1608). During that proceeding the landowner objected to the 0.4 cfs minimum bypass term because it would “*in practice prohibit diversion of water to the lake during the months of May, June, and July*.” Monitoring juvenile steelhead densities in Sonoma County streams, Merritt and Smith Consulting (2003) reported good quality salmonid habitat in the middle zone of Maacama Creek, however, “*much of this reach was completely dry in summer 1994* [a relatively dry summer], *and one water user was observed in August pumping water from a large pit he had dug in the middle of the dry streambed*.” More recently NMFS has received and investigated several cases in which diversions for frost protection had deleterious effects on salmonid habitat (D. Torquemada, NMFS Enforcement, personal communication, 2007).

Extensive development of irrigation and small water supply projects in the Russian River basin have a strong potential to diminish stream flows that are a fundamental component of salmon and steelhead habitat. As noted previously, over ten years ago more than 1,300 water diversion projects had received water right permits or licenses in the Russian River basin. Today, the SWRCB is processing 175 pending permits to appropriate water in this watershed, approximately 90% of which have already been built or are partially constructed (E. Oppenheimer, SWRCB, personal communication, 2007). Constructed projects with pending permits do not have permits; they have not undergone environmental review that addresses cumulative impacts of numerous diversions, and they are operated without permit terms requiring minimum bypass flows below the points of diversion, structures for facilitating bypass flows, limitations on maximum rates of diversion, or seasonal limits to avoid diversions during the sensitive low flow season, especially May through November when precipitation is usually minimal. Many water diversion projects with permits and licenses have wide seasons of diversion that extend to the end of May or June. Such projects allow landowners to fill ponds in winter, irrigate heavily (*e.g.*, for frost protection) and then refill ponds in late spring or early summer when flows are minimal. Some ponds are maintained full throughout the summer by means of pumping from wells adjacent to the stream, despite the absence of precipitation for four to five months and the drying of nearby stream reaches. Pumping during summer is especially problematic. Landowners are required to file statements of use for diversions under riparian or pre-1914 water rights, although there is no penalty for not reporting these statements of use. The SWRCB recently recorded 449 active statements of use in the Russian River watershed (E. Oppenheimer, SWRCB, personal communication, 2007); however, SWRCB estimates that the number of reported statements of use via riparian and pre-1914 rights is only about 10% of the total number of actual diversions under these rights (S. Herrera, SWRCB, personal communication, 2007). Despite the limited reporting of use under riparian rights, SWRCB records document numerous points of diversion in tributaries to Dry Creek, Maacama Creek, and Alexander Valley (Table 9). CDFG habitat survey data documented water diversion related pipes and other structures in these streams (Table 10).

Table 9. Points of water diversion under appropriative, riparian, and pre-1914 rights recorded by SWRCB for selected streams in Dry Creek Valley, Alexander Valley, and the Maacama Creek watershed.

Watershed	Stream	No. of Points of Diversion
Dry Creek Valley downstream from Warm Springs Dam	Dutcher Creek	4
	Grape Creek	3
Alexander Valley	Crocker Creek	4
	Gill Creek	16
	Gird Creek	11
	Miller Creek	14
	Sausal Creek	40
Maacama Creek (Knights Valley)	Maacama & Redwood Creeks	45
	Franz Creek	79
	Kellogg & Yellowjacket Creeks	21
	McDonnell Creek	4
	Briggs Creek	18

Table 10. Number of diversion related pipes and structures recorded during CDFG field surveys of the 12 project streams (CDFG, unpublished data).[1]

Watershed	**Stream**	**Year**	**No. of Observed Diversion related structures**
Dry Creek Valley downstream of Warm Springs Dam	Crane Creek	1999	6
	Dutcher Creek	1998	7
	Grape Creek	1998	7
	Wine Creek	1998	9
Alexander Valley	Crocker Creek	1998	2
	Unnamed tributary to Gill Creek	1998	2
	Unnamed tributary to Gill Creek	1998	2
	Gird Creek	2001	1
Maacama Creek (Knights Valley)	Franz	1997	19
	Maacama Creek	1996	16
	Redwood Creek	2001	2

[1]CDFG data concerning diversion structure are often less than SWRCB data in previous table because CDFG data reflect limited access, limited survey window, and structures such as stream side wells may not be counted.

Any plan for conserving habitat for listed salmonids in tributaries in the Russian River watershed will need provisions for ensuring that the diversion of surface and subterranean stream flow does not have significant adverse effects on that habitat. Given the vulnerability of salmonid habitats to stream diversions, the multitude of water storage projects requiring appropriative water rights, the lack of information concerning the timing and magnitude of unregulated riparian and pre-1914 diversions, and the lack of coordination of these diversions, the protection of these habitats and their fish will require greater transparency of water use and efforts to minimize impacts of that water use. To conserve and protect salmonid habitats, water diversions:

A) **Should not contribute to the dewatering of surface flows in stream reaches downstream from the point of diversion (POD), nor should they significantly degrade existing habitats downstream from the POD.** For new projects requiring appropriative water rights (including those with pending permits), CDFG and NMFS (2002) provide recommendations for maintaining bypass flows, limiting diversions to the period of seasonal high flows (December 15-March 31), and evaluating and avoiding potential cumulative impacts. It is important that facilities be constructed at POD's so that water diversion does not cause the dewatering of stream habitats, block fish movements, or otherwise significantly degrade downstream habitats.

B) **Should be coordinated between landowners within a watershed to minimize synchronous diversions that have a greater likelihood of dewatering streams or degrading stream habitats.** This should be done for diversions under appropriative rights, riparian rights, and pre-1914 rights.

C) **During the low flow season (especially between June1 and October 31), diversions under riparian right should be minimized and where possible offset with reclaimed water or additional water supply obtained from the storage of winter runoff in benign offstream reservoirs.**

We encourage the construction of environmentally sensitive minor project (<200 acre ft) reservoirs that would offset summer diversions and conserve stream flows during periods of relatively low flow, especially May through November. However, when winter storage projects are built, and historic riparian diversions are offset, mechanisms must be established to ensure that restored stream flows are protected and not subject to appropriation by a few, non cooperating parties or diversions from mobile tank trucks.

The concerted efforts of landowners can promote and achieve the conservation of stream flows during the predictable low flow season, with resulting benefits to both aquatic resources and future generations of landowners.

4.0 Discussion

NMFS review of existing habitat data and follow-up field surveys indicate that habitat conditions for coho salmon and steelhead in each of the 12 project streams are significantly impaired in portions of one or more reaches. The apparent sources or causes of the impairment vary between streams and between reaches within streams. Designated critical habitat in the 12 streams has been adversely affected by land use activities adjacent to the stream, from road crossings and construction of a variety of small dams, and stream channelization that has diminished the quality of pool habitat essential for survival of older juvenile fish. In this section, we discuss those issues that are most severely impacting habitat quality in the project streams (Section 4.1). We also discuss some of the more serious information gaps and recommend ways to improve our understanding of the affects of some land use practices on salmonid habitat (Section 4.2). We then recommend an overall prioritization of measures that would provide the most immediate benefits to population recovery in the project streams and, ultimately, the Russian River Basin (Section 4.3) followed by preferred strategies for implementing habitat restoration actions (Section 4.4).

Before discussing the observed habitat conditions and opportunities for increasing survival rates and production of juvenile salmonids in the project streams, it is worth considering the juvenile steelhead that were observed in each of the project streams during the 2007 field surveys. It might be argued that the streams are already in sufficiently good condition, because if it were not so, there would not be any steelhead. However, almost all of the observed fish were small fry (young-of-year) whose chances of surviving one or more years to the smolt stage (the life stage that migrates downstream towards the ocean) are greatly affected by the loss of high quality pool habitat, passage barriers, and diminished food resources as the result of stream sedimentation and/or reduced stream flows. Habitat degradation reduces a stream's ability to produce juvenile fish that grow to the smolt stage. This is especially true in the case of juvenile coho salmon that require deep, coldwater pools with abundant complex cover (*e.g.*, large woody debris). Reduced smolt production can ultimately affect the numbers of adult salmon and steelhead returning to the Russian River and to the project streams.

The significance of the 12 project streams in the coast-wide efforts to protect and recover salmon and steelhead runs is also worth considering. Recovery of CCC coho salmon and CCC steelhead will likely require successful restoration and protection of substantial amounts of habitat in the Russian River Watershed. The Russian River is the largest watershed occupied by CCC coho salmon, and it is centrally located within the range of this evolutionarily significant unit of coho salmon. Tributaries of Dry Creek Valley and Knights Valley are among the relatively few remaining streams in the Russian River Basin where coho salmon presence was documented within the last decade. The Russian River Watershed also represents a very significant portion of the range of CCC steelhead; the Russian River contains approximately one-third of the entire historic habitat for this distinct population segment. Moreover, Bjorkstedt et al. (2005) report that, within this basin, the Dry Creek watershed historically supported the largest potentially independent[1] population of steelhead in the Russian River, the Maacama Creek watershed supported its own potentially independent population of steelhead, and Sausal Creek is identified as one of seven tributaries in the Russian River to have historically had its own population of steelhead. The project streams are centrally located in the Russian River Watershed. The enhancement of salmonid habitat in Alexander Valley, Dry Creek Valley, and Knights Valley will improve the likelihood of population recovery in the Russian River Basin and promote increased returns of adult fish to these streams.

4.1 Prevailing habitat conditions

The downstream-most portions of many of the project streams generally contain poor quality habitat for all life stages of anadromous salmonids. Natural conditions (*e.g.*, naturally low summer flows) have contributed to this; however, in many cases, artificial conditions (*e.g.*, channelization from levies and stream bank armoring) have imposed further limitations. Fortunately, riparian vegetation condition in some of these same lower stream segments is not as consistently impaired. In stream segments where riparian conditions are relatively good, alleviating artificial channel confinement on its own may improve the stream's function as a migration corridor. In stream segments where riparian conditions are not as good, combined approaches that include reducing artificial channel confinement, limiting land use activities in the riparian zone, and bioengineering new stream channels are needed to eliminate long stretches where fish passage is hindered by high winter flows and the lack of resting pools.

In addition to the steep topography that is characteristic of many stream reaches, the underlying soil types in project watersheds is a naturally occurring characteristic that contributes fine sediment to the stream channel. The high amount of sediment we observed in most stream reaches are at least partially explained by these conditions, but land use activities have also played a role. Regardless of its source, the natural conditions in project streams elevate the importance of a healthy riparian corridor. Some of the fine sediment we identified was from several anthropogenic point sources (erosion sites) that were simply started by vegetation clearing. In most cases, these site-specific sources could be easily repaired. In some streams, fine sediment is coming from the over-steep banks that are the result of artificially confined and/or incised stream channels. In these cases, even though vegetation has not necessarily been cleared, vegetation can not be maintained or become established on these steep banks to keep them from eroding. The ultimate solution to reducing sediment input from these failing stream banks is to reduce artificial channel confinement. In all cases, simply reshaping and planting (with native vegetation) these over-steep banks is an excellent first step. However, reducing sedimentation from non-point sources often represents a greater challenge. For example, in Wine Creek where roads appear to be making a significant contribution to instream sediment, the ultimate solution of realigning roads may be logistically and financially unfeasible. In such cases, new and innovative solutions that draw on the expertise of landowners and engineers may be required.

[1] 'Independent' populations are those with a high likelihood of persisting over 100-year time scales (Bjorkstedt et al. 2005).

The importance of pools and pool characteristics to all life stages of salmonids can not be overstated. Pools are vital as flow and predator refugia, as nutrient reservoirs, for macroinvertebrate production, for spawning, as sediment traps, and for substrate sorting. In cases where pool frequencies, pool depths, and pool shelter quality are low, survival and productivity of salmonids is low. This is particularly true for juvenile coho salmon and over-yearling juvenile steelhead. Because of the Mediterranean climate typical of the Russian River Basin, pools may be even more important than in more temperate climates that experience higher summer rainfall and stream flows. The lack of summer rainfall in the Russian River Basin and warm water temperatures prevailing throughout the mainstem and larger tributaries suggest that cooler and generally smaller tributaries (*e.g.*, several of the project streams) provide vital summer habitat for sustaining juvenile salmonids. Because of their smaller size, however, these streams are more susceptible to having disconnected flow (isolated pool conditions) or drying up altogether in the summer. In addition to these natural conditions, flow can be further reduced by water extraction, pool forming processes can be disrupted by artificial channelization, and pool shelter conditions can be impacted by both artificial channelization and disturbance of riparian vegetation. During our assessments in spring 2007, we observed young-of-the-year steelhead in all 12 of the project streams. However, near the end of our assessment period, we began to see disconnected stream flow and fish in isolated pools that later dried up. In one case on Franz Creek and another on Gird Creek, we actually observed juvenile steelhead that had become stranded and died. Because our assessments were conducted in spring before the onset of low summer flow, we expect that juvenile mortality rates continued to increase as the summer progressed. Although the low stream flow and fish stranding that we observed was likely due in part to natural conditions (*i.e.*, normal lack of summer rainfall), it is also likely that impairments from land use (*e.g.*, activities that reduce pool frequency and quality) also played a role.

Because of its relationship to so many of the fundamental habitat factors (Table 3), we suggest that, with the exception of Maacama and Franz Creeks, impacts to the riparian zone, and artificial channel confinement and incisement are the primary mechanisms through which land use activities have operated to impair anadromous salmonid habitat in the project streams. This conclusion is supported by the relationship of agriculture (including viticulture) to channel conditions which lead to diminished pool frequency and quality (NMFS 2004 and references therein). In the project streams, impaired channel conditions often began with a lowering in elevation of the receiving streambed. For streams that flow directly into Dry Creek, the receiving stream is Dry Creek while for streams that flow directly into the mainstem of the Russian River, the receiving stream is the Russian River. For these two systems, the activities that led to incised stream channels are the removal of sediment from the system by gravel mining (losses) and from dams[1] that have trapped and deprived downstream areas of sediment that would otherwise help offset sediment losses. Additionally, stream channel confinement (*e.g.*, rip-rap, levies) directs erosion downward through the streambed instead of laterally against the armored stream banks. During this gradual lowering of the streambed, tributary streams constantly have to 'catch-up' as they down-cut their way to maintain connection with the receiving stream. Channel straightening and confinement from rip-rap and levies has occurred on tributary streams simultaneous to incision on receiving streams which, in turn, accelerates the

[1] Warm Springs Dam on Dry Creek and Coyote Dam on the Russian River as well as numerous smaller dams.

process of incision in the tributaries. Stream channel incision in tributaries has led to long stretches of entrenched channels that characteristically have higher water velocities as gradient increases and stream channels straighten. Additionally, stream banks become over-steep, unable to hold vegetation, and therefore continually deliver sediment to the stream channel while restricting the ability of riparian vegetation to become established. The fine sediment from failing stream banks accumulates at constrictions in the channel or in lower gradient areas such as pools and near the stream mouth. In these portions of the stream, substrate accumulates (aggradation) and can cause stream flows to become disconnected during low water periods. Historically, the reaction to failing stream banks has been to protect them with some material to reduce erosion (*e.g.*, rip-rap). Unfortunately, this 'armoring' has the effect of accelerating the incision process further as erosion forces are directed downward instead of laterally against the stream bank. Gradually, the natural stream channel is confined to a new, artificial stream channel that is straighter and has higher water velocities that tend to move large woody debris downstream and out of the stream at a higher rate. Depending on the resistance of the streambed material, the resulting increase in gradient as the tributary tries to down-cut its way to the elevation of the receiving stream can result in a head-cut and fish passage barrier (*e.g.*, Crane Creek, Grape Creek). In many portions of the project streams, the combined effect of these actions has been to disconnect streams from their floodplains (both intentionally to prevent flooding and unintentionally). This is particularly problematic in low gradient reaches where pool formation is more reliant on floodplain connection where the channel needs to move laterally across the landscape (*i.e.*, periodically flood) and meander in order to form pools.

With a few notable exceptions (Gill, Dutcher, Grape, and Redwood Creeks), artificial passage barriers are not a serious concern in the project streams. However, where they are present, they are often located downstream of a significant amount of habitat which may, at best, be inconsistently available to a portion of the population because of the barrier. Habitat restoration projects upstream of such barriers can not provide maximal benefits unless solutions to these barriers are implemented.

In the project streams, invasive plant species were noted on every stream reach during our habitat assessments. Introduced exotic plants can spread rapidly and take over streamside habitat. In general, invasive non-native plants are out of balance with the habitat they invade in that they impede the natural structure and function of the area and have no natural mechanisms (such as predators) to keep them in check. These invasive species have a variety of impacts that are detrimental to the riparian area ranging from excluding regeneration and establishment of native vegetation to increased water consumption and fire danger. Whereas native riparian plants have evolved to create a functioning riparian corridor, non-native plants that infest riparian corridors tend to pose a serious threat to this functionality and lack the characteristics that provide quality habitat for aquatic and semi-aquatic species. Most invasive plants provide poor protection against stream bank erosion, do not effectively shade the stream corridor, are not as effective at filtering runoff entering the stream, and several serve as hosts for Pierce's disease. This widespread issue as well as past experiences attempting to eliminate or manage invasive plants should modify any expectation we may have of complete removal. Nevertheless, we are aware of ongoing invasive plant species management efforts (*e.g.*, by the SRCD) and recommend continuation of these efforts with additional targeting to salmonid habitat segments that we identified as being particularly impacted by invasive plants. Such an effort may require additional cataloging and quantification of where invasive plants represent the biggest threats.

4.2 Information gaps

As mentioned throughout this document, significant gaps exist in the available information to assess two of the six FHFs (water quality and water quantity). Until data are available, it will be impossible to fully assess habitat conditions.

Water quality. For the project streams, water quality data have been collected inconsistently if at all (Robert Klamt NCRWQCB, personal communication, 2006; Derek Acomb CDFG, personal communication, 2006). Temperature is the water quality parameter that has probably been monitored most consistently; however, with few exceptions (Maacama Stream), even these data are limited in both space and time for project streams. The reason for the lack of data include 1) difficulty of designing cost-effective sampling programs that are also spatially and temporally representative, 2) threshold water quality values that are often dependent on species and life stage, 3) difficulty in summarizing the data in a meaningful way, and 4) interpretation of the data in a way that allows evaluation of acute and especially chronic effects. In the case of screening for toxic chemicals in surface water (*e.g.*, from pesticides), the high cost of assays and the transient nature of pesticides add to these complications. Close adherence to carefully structured BMPs that are protective of water quality (Part II) should, in most cases, provide the necessary precaution. These include an adequate riparian corridor size and composition that serves to provide stream bank stability and shade, buffer the stream from pesticides, and help to enhance instream habitat.

Despite recent efforts to minimize impacts, current land use patterns have impacted water quality. Therefore, in addition to adherence to BMPs, we recommend an approach that includes water quality monitoring efforts to gather physical water quality data (temperature, turbidity, suspended sediment concentrations, etc.) and allows for periodic pesticide or toxicity monitoring. Routine bioassessment monitoring (see 'Aquatic bioassessment monitoring' below) can also provide valuable biological data. Detection of imbalances to the aquatic community would afford us the opportunity to precisely target water quality sampling efforts to impacted stream reaches.

Water quantity. As discussed in Section 3.3, the conservation of flows to protect salmonid habitats is a complex issue that requires site specific knowledge of stream geology, surface and subsurface hydrology, salmonid biology, and patterns of water extraction and use by landowners within a watershed. Salmon and steelhead cannot be sustained without adequate flows that protect spawning habitats during the winter and early spring; nor can they be sustained if streams are dewatered or substantially impaired during the extended period of low flow (usually May through October). Cumulative diversions from many sites and several landowners can significantly diminish stream flows, especially if they occur simultaneously. However, cumulative impacts due to diversions from multiple landowners cannot be minimized unless landowners assess and implement mechanisms that address both water supply and habitat conservation needs.

To conserve stream flow that supports habitat, information is needed on the timing, magnitude, and location of diversions so that diversions can be coordinated and projects (e.g., winter storage projects) can be designed to offset deleterious diversions during the low flow season. Information is also needed on the hydrology of the project streams. Stream segments with seasonal or intermittent flow may go dry as the result of natural processes, aggradation of sediment, depletion of subterranean flow due to pumping or natural processes, or surface diversions. Likewise, additional site-specific information is needed to assess the cumulative affects of multiple diversions on the hydrology of the project streams during winter. Most importantly, the conservation of flows in the project streams will require transparency of diversion operations and a willingness to evaluate alternatives that lessen impacts to salmonid habitats.

Aquatic bioassesment monitoring

The ultimate measure of success for habitat restoration efforts will be the benefits accrued to the listed fish species and the aquatic communities that support them. Implementation of a well-designed aquatic bioassesment monitoring plan would serve the dual role of filling data gaps (*e.g.*, alerting us to degraded habitat conditions such as water quality) while allowing us to sense positive changes in habitat conditions. By incorporating a targeted habitat monitoring component based on a bioassessment component as described above, a better understanding of relationships between biological indicators and specific habitat attributes (and their improvement) can be gained while providing important feedback to guide future restoration efforts. The development of any monitoring program should rely heavily on input from an interdisciplinary team that includes federal (*e.g.*, NMFS, Natural Resources Conservation Service, state agencies (*e.g.*, NCRWQCB, CDFG), and other entities (*e.g.*, SRCD).

4.3 Overall habitat restoration priorities for the 12 project streams

There are two main reasons why streams or portions of streams we assessed may have little (or no) suitability for certain life stages of salmonids. The first is that some stream segments may simply always have been naturally unsuitable. The second is that land and water use activities may have decreased the suitability for one or more life stages. In this document, our focus has been on the latter. Ultimately, it is our goal to identify those anthropogenic activities that have degraded habitat conditions and take steps to modify those activities while simultaneously restoring impaired habitat. Towards that end, we used the linkages in Table 2 to guide our development of watershed restoration projects.

4.3.1 Prioritization framework for habitat restoration projects

The tradeoff between investment in habitat restoration and expected benefits should be central to any plan for habitat restoration. Therefore, in addition to our review of current habitat conditions (Results Section, Appendix 2), we considered potential population-level benefits to the coho salmon and steelhead populations in the Russian River Basin. In prioritizing potential restoration efforts in the project streams, we considered such factors as salmonid production potential, species decline, and population structure. The relevance of these factors in evaluating project priorities is described below.

<ins>1. Salmonid production potential.</ins> We define salmonid production potential as the capacity for a stream to produce individuals of diverse life stages necessary to complete the species freshwater life cycle. Even under pristine conditions, that capacity varies from year to year, from stream to stream and, probably, from reach to reach based on the available quantity and quality of habitat. This spatial and temporal variability in available habitat influences the number of individuals of a given species and life stage that can be produced. It is important to consider the amount of habitat that can be gained or enhanced by a given restoration project. For example, consider a very short, narrow stream consisting of high quality habitat for all life stages. The salmonid

production potential of such a stream may be high on a per area basis, but it could be low as compared to a longer, wider stream with moderate or even low quality habitat.

2. Species decline and presence. CCC coho salmon populations have declined precipitously in the past decade. This is especially true in the Russian River where, despite monitoring efforts, returns in the past few years have been too few to detect. Steelhead numbers have also declined though not as dramatically. It is estimated that the current population size of steelhead in the Russian River is less than 15 percent of historic levels (SEC 1996).

We suggest that priorities for habitat restoration efforts should be higher for project streams with recent presence of coho salmon and steelhead as compared to streams without recent evidence. We observed juvenile steelhead in all 12 project streams during our 2007 assessments and we have no evidence contradicting the presence of steelhead populations in these streams in recent years. According to CDFG, however, coho salmon have not been present in the project streams in recent years. In fact, during the past 10 years, naturally reproduced populations of coho have only been documented in the Grape/Wine system (1998) and Redwood Creek (2001). Even though there is no similar documentation of coho salmon in Crane Creek, because of its proximity to the Grape/Wine system and other streams with ongoing coho salmon restoration work (*i.e.*, Mill Creek), we include it as a likely candidate for recent occupation by coho salmon as well.

3. Population structure. Population structure is influenced by the degree to which various sub-populations of a larger population interbreed. It is often measured by indices of genetic relatedness. Bjorkstedt et al. (2005) analyzed CCC steelhead population structure and concluded that, historically, steelhead from the Dry Creek system represented an independent[1] population and that steelhead from the Maacama system represented another separate independent population. They also concluded that steelhead from the four Alexander Valley project streams were dependent[2] populations. We interpret the findings of Bjorkstedt et al. (2005) to mean that the eight project streams that are part of independent populations (the four in Dry Creek Valley plus the four in Knights Valley) are of a higher relative importance to overall population structure for steelhead in the Russian River.

[1] 'Independent' populations are those with a high likelihood of persisting over 100-year time scales (Bjorkstedt et al. 2005).
[2] 'Dependent' populations have a substantial likelihood of going extinct within a 100-year time period in isolation, yet receive sufficient immigration to alter their dynamics and reduce extinction.

4.3.2 Prioritized list of habitat restoration projects

In Results Section 3.1 we prioritized non-water quality/quantity related salmonid habitat restoration projects ***within*** each stream. In this section, we summarized salmonid production potential, species decline and presence, and population structure for each stream as a means of ranking the relative value of improving habitat conditions ***among*** all project streams (Table 11). This among stream ranking was then combined with the Results Section's within stream prioritization to arrive at an ***overall*** prioritization of habitat restoration projects (Table 12) using the following scheme:

Overall priority 1. Within stream priority 1 habitat restoration projects for rank 1 streams.

Overall priority 2. Within stream priority 1 habitat restoration projects for rank 2 streams.

Overall priority 3. Within stream priority 1 habitat restoration projects for rank 3 streams.

Overall priority 4. Within stream priority 2 habitat restoration projects for rank 1 streams.

Overall priority 5. Within stream priority 2 habitat restoration projects for rank 2 streams.

Overall priority 6. Within stream priority 2 habitat restoration projects for rank 3 streams.

Overall priority 7. Within stream priority 3 habitat restoration projects for rank 1 streams.

Overall priority 8. Within stream priority 3 habitat restoration projects for rank 2 streams.

Overall priority 9. Within stream priority 3 habitat restoration projects for rank 3 streams.

Table 11. Salmonid production potential, recent presence of coho salmon, steelhead population structure, and recommended rank for implementing habitat restoration actions in the project streams. The table is sorted in decreasing order by stream length of CCC steelhead critical habitat.

Stream	Stream length (miles) of CCC steelhead critical habitat	Documented coho salmon presence in past 10 years	Member of a historically independent[1] population of CCC steelhead	Habitat restoration rank
Redwood Creek	4.5	**Yes**	**Yes**	**1**
Grape Creek	2.3	**Yes**	**Yes**	**1**
Wine Creek	1.8	**Yes**	**Yes**	**1**
Crane Creek	1.3	**Likely**[2]	**Yes**	**1**
Franz Creek	11.1	No	**Yes**	**2**
Maacama Creek	7.2	No	**Yes**	**2**
Foote Creek	1.3	No	**Yes**	**2**
Dutcher Creek	1.2	No	**Yes**	**2**
Gill Creek	3.4	No	No	**3**
Gird Creek	2.4	No	No	**3**
Miller Creek	2.4	No	No	**3**
Crocker Creek	1.1	No	No	**3**

[1] 'Independent' populations are those with a high likelihood of persisting over 100-year time scales (Bjorkstedt et al. 2005).
[2] Based on proximity to streams where coho have been recently documented and proximity to streams with ongoing coho salmon restoration efforts (*i.e.*, Mill Creek).

Table 12. Recommended overall habitat restoration priorities in the 12 project streams. This list does not include projects to address water quality or water quantity related issues.

Priority	Stream	Habitat restoration project
1	Redwood Creek	Address artificial passage barriers in Reach 2
		Address fish passage conditions in the middle portion of Reach 2
	Grape Creek	Address artificial passage barrier located in downstream stream segments
	Wine Creek	Reduce fine sediment input
	Crane Creek	Address artificial passage barriers near the mouth of the stream
2	Franz Creek	Identify and reduce fine sediment input to the stream
	Maacama Creek	Reduce non-point sediment sources
	Foote Creek	Address artificial passage barriers in Reach 1
	Dutcher Creek	Address artificial passage barriers located in downstream segments
3	Gill Creek	Enhance cover in existing pools
		Assess habitat upstream of Reach 3
	Gird Creek	Address fish passage conditions in the lower portion of the stream
	Miller Creek	Design and build pools for juvenile rearing
	Crocker Creek	Address the accumulation of sediment in Reach 1
		Design and build pools for juvenile rearing
4	Redwood Creek	Enhance cover in existing pools
		Livestock management
	Grape Creek	Reduce fine sediment
		Livestock management
		Enhance cover in existing pools
	Wine Creek	Enhance cover in existing pools
		Design and build pools for juvenile rearing
		Address fish passage issues caused by grade control structures
	Crane Creek	Enhance cover in existing pools
5	Franz Creek	Enhance cover in existing pools
		Design and build pools for juvenile rearing
	Maacama Creek	Enhance cover in existing pools
	Foote Creek	Reduce fine sediment input to the stream
		Design and build pools for juvenile rearing
	Dutcher Creek	Address artificial passage barriers located in upstream stream segments
		Enhance cover in existing pools
6	Gill Creek	Address fish passage conditions in the lower portion of the stream
		Identify and reduce fine sediment input to the stream
	Gird Creek	Enhance cover in existing pools
	Miller Creek	Address fish passage conditions in the lower portion of the stream
	Crocker Creek	Enhance cover in existing pools
		Address fish passage conditions in the lower portion of the stream

Continued next page

Priority	Stream	Habitat restoration project
7	Redwood Creek	Develop and implement a water quality monitoring plan
	Grape Creek	Address fish passage issues caused by grade control structures
	Wine Creek	Address artificial passage barrier located in upstream stream segment
	Crane Creek	Repair human-related point sources of sediment throughout the stream
		Address artificial passage barriers located in upstream stream segments
8	Franz Creek	Livestock management
		Evaluate the need and remove artificial structures that are acting as passage barriers
	Maacama Creek	Livestock management
		Evaluate the need and remove artificial structures that are acting as passage barriers
	Foote Creek	Address artificial passage barriers in Reach 1
		Enhance cover in existing pools
	Dutcher Creek	Repair human-related point sources of sediment throughout the stream
9	Gill Creek	Identify and reduce impacts from cattle (as appropriate) upstream of Reach 3
	Gird Creek	Reduce fine sediment input to the stream
	Miller Creek	Reduce fine sediment input to the stream
	Crocker Creek	Evaluate sediment sources

4.4 Strategies for implementing habitat restoration actions

Even under pristine conditions, the capacity of habitat to produce individuals of a given life stage is limited by attributes that vary in both space and time. We conclude that additional constraints in production capacity for anadromous salmonids have been imposed by land use activities in all 12 project watersheds and that the relative importance of natural vs. human imposed limitations varies within and among streams. The task before us is to respond by alleviating those human-imposed habitat limitations. It is important to recognize that failure to respond will result in continued salmonid population decline in the project streams and the Russian River Watershed. We have two options for alleviating human-imposed limitations. First, we could focus our efforts in a way that may lead to short-term gains in habitat restoration but would perhaps fail to result in long-term habitat protection. These short-term gains could be accomplished by implementing the habitat restoration priorities listed in Table 12 but stop short of addressing the broader-scale issues that led to current habitat impairments. We have stated that the broad-scale issues of impacts to the riparian zone, and artificial channel confinement and incisement are the primary mechanisms through which land use activities have impaired anadromous salmonid habitat in the majority of project streams. Without restoring the proper function of the riparian corridor and channel condition, habitat restoration projects will not be sustainable unless there is periodic intervention to repair project sites that, over time, are rendered ineffective because of these broad-scale issues (*e.g.*, sedimentation due to artificial channel incisement filling in newly constructed pools). Because of this, we advocate a second option for alleviating human-imposed limitations that would afford long-term protection. This option includes implementing the habitat restoration priorities listed in Table 12, but doing so in their proper, broader context. This broader context should be part of a long-term view that would include a carefully designed riparian setback scheme and serious efforts to reduce artificial channelization. Choosing this second option will mean hard work, but it will also ensure the greatest likelihood of habitat protection and population recovery.

The benefits of implementing habitat improvement actions that include multiple projects on long stream segments will strongly outweigh the benefits of individual or site-specific efforts. For example, by designing, planning, and implementing restoration actions in a way that encompasses several projects simultaneously (*e.g.*, repairing all erosion sites in the entire stream or reach), there can be tremendous gains in efficiency and cost savings as compared to taking a site by site approach. For complicated issues where cumulative impacts from multiple sites or land users (*e.g.*, water use) are of higher concern than any single site (*e.g.*, a single artificial passage barrier), comprehensive approaches that result in cumulative benefits should be preferred. This kind of project planning should lead to speedier habitat restoration and, ultimately, population recovery. An important role for the Salmon Coalition, SRCD, and public agencies can be to promote and facilitate these approaches.

Many of the habitat impairments identified throughout this document are reflections of cumulative land use impacts within a watershed. While moving forward with site-specific plans is certainly critical to improving habitat conditions, the long-term protection of stream habitats will necessitate a commitment to maintaining quality habitat conditions that support diverse life stages of salmonids. Site-specific habitat restoration projects that enhance pool quality or reduce sedimentation provide important ecological benefits. However, such projects are prone to destruction or degradation by periodic flooding events. The level of commitment to the efforts outlined in this plan must be consistent, long term, and have broad support from private landowners. Reduced channelization and restoration of natural pool forming processes would promote high quality stream habitats and reduce the need for maintaining artificial structures that sustain pool habitats. Careful monitoring for changes in habitat conditions will be important so that we learn from both our successes and failures. Restoration projects will require periodic visits to inspect their condition and a commitment to maintaining their proper function. This means that resources (*e.g.*, funds) and contingency plans should be available to respond quickly with repairs, upgrades, or re-implementation.

We believe that the majority of residents in the Russian River Watershed take satisfaction and interest in restoring and preserving anadromous salmonid populations. We are also confident that habitat restoration and lasting protection can be achieved without unduly restricting the rights or abilities of people in the watershed to make a living. However, while not technically complicated, many of the issues discussed in this document will be costly to solve, and will require commitment and compromise from landowners, local governments, state and federal agencies, and public and private entities. The process we outlined here was based on an objective assessment of physical habitat conditions and factors leading to these conditions in the 12 project streams. To the extent possible, we attempted to account for natural limitations on the capacity of these streams to produce anadromous salmonids. Our assessments and the recommended solutions are equally objective but they are not the only steps necessary nor are they the only solutions possible. For example, additional information concerning the quantity, location, and timing of diversions affecting stream flow could help facilitate systematic diversion practices that limit impairment of stream flows. Likewise, this information together with knowledge of water demand could be useful in identifying sites for water storage reservoirs that could offset deleterious spring and summer diversions.

We view this plan as a framework in which efforts can occur in an organized, efficient, and effective way. This plan for restoring salmonid habitat is adaptable, so that as we learn new methodologies, re-assess habitat conditions, or gain new understanding of land use effects, this new information can be used as feedback to modify and, if appropriate, extend the plan. By viewing the efforts that evolve from this plan in a broader context than just the 12 project streams, the Russian River Watershed, or even anadromous salmonids, our collective efforts can serve as a model for similar efforts.

PART II. BENEFICIAL MANAGEMENT PRACTICES [TO BE COMPLETED]

APPENDIX 1. CRITERIA FOR ASSESSING CURRENT FRESHWATER HABITAT CONDITIONS FOR ANADROMOUS SALMONIDS

INTRODUCTION

The objective of this appendix is to present a framework for assessing current freshwater habitat conditions for anadromous salmonids of in the 12 project streams.

In Part I, we listed six habitat factors that we considered fundamental to salmonid population persistence in freshwater (Fundamental Habitat Factors, FHFs) and outlined our reasons for developing rating criteria for only three of those FHFs:

1. Channel complexity (*e.g.*, amount of pool habitat, pool quality, pool shelter)
2. Substrate quality
3. Riparian quality.

Each of the three FHFs consists of multiple habitat components. Our approach was to first identify an indicator variable for each component identified (Part I, Table 2) and then to develop criteria to rate each FHF. Rating criteria are based on work by other agencies in these or similar watersheds in Northern California (*e.g.*, CDFG, NCRWQCB) or from the primary and gray literature. Draft criteria have been reviewed by biologists from the NMFS, Natural Resources Conservation Service (NRCS), CDFG, NCRWQCB, and SRCD.

RATING CRITERIA

1) Channel complexity

Stream channel complexity is a reflection of geomorphological processes. In smaller streams, pool characteristics can be a good indicator of stream channel conditions. Because there is also a substantial body of evidence showing relationships between salmonid production and characteristics of pool habitat in streams (Bilby and Bisson 1998, annotated bibliography of Bauer and Stephen 1999), channel complexity was rated on the basis of the amount of pool habitat, the depth of pools, the amount of shelter in pools, the complexity of shelter material in pools, and the composite shelter quality in pools.

Habitat component: Amount of pool habitat
Indicator variable: Pool to riffle ratio

The amount of pool habitat in a stream has been shown to directly correlate with juvenile salmonid production (Bauer and Stephen 1999). Pools provide flow refugia, as well as important functions related to spawning and food production (Part I, Table 1). In their habitat suitability index (HSI) model for rainbow trout, Raleigh et al. (1984) indicate that there should be a balance between the amount of pool habitat and the amount of riffle habitat. This is reflected in the rating criteria we adopted (Table A2-1).

Table A2-1. Scores and ranges of values for rating the pool to riffle ratio.

Score	Lower bound	Upper bound
1	0	20
2	20	40
3	70	100
4	40	50
5	50	70

Habitat component: Depth of pools
Indicator variable: Percent primary pools

A primary pool is defined as having a maximum residual depth of at least 2 feet in 1^{st} and 2^{nd} order streams and a maximum residual depth of at least 3 feet in 3^{rd} and 4^{th} order streams (Flosi et al. 2004). The residual depth of a pool is defined as the maximum water depth in the pool minus the water depth of its downstream riffle crest (NCRWQCB 2006). Coey et al. (2002) state that a primary pool frequency ≥50% is ‘desirable’ and <40% is ‘undesirable’. Based on measurements in 1,000 m stream reaches of 16 different streams, Knopp (1993) found that in pristine or near pristine streams in Northern California (where the underlying geology is similar to that of the streams we assessed), the average pool frequency was only 41.5% (range=16.7-55.8%). The rating criteria we developed are reflective of that natural range (Table A2-2).

Table A2-2. Scores and ranges of values for rating the percent of primary pools.

Score	Lower bound	Upper bound
1	0	20
2	20	30
3	30	40
4	40	50
5	50	100

Habitat component: Amount of shelter in pools
Indicator variable: Percent of substrate in pools covered with material to shelter a 6” fish

As stated, a primary role of pools is to shelter juvenile salmonids both from high flows and from predators. The amount of material in a pool is a key determinant of how well a given pool provides those functions. We adopted the criteria recommended by Coey et al. (2004) that greater than 40% coverage of the substrate in a pool by shelter material is desirable (Table A2-3).

Table A2-3. Scores and ranges of values for rating the percent of substrate in pools covered with material large enough to shelter a 6” fish.

Score	Lower bound	Upper bound
1	0	10
2	10	20
3	20	30
4	30	40
5	40	100

Habitat component: Complexity of shelter material in pools
Indicator variable: Percent of pools with a shelter complexity of 2 or 3

The presence of large woody debris in a stream channel is of particularly high value for pool formation and by contributing to macroinvertebrate production (Bisson et al. 1987, Peterson et al. 1992). Logs and root wads are highly beneficial for enhancing both survival and growth of salmonids (Bauer and Stephen 1999). CDFG recognized this importance and has adopted shelter complexity values that give a higher rating to pools that provide shelter from large woody debris as opposed to other types of material (Flosi et al. 2004).

Table A2-4. Scores and ranges of values for rating the percent of pools with a shelter complexity[1] values of 2 or 3.

Score	Lower bound	Upper bound
1	0	10
2	10	20
3	20	30
4	30	40
5	40	100

Habitat component: Composite shelter quality in pools
Indicator variable: Shelter rating

There is no doubting the importance of shelter in pools for stream salmonids. Both the type and amount of shelter have been shown to strongly influence the production of juvenile, stream-dwelling salmonids (see annotated bibliography of Bauer and Stephen 1999). Flosi et al. (2004) developed a metric that combines the amount of stream bottom covered expressed as a percentage ('cover') and four qualitative shelter complexity values[1] that reflect the type of cover ('instream shelter complexity') into a single metric termed 'shelter rating' (Flosi et al. 2004):

Shelter rating = Cover * Instream shelter complexity.

We adopted the suggestion by Coey et al. (2004) that a shelter rating <80 is undesirable while a shelter rating of >100 is desirable (Table A2-5).

Table A2-5. Scores and ranges of values for shelter rating of pools.

Score	Lower bound	Upper bound
1	0	70
2	70	80
3	80	90
4	90	100
5	100	300

[1] See Flosi et al. (2004), page III-43 for definitions of instream complexity shelter values.

2) Substrate quality

Stream substrate plays a role in almost every aspect of salmonid life history including shelter, food production, feeding, spawning, and incubation. Substrate size interacts with components of water quality and stream velocity to govern macroinvertebrate production and dictate whether a given location in a stream is suitable for spawning or incubation. To evaluate substrate quality, we assessed the amount of fine sediment in spawning substrate.

Habitat component: Fine sediment in spawning substrate
Indicator variable: Percent of pool tail-outs with embeddedness <25%
We chose embeddedness is the primary metric that will be used to assess fines in spawning substrate. Embeddedness is defined by NCRWQB (2006) as the degree to which larger particles such as gravels and cobbles are surrounded or covered by fine sediment. Embeddedness sampling methods have been applied by CDFG to pool tail-outs as a means for assessing spawning, incubation and rearing conditions for salmonids (Flosi et al. 2004). Pool tail-outs were selected for measuring embeddedness because they generally have conditions (*e.g.*, depth, velocity, substrate size) that are selected by adult females for redd construction (Table A2-6).

Table A2-6. Scores and ranges of values for rating the percent of pool tail-outs with embeddedness <50%.

Score	Lower bound	Upper bound
1	0	20
2	20	40
3	40	60
4	60	80
5	80	100

3) Riparian quality

The functions considered when developing assessment criteria for riparian quality were stream shading and protection from erosion. Riparian quality was assessed by rating canopy, stream bank vegetation cover, and dominant riparian vegetation type.

Habitat component: Canopy
Indicator variable: Percent canopy closure
Canopy provides the important functions of temperature modification (*e.g.*, shading, Beschta et al. 1987, a source for instream cover (*i.e.*, organic debris, Bisson et al. 1987), and as a source of nutrients and substrate for aquatic macroinvertebrate production (Bilby and Bisson 1998). The HSI model for rainbow trout (Raleigh et al. 1984) and the HSI model for coho salmon (McMahon 1983) both present habitat suitability for canopy closure as an increasing function up to 50% and then decreasing beyond 75%. The basis for the decreasing portion of the function at canopy closure values in excess of 75% is that winter temperatures can become too cold thereby decreasing survival of early life stages (McMahon 1983). However, because of the relatively mild winter temperatures common to the Russian River Basin, we rejected this idea for assessing canopy closure. Instead, we used the canopy closure categories developed by CDFG (Acomb et

al. 2006) which are based on statistical clustering using the Jenks optimization method for ‘natural breaks’ (as implemented in ArcView Version 3, ESRI 2006) (Table A2-7).

Table A2-7. Scores and ranges of values for rating the percent canopy closure.

Score	Lower bound	Upper bound
1	0	20
2	20	40
3	40	60
4	60	80
5	80	100

Habitat component: Amount of riparian vegetation cover
Indicator variable: Percent of stream bank covered with vegetation

The amount of riparian vegetation shares some functions with canopy, specifically stream bank stabilization to reduce the likelihood of fine sediment input to the stream and as a source for instream cover. Our rating criteria were based on the HSI model for rainbow trout (Raleigh et al. 1984); however, instead of combining riparian vegetation cover and riparian substrate cover as presented in Raleigh et al. (1984), we only considered riparian vegetation cover (Table A2-8).

Table A2-8. Scores and ranges of values for rating the percent of the stream bank covered with vegetation.

Score	Lower bound	Upper bound
1	0	15
2	15	35
3	35	50
4	50	70
5	70	100

Habitat component: Riparian vegetation type
Indicator variable: Dominant riparian vegetation type

Certain vegetation types (*e.g.*, mature trees with dense canopy) function better at reducing the impact from rain on mobilizing soil particles. The often dense leaf litter from these trees, or duff, performs a similar function as well as providing a source of organic matter organic debris for instream shelter (Table A2-9).

Table A2-9. Scores and ranges of values for rating the dominant riparian vegetation type.

Score	Vegetation type
1	No vegetation
2	Grass/Invasive/Moss
3	Brush
4	Hardwood trees
5	Coniferous trees

APPENDIX 2. SPATIAL REPRESNTATION OF CURRENT FRESHWATER HABITAT CONDITIONS FOR ANADROMOUS SALMONIDS

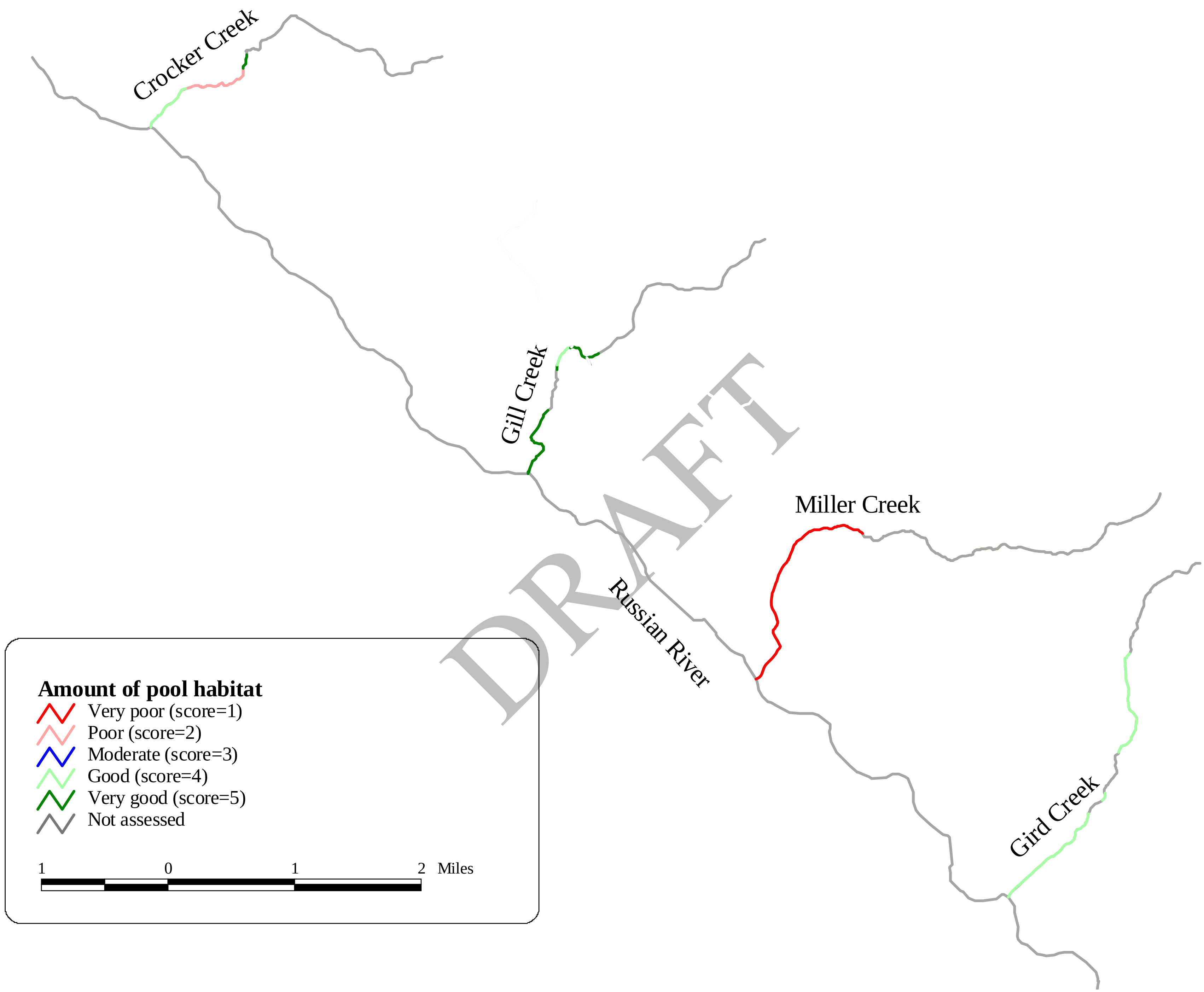

Figure A1-1a. Scores for amount of pool habitat in Alexander Valley project streams.

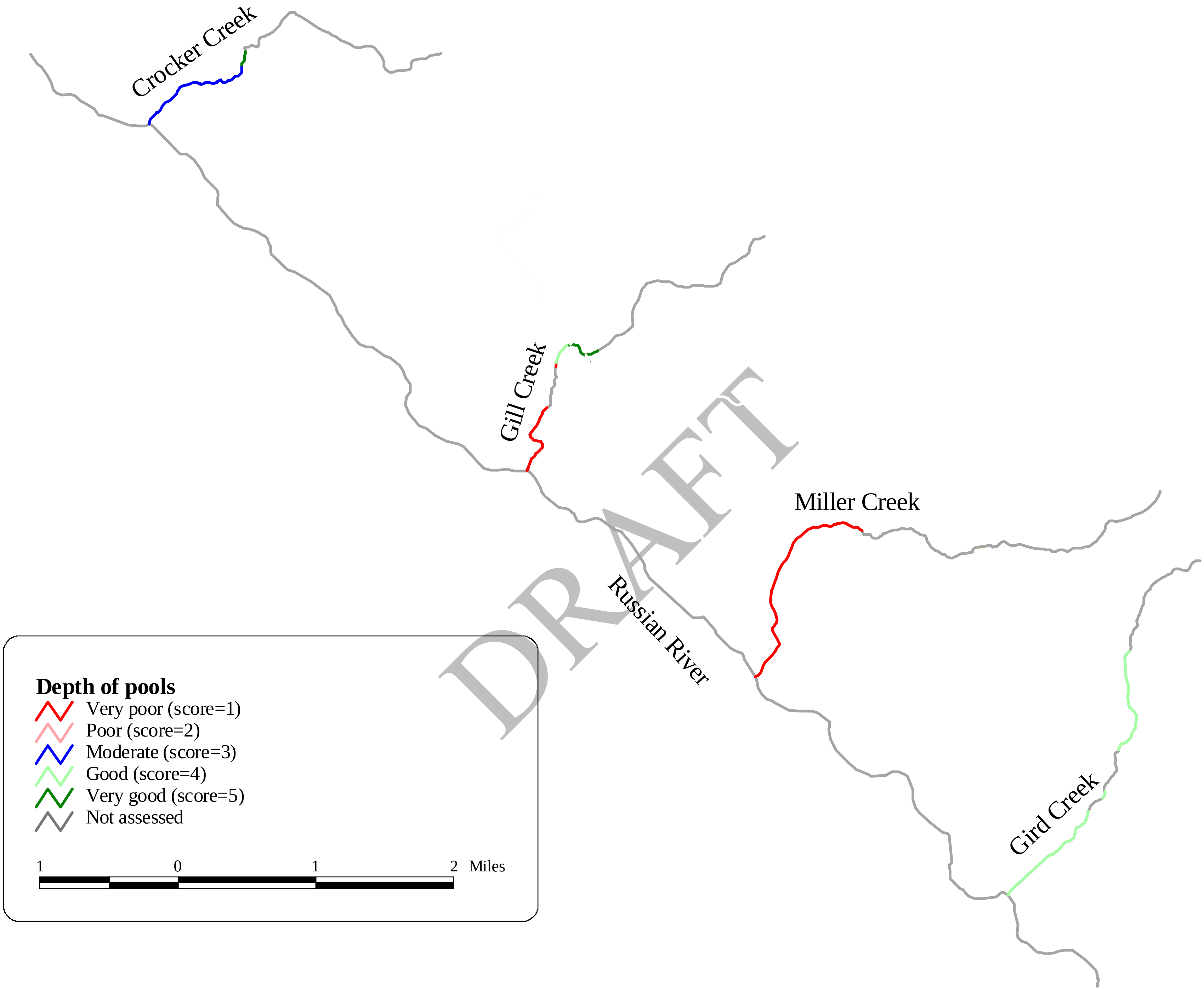

Figure A1-1b. Scores for depth of pools in Alexander Valley project streams.

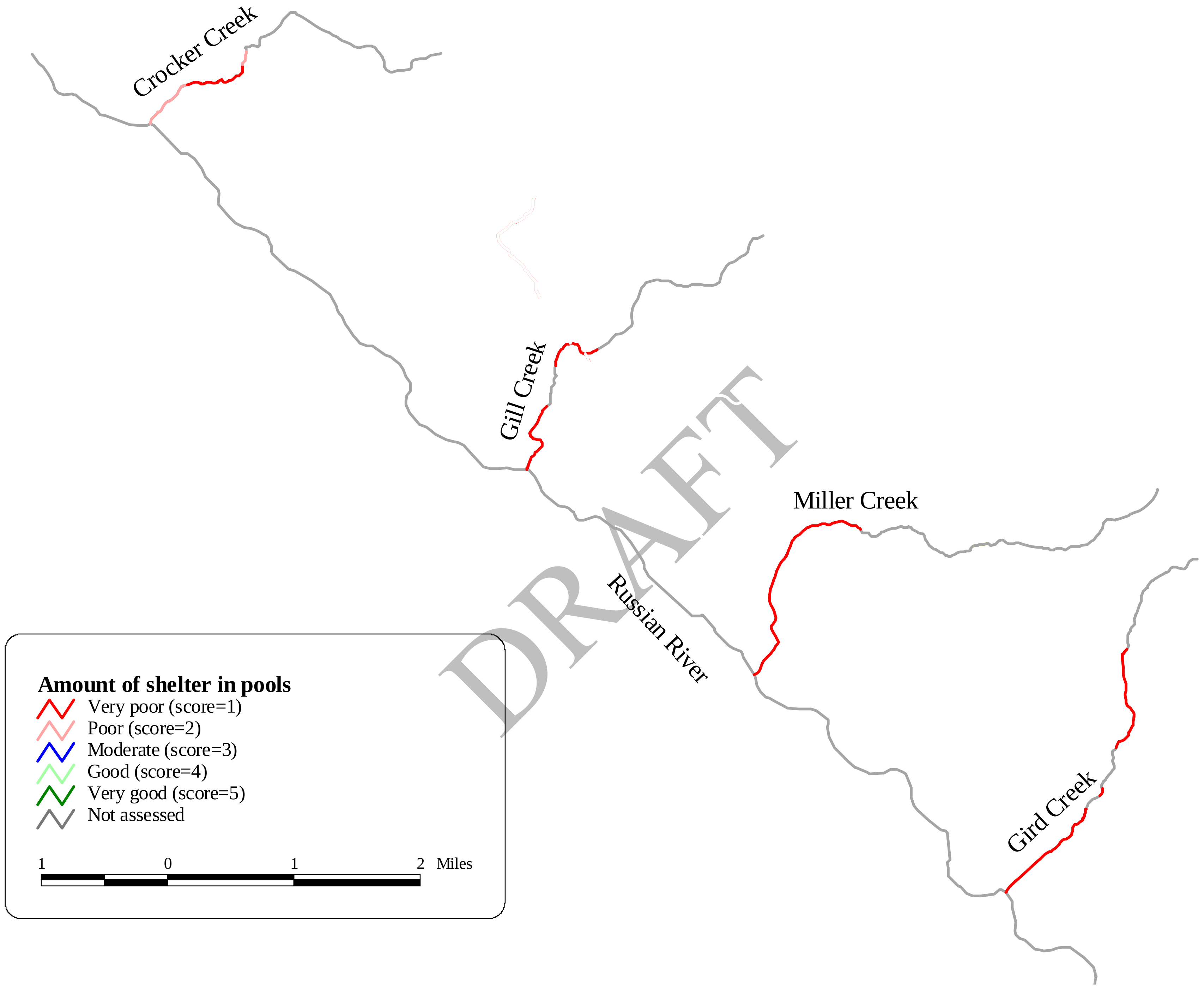

Figure A1-1c. Scores for amount of shelter in pools in Alexander Valley project streams.

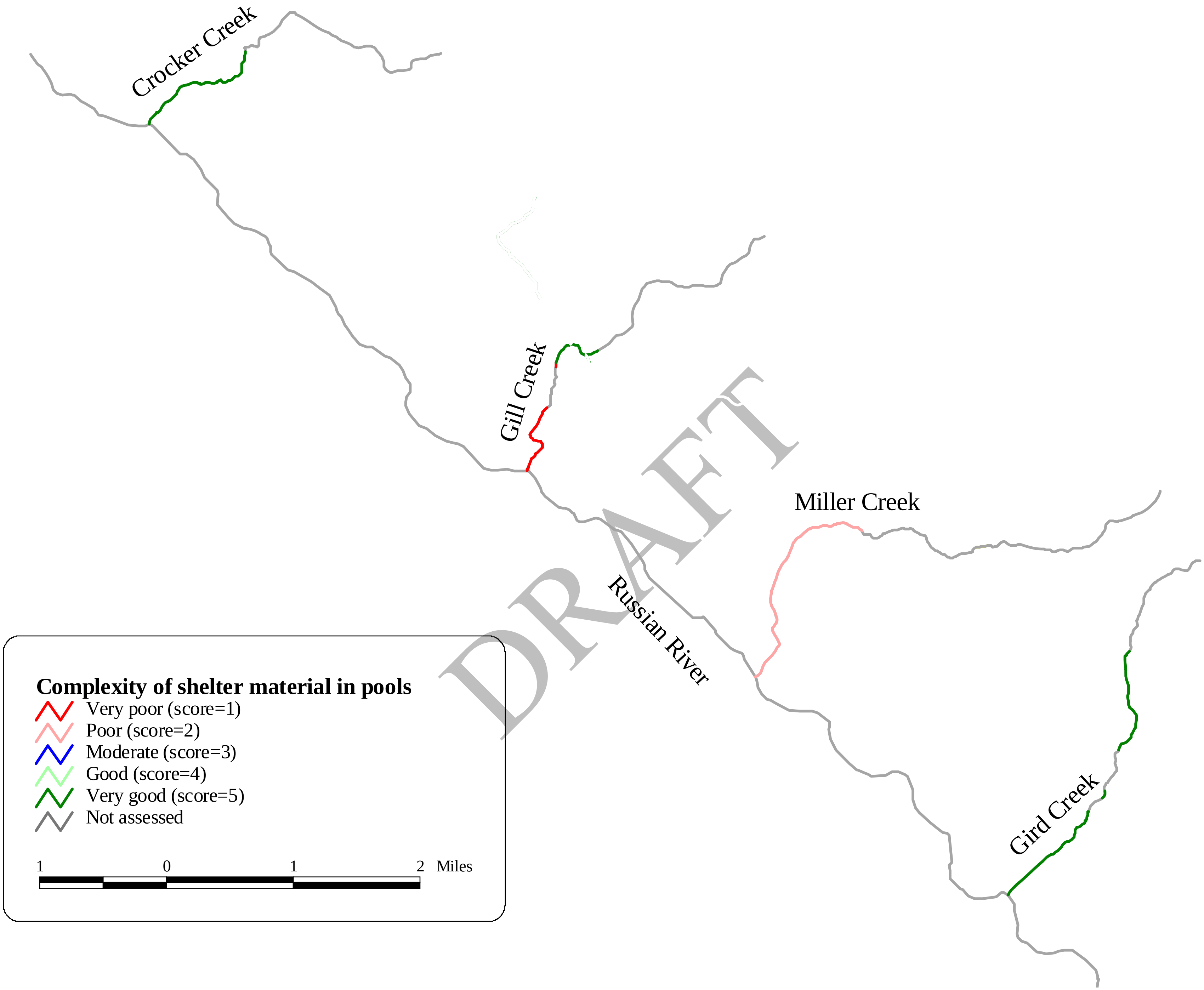

Figure A1-1d. Scores for complexity of shelter material in pools in Alexander Valley project streams.

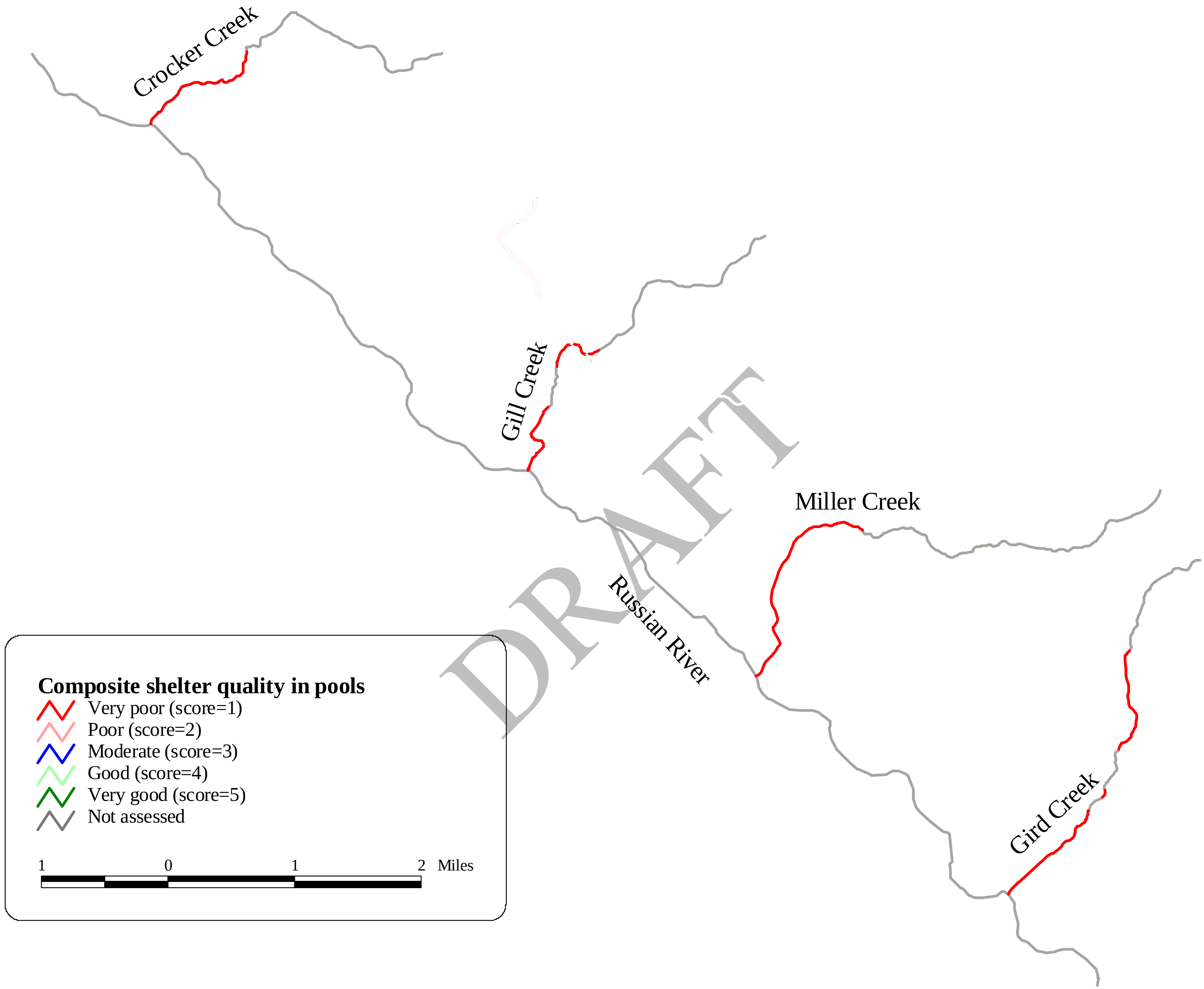

Figure A1-1e. Scores for composite shelter quality in pools in Alexander Valley project streams.

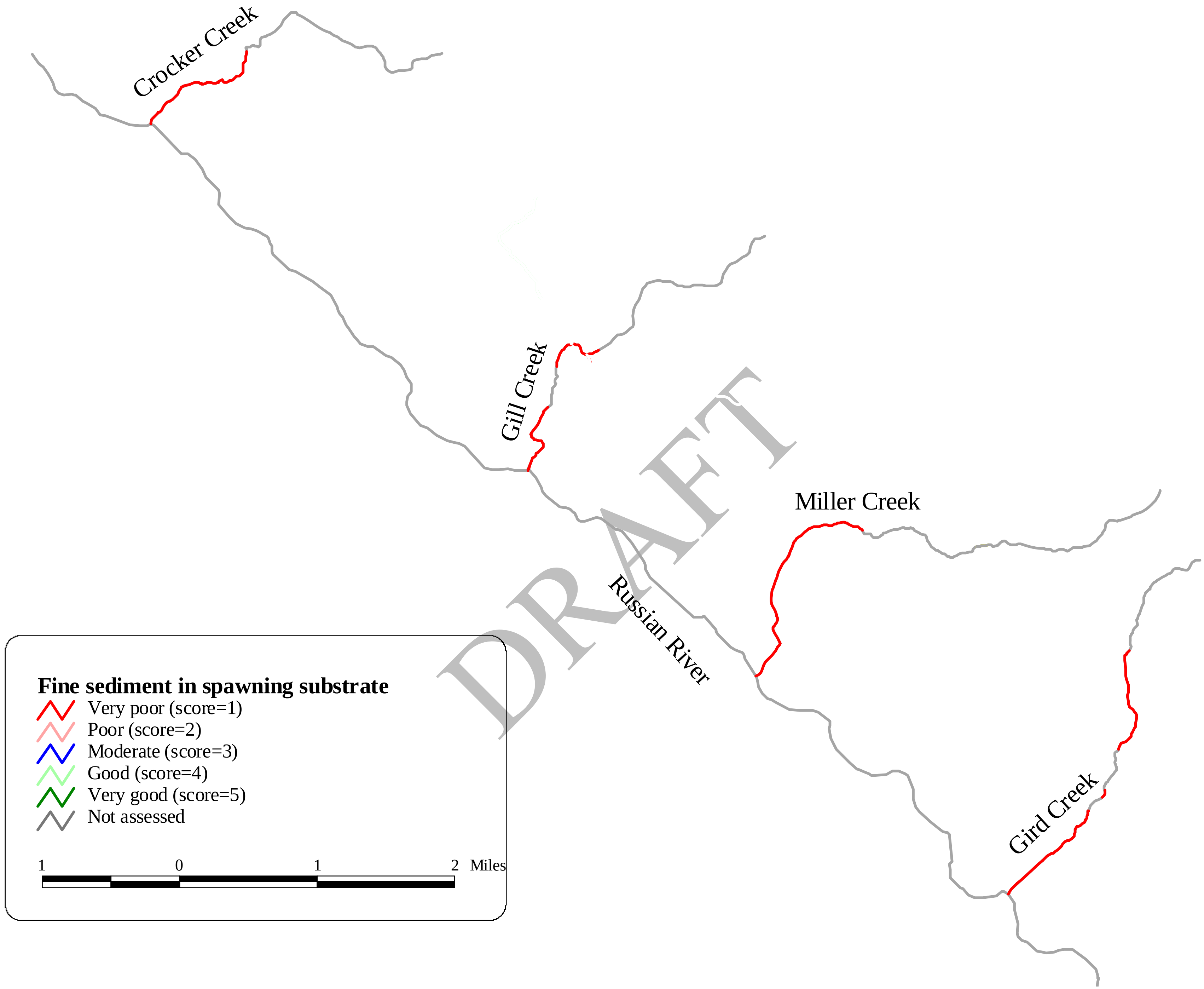

Figure A1-1f. Scores for fine sediment in spawning substrate in Alexander Valley project streams.

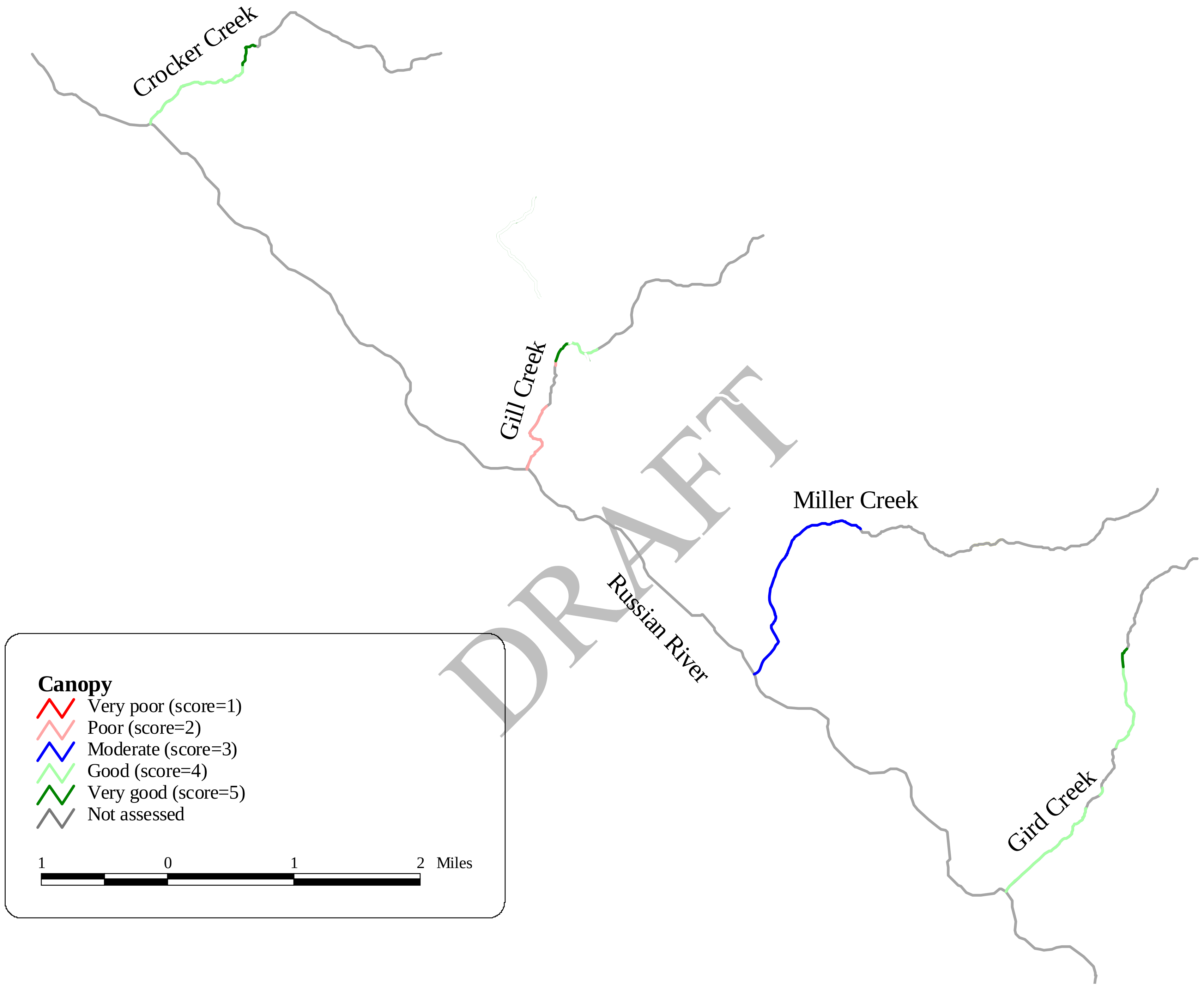

Figure A1-1g. Scores for canopy in Alexander Valley project streams.

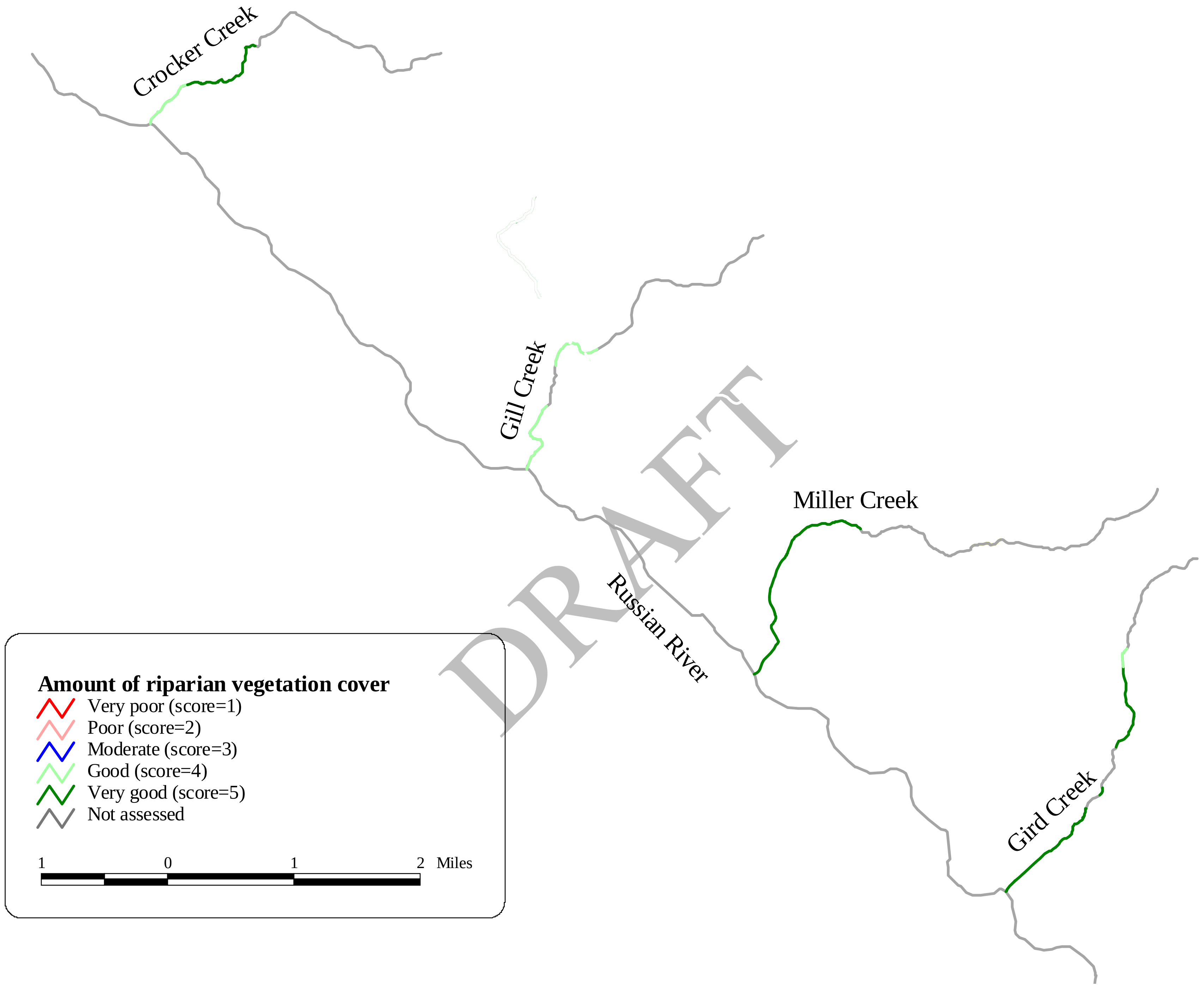

Figure A1-1h. Scores for amount of riparian vegetation cover in Alexander Valley project streams.

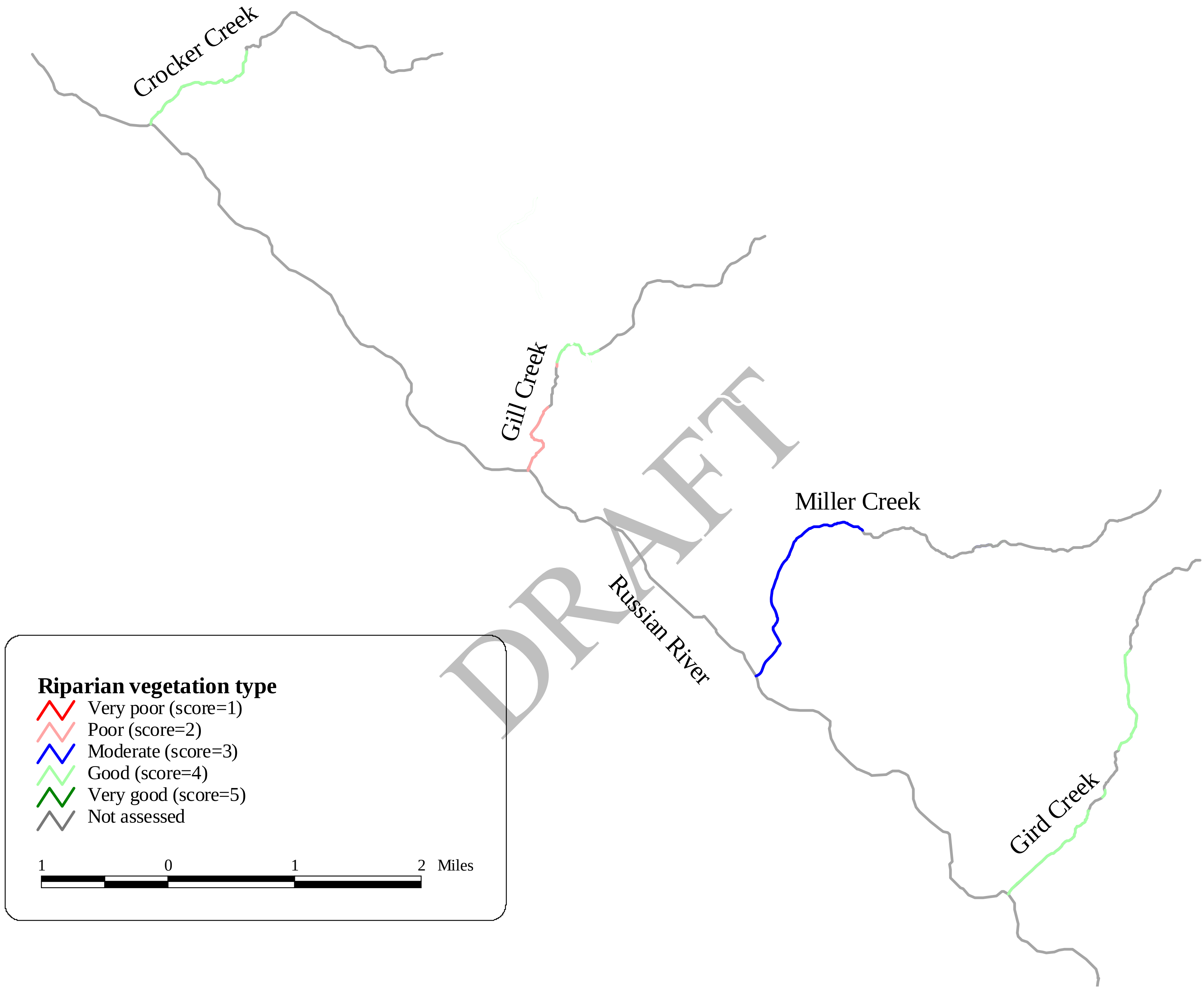

Figure A1-1i. Scores for riparian vegetation type in Alexander Valley project streams.

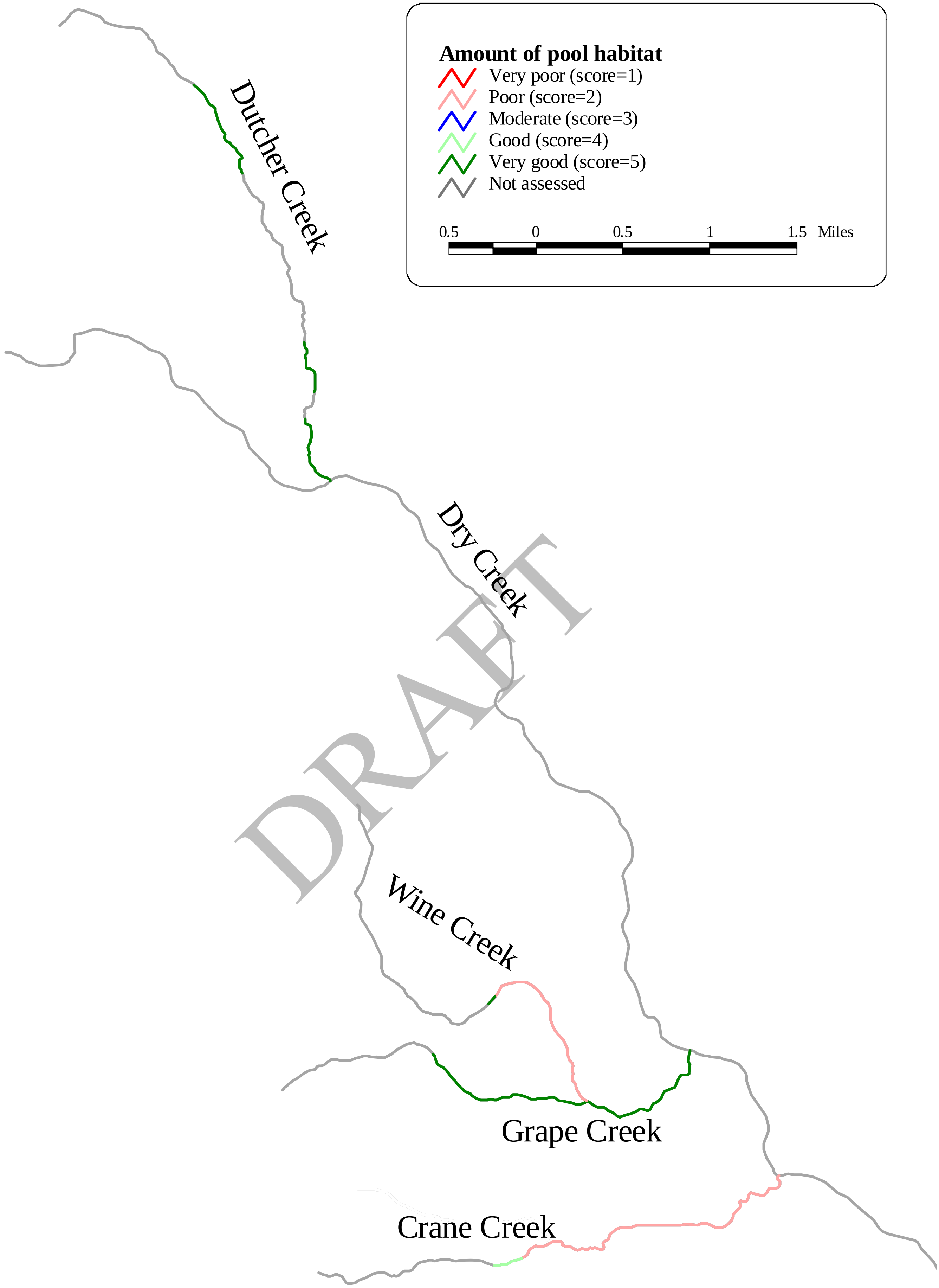

Figure A1-2a. Scores for amount of pool habitat in Dry Creek Valley project streams.

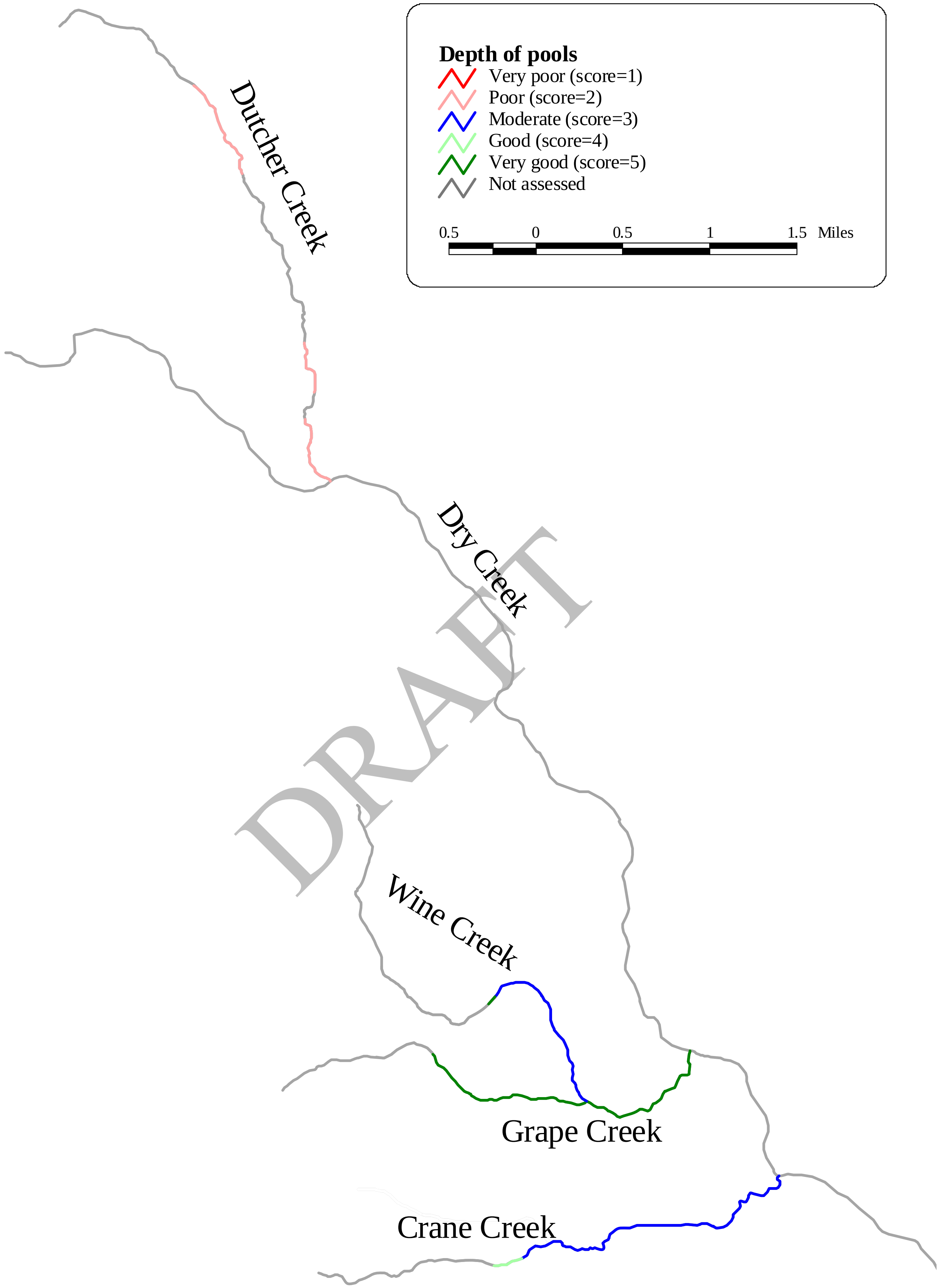

Figure A1-2b. Scores for depth of pools in Dry Creek Valley project streams.

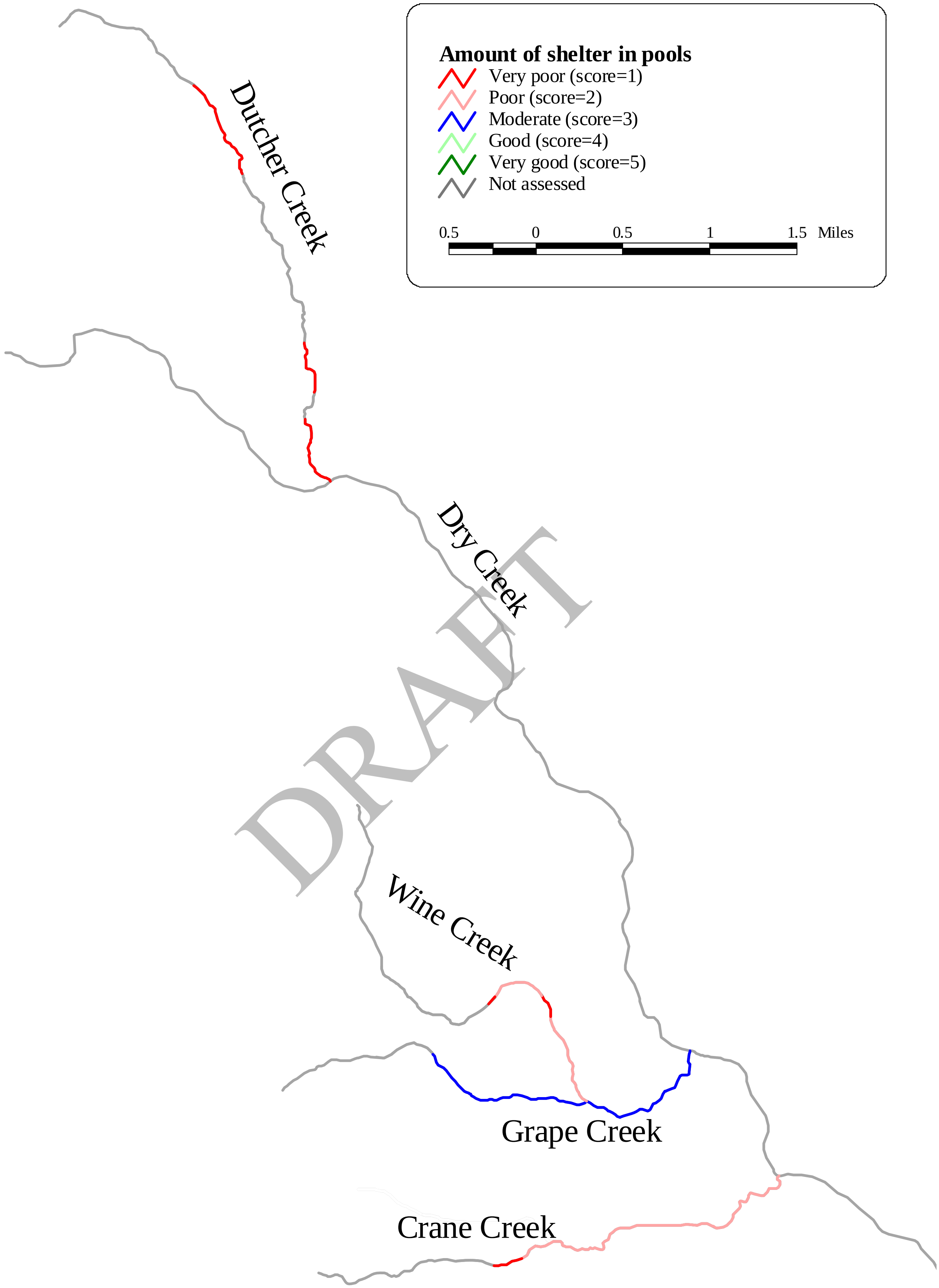

Figure A1-2c. Scores for amount of shelter in pools in Dry Creek Valley project streams.

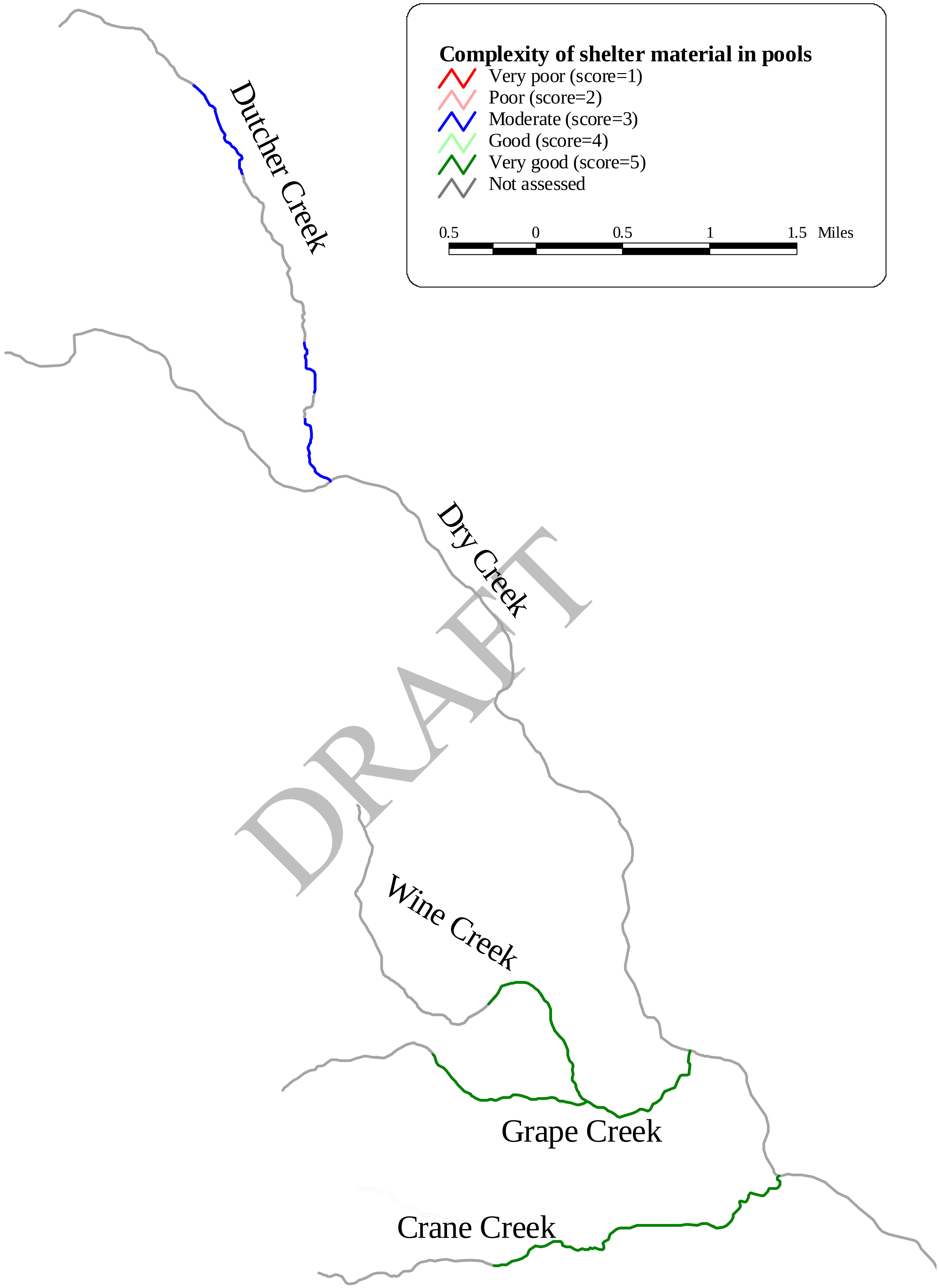

Figure A1-2d. Scores for complexity of shelter material in pools in Dry Creek Valley project streams.

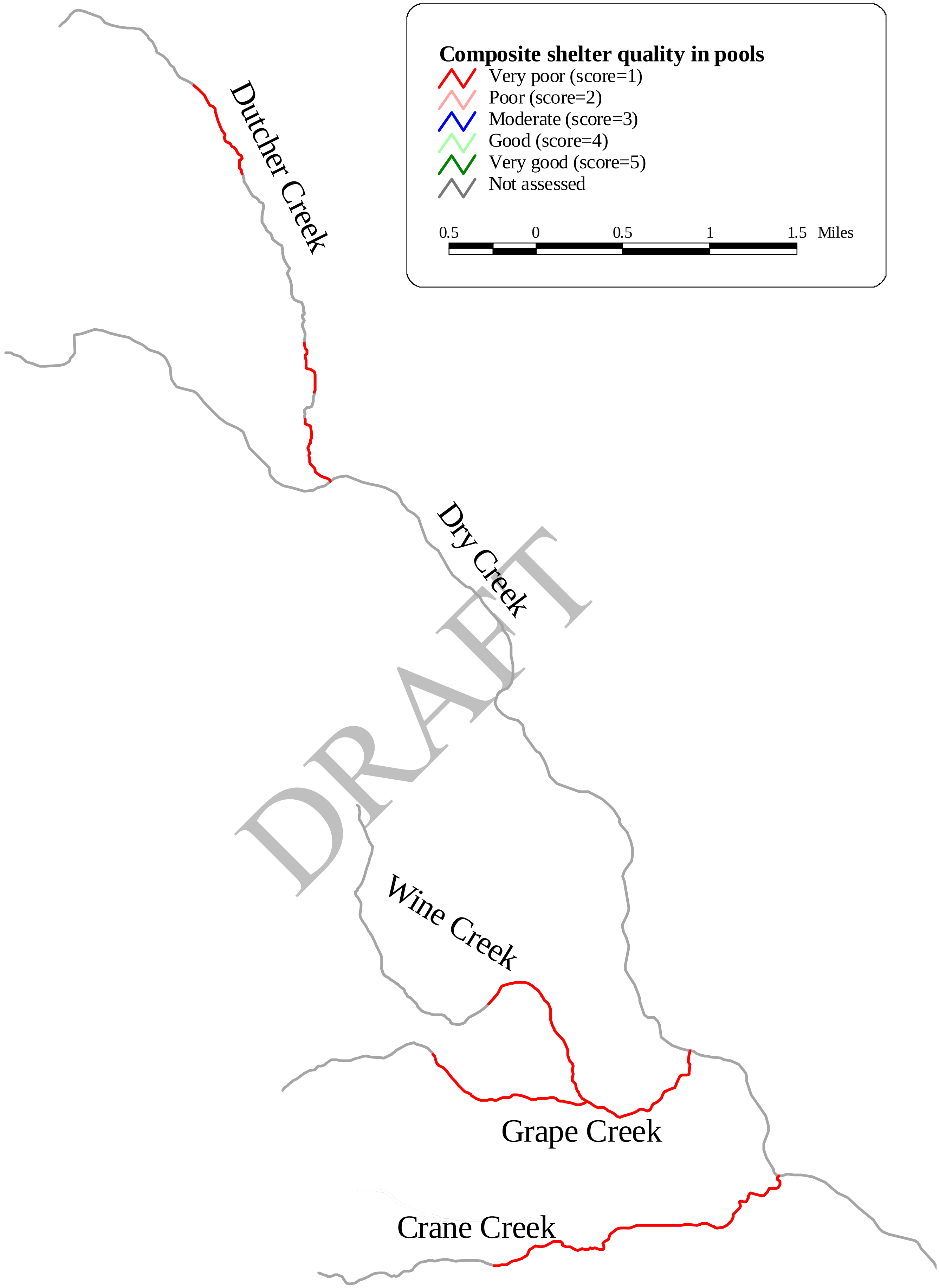

Figure A1-2e. Scores for composite shelter quality in pools in Dry Creek Valley project streams.

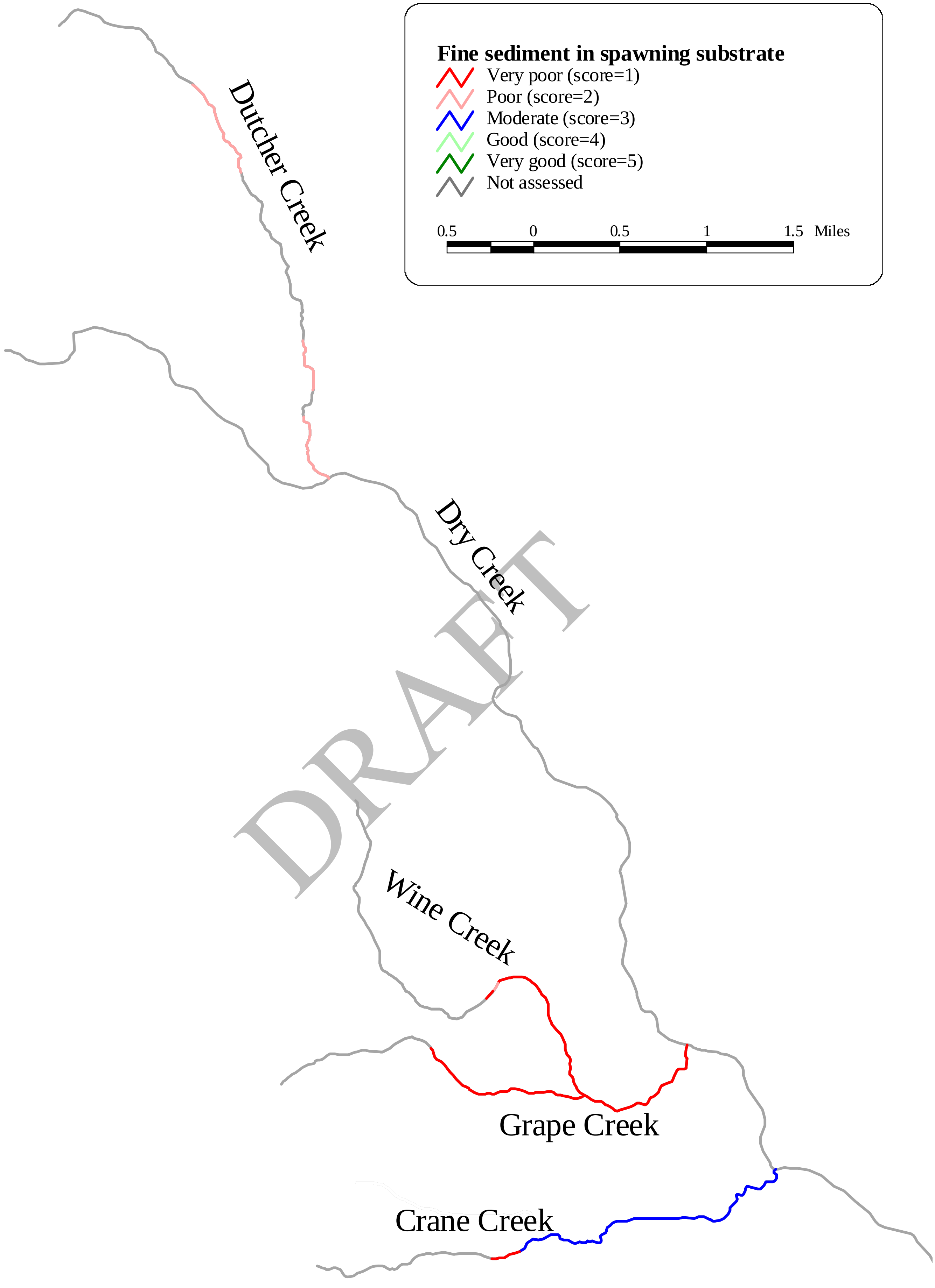

Figure A1-2f. Scores for fine sediment in spawning substrate in Dry Creek Valley project streams.

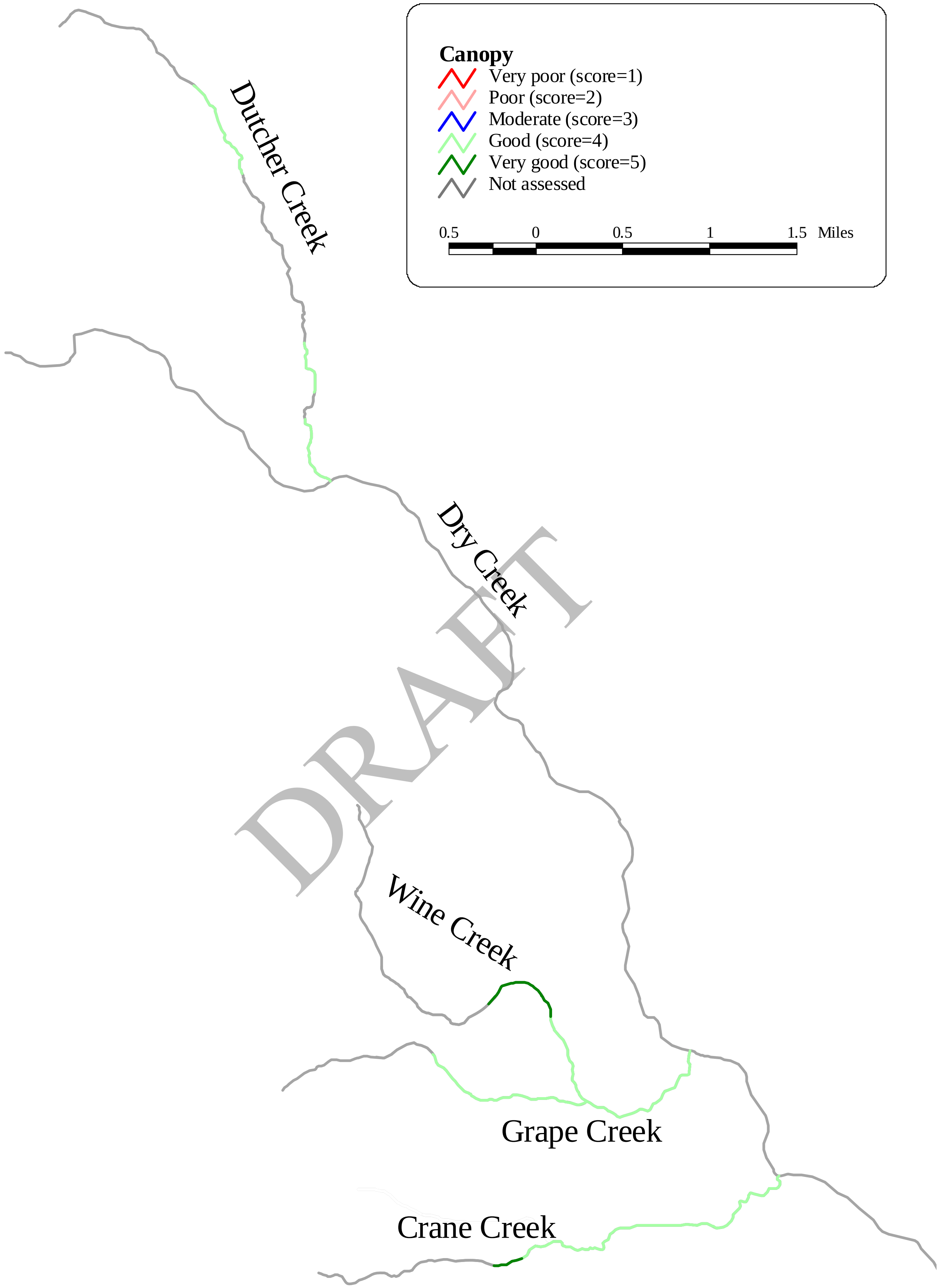

Figure A1-2g. Scores for canopy in Dry Creek Valley project streams.

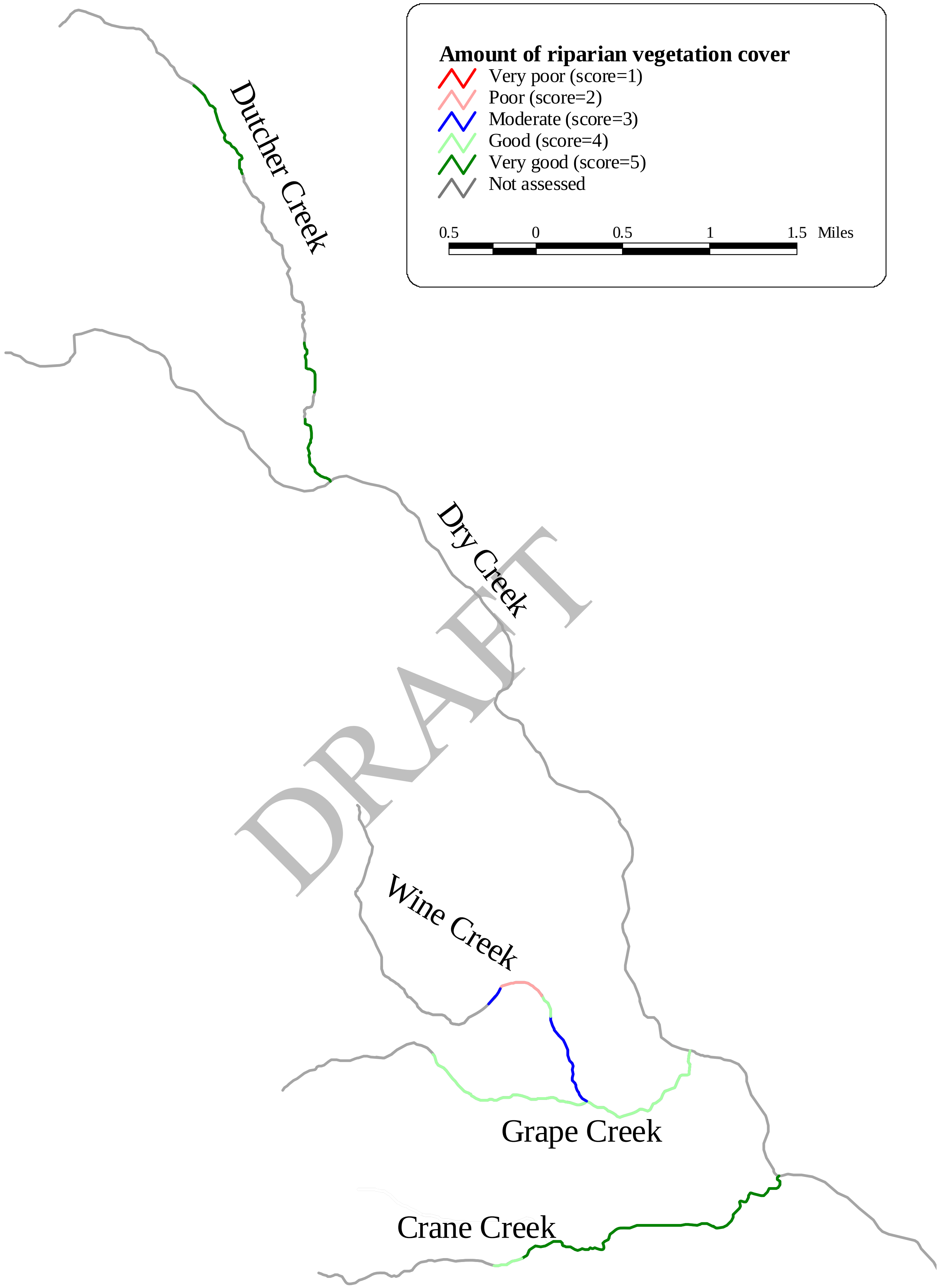

Figure A1-2h. Scores for amount of riparian vegetation cover in Dry Creek Valley project streams.

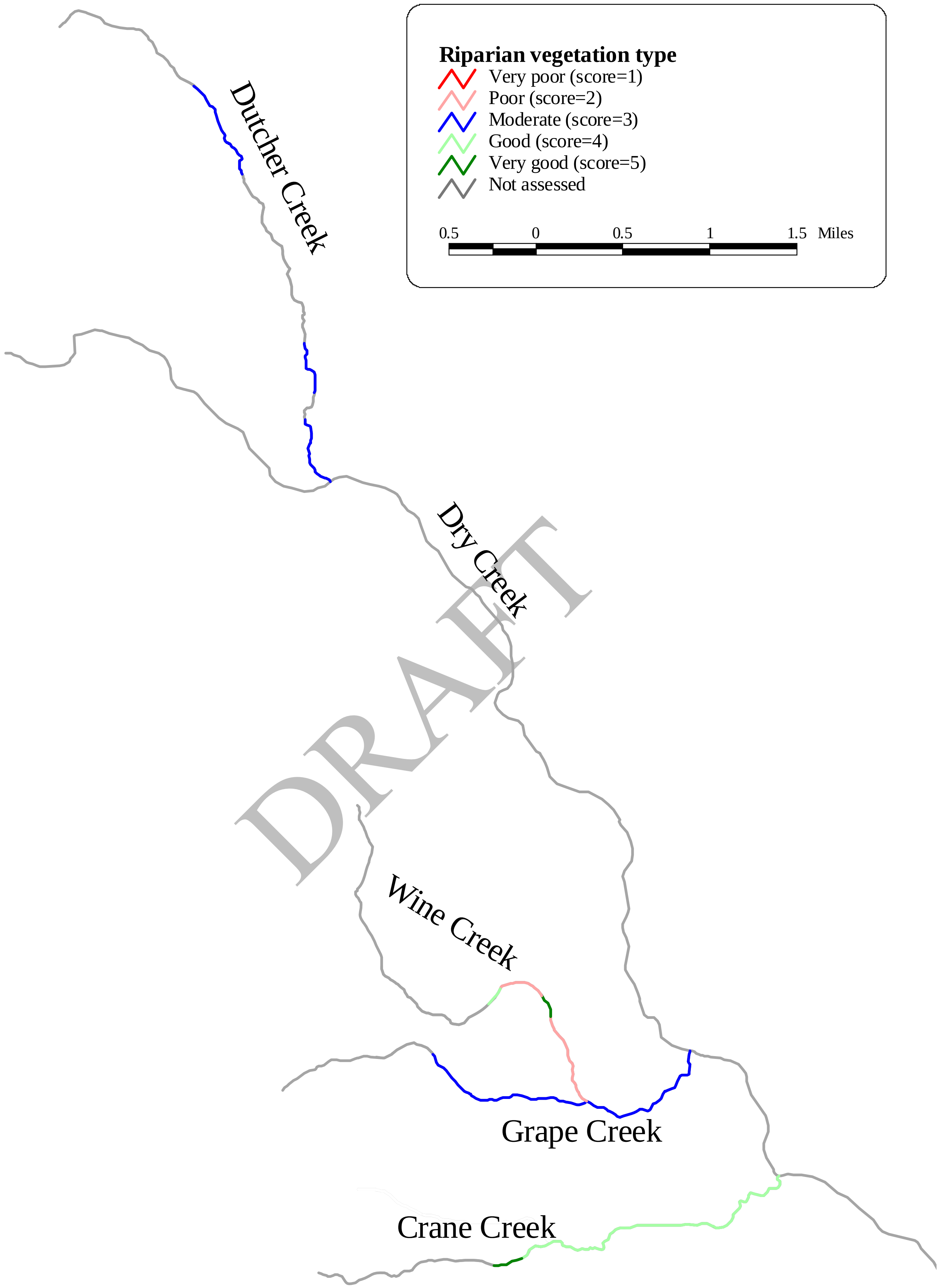

Figure A1-2i. Scores for riparian vegetation type in Dry Creek Valley project streams.

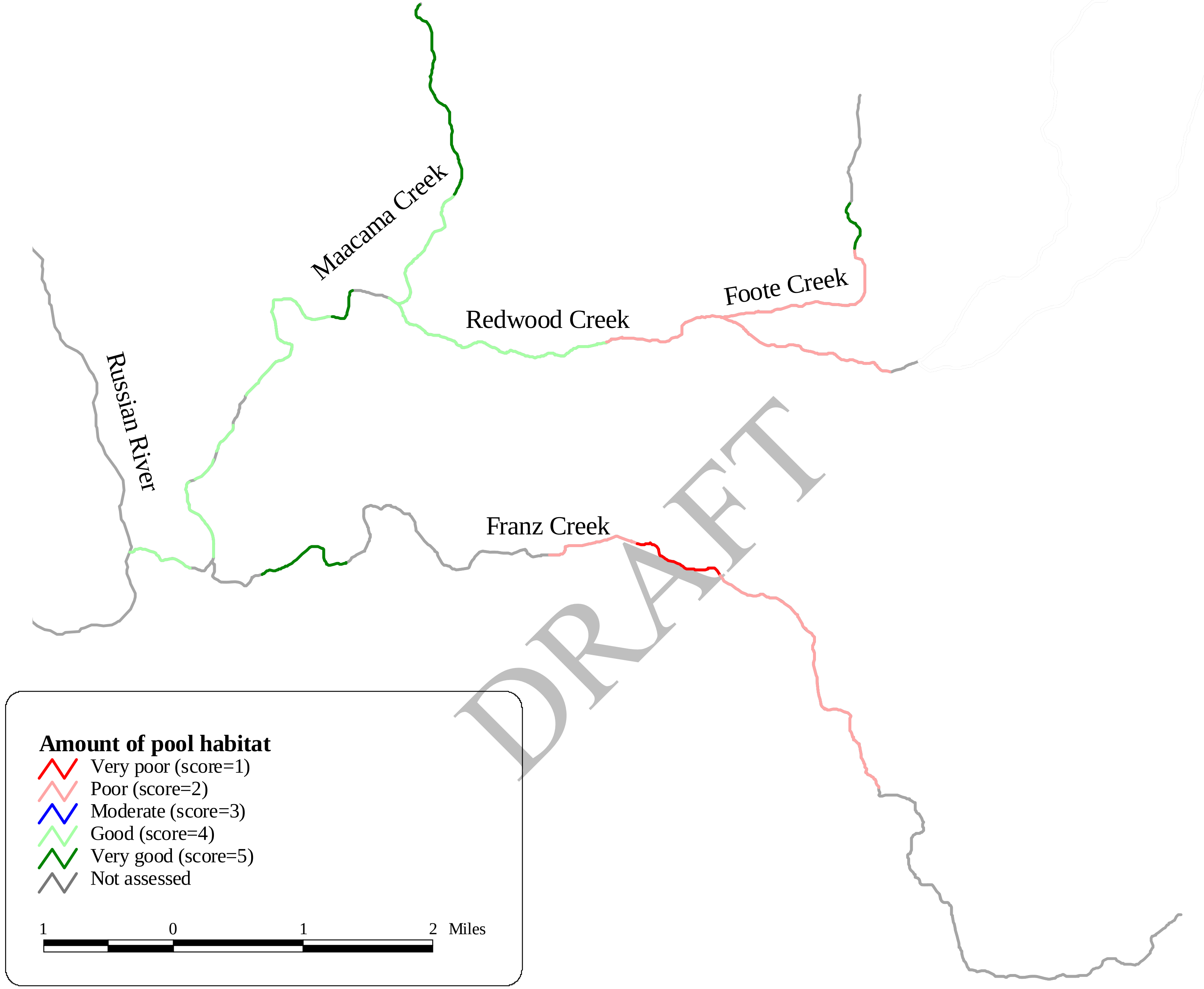

Figure A1-3a. Scores for amount of pool habitat in Knights Valley project streams.

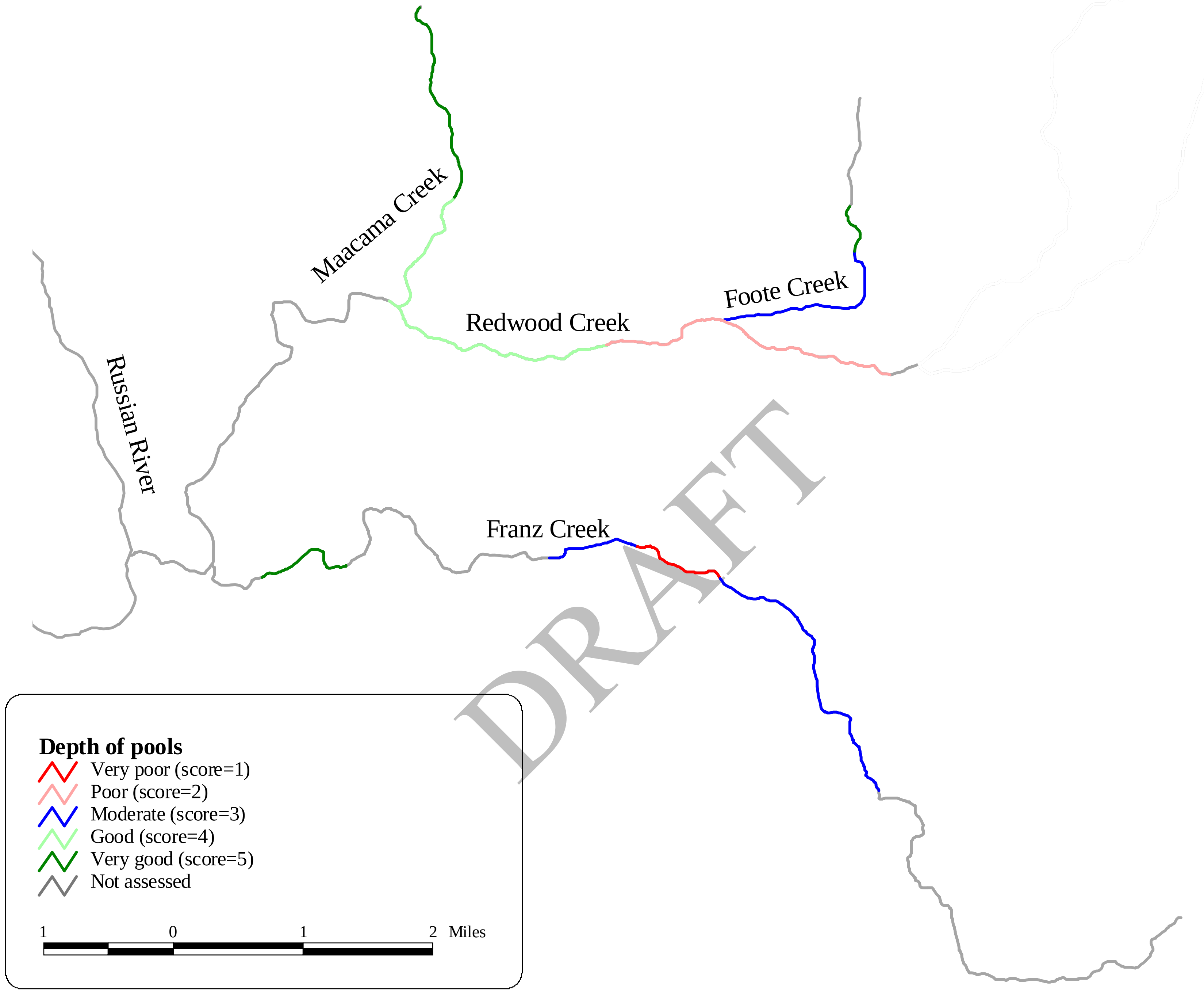

Figure A1-3b. Scores for depth of pools in Knights Valley project streams (note that depth of pools was not rated for the lower part of Maacama stream because the stream is 5th order in this reach which means there is no threshold depth for defining a primary pool).

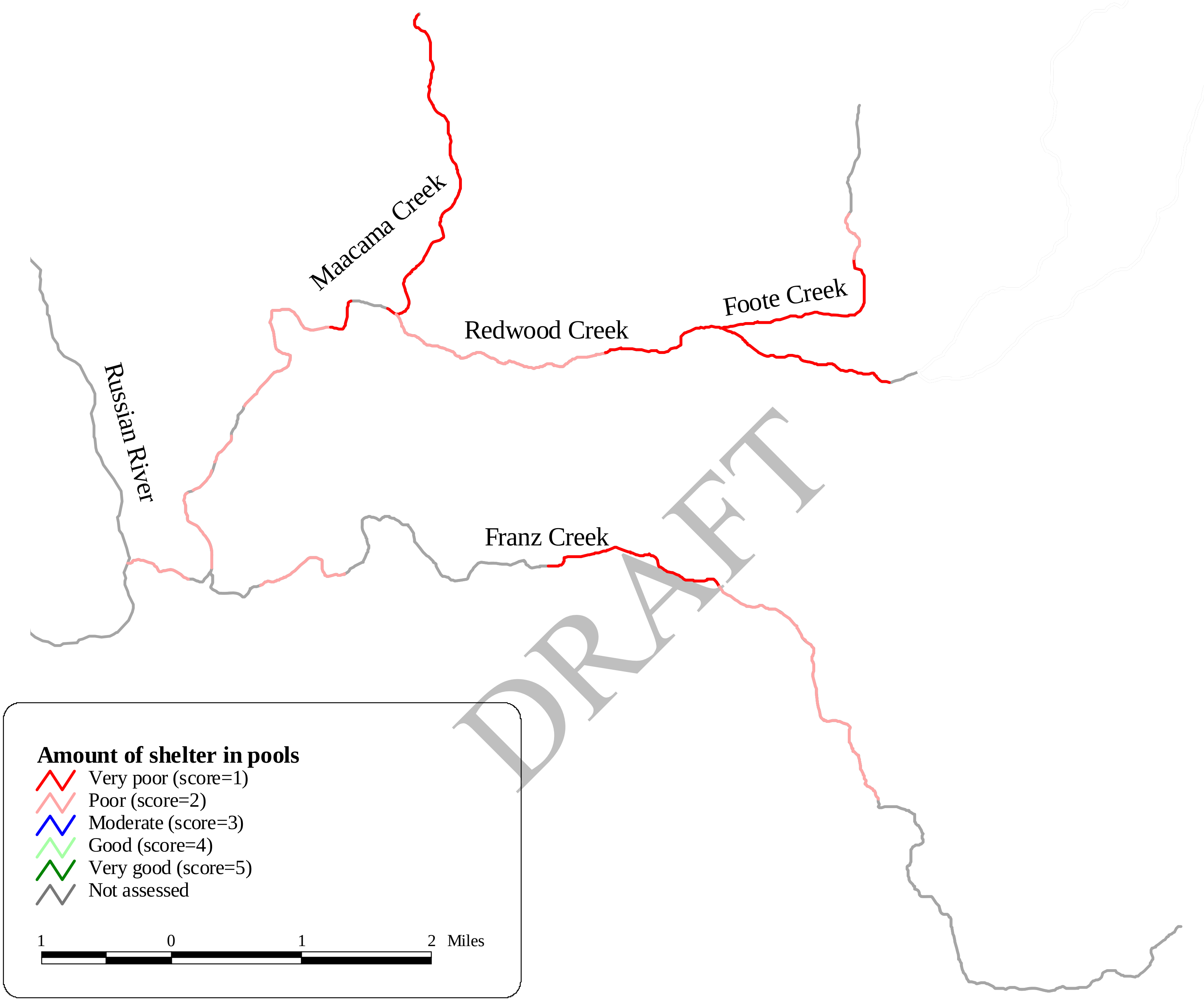

Figure A1-3c. Scores for amount of shelter in pools in Knights Valley project streams.

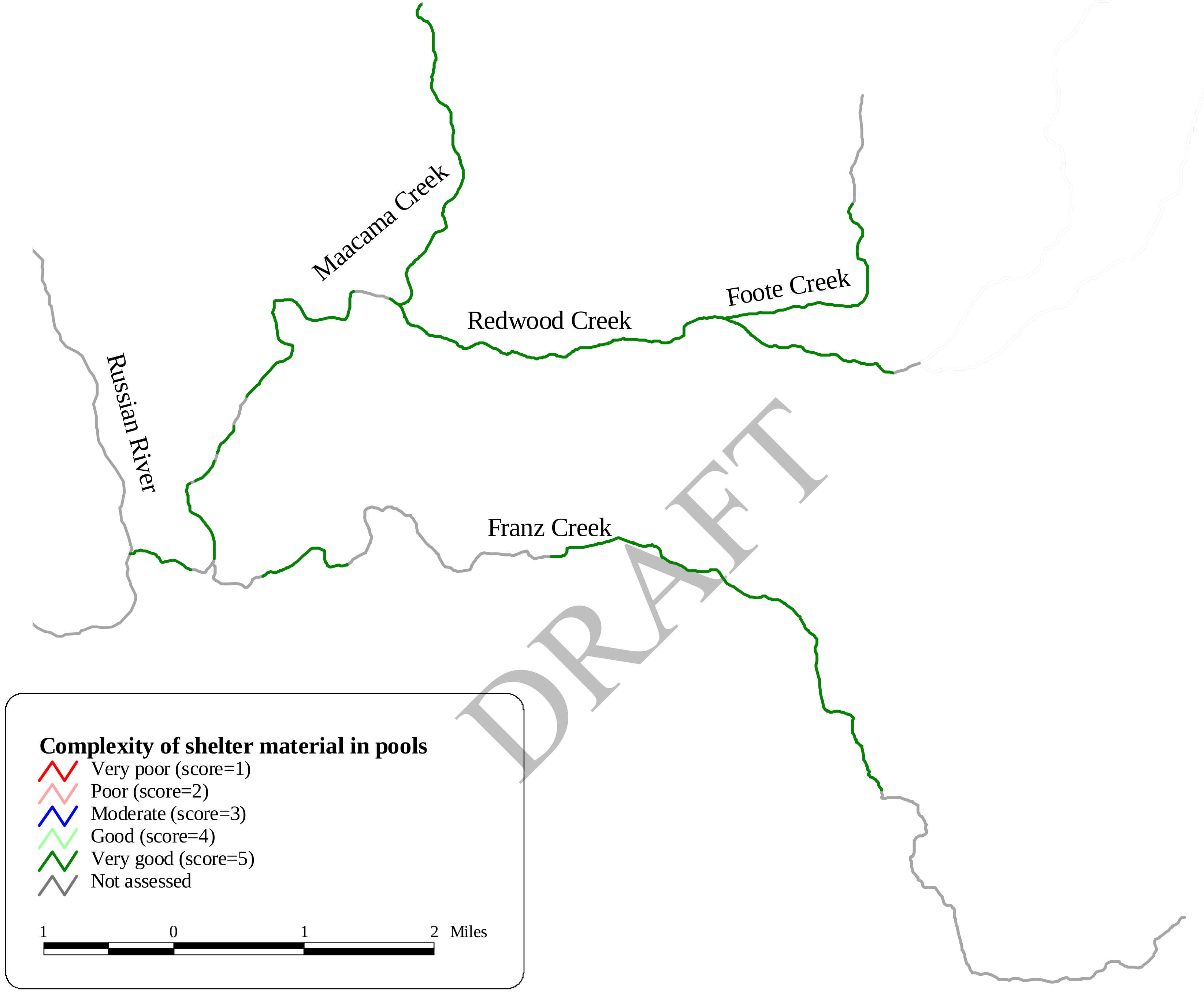

Figure A1-3d. Scores for complexity of shelter material in pools in Knights Valley project streams.

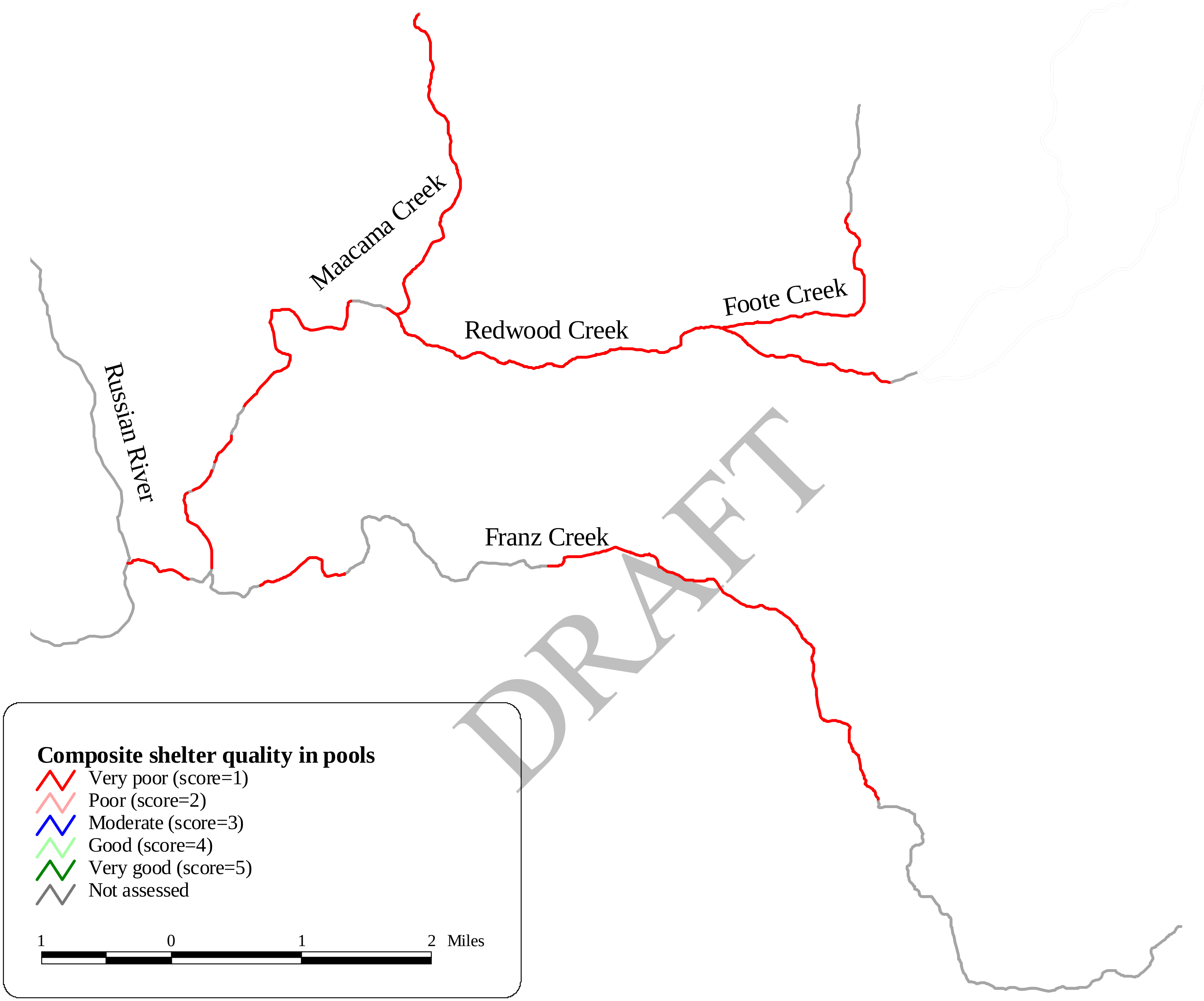

Figure A1-3e. Scores for composite shelter quality in pools in Knights Valley project streams.

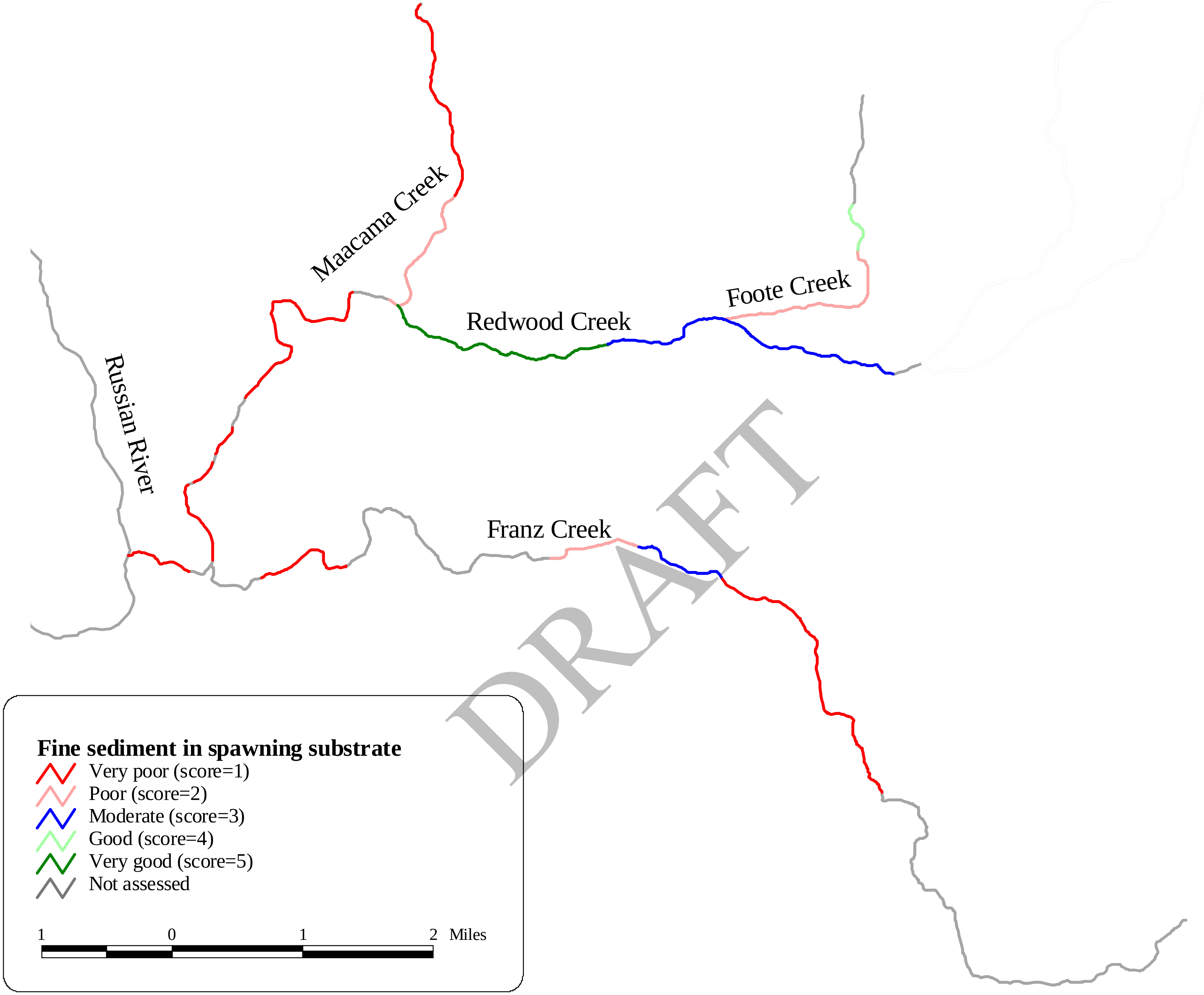

Figure A1-3f. Scores for fine sediment in spawning substrate in Knights Valley project streams.

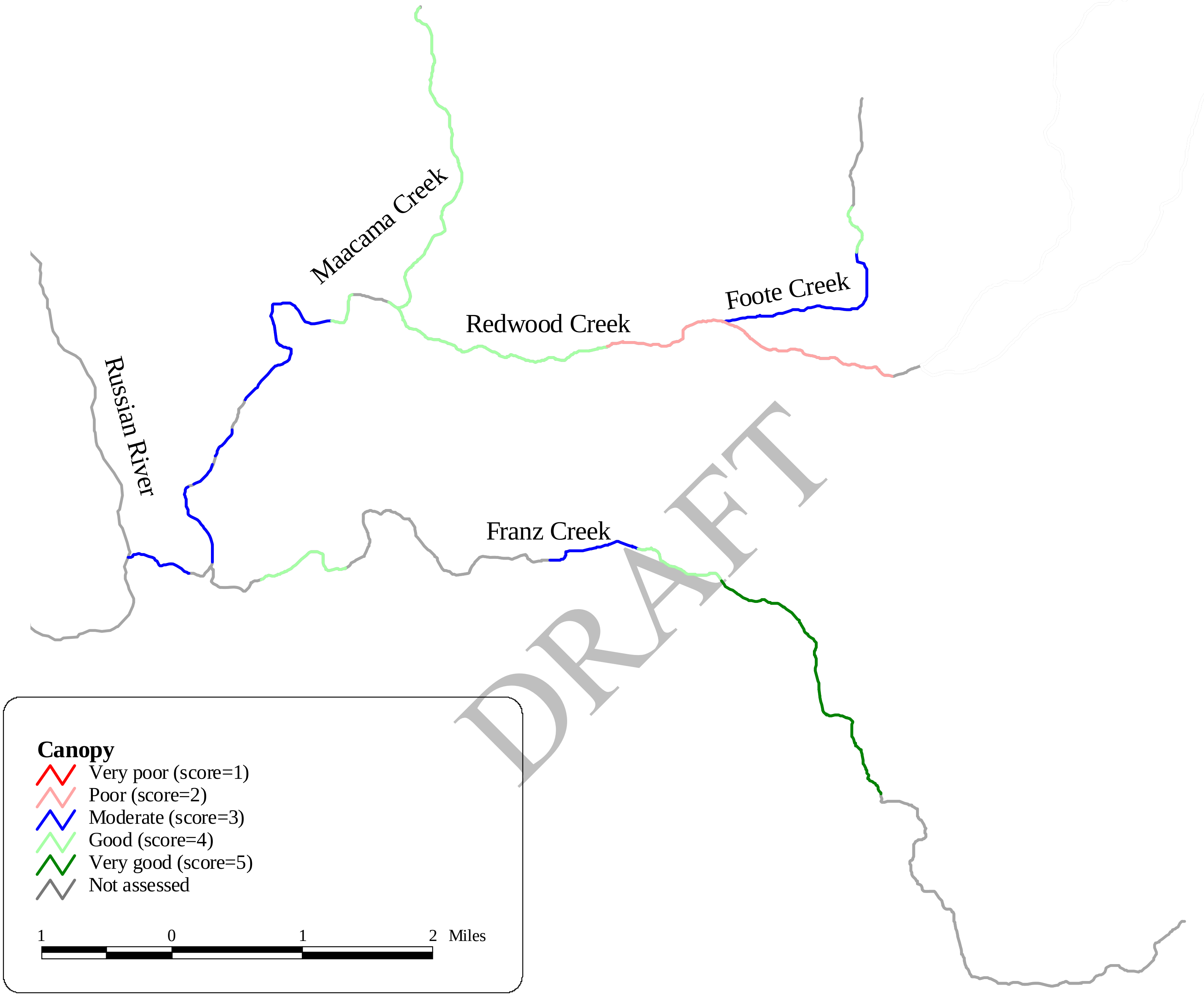

Figure A1-3g. Scores for canopy in Knights Valley project streams.

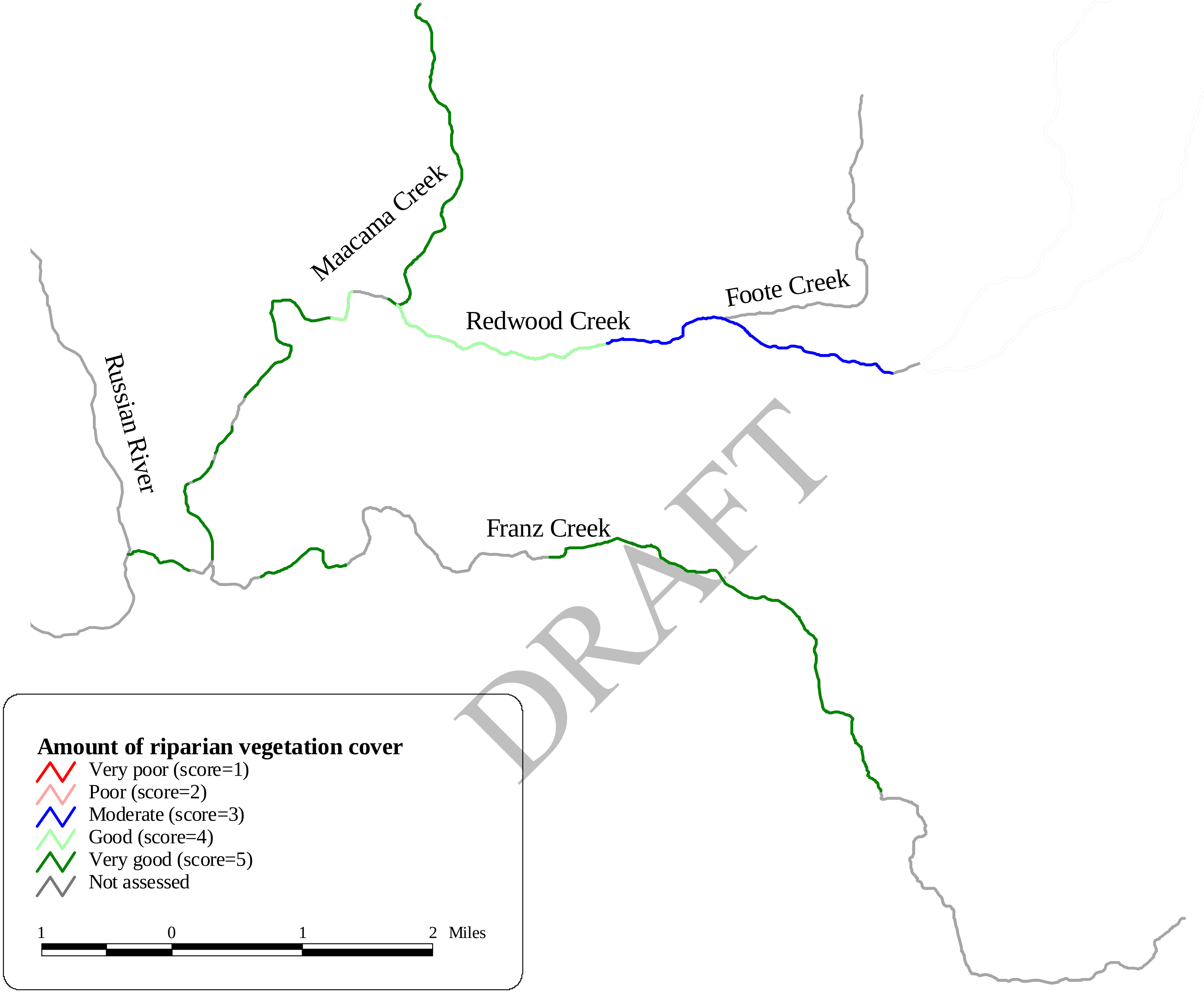

Figure A1-3h. Scores for amount of riparian vegetation cover in Knights Valley project streams.

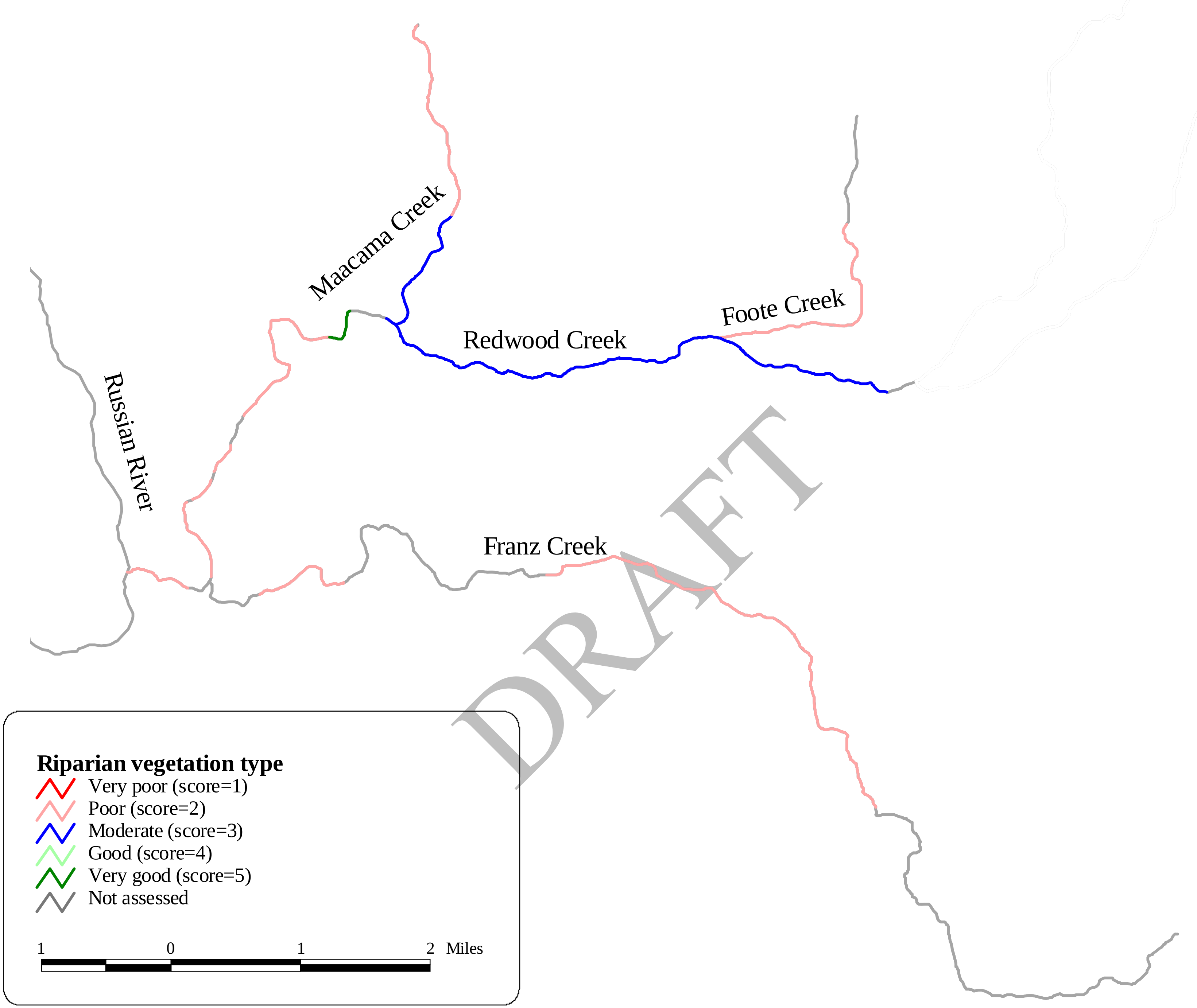

Figure A1-3i. Scores for riparian vegetation type in Knights Valley project streams.

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