TABLE OF CONTENTS

Hydrology 3
Geology 5
Compositional Overview 5
Landslides 7
Earthquakes and Faults 8
Soils 8
Fluvial Geomorphology 8
Vegetation 9
Land and Resource Use 11
Historic Land Use 11
Forest Management 12
Current Land Use 13
Forest Management 14
Gravel Mining 14
Fish Habitat Relationship 15
Fishery Resources 15
Habitat Overview 20
Habitat Conclusions 40
Restoration Projects 42
Integrated Analysis 43
Analysis of Tributary Recommendations 43
Refugia Areas 45
Key Subbasin Issues 46
Responses to Assessment Questions 46
Subbasin Conclusions 52

TABLE OF FIGURES

Figure 1. Upper Subbasin locator map and CalWater Units. 4
Figure 2. Geology of the Upper Subbasin. 6
Figure 3. Landslides near Scotia following 2005/2006 storms. 7
Figure 4. Vegetation of the Upper Subbasin. 10
Figure 5. Habitat surveys conducted by CDFG on fourteen tributaries of the Upper Subbasin. 23
Figure 6. The relative percentage of coniferous, deciduous, and open canopy covering surveyed streams in the Upper Subbasin. 24
Figure 7. Canopy Density in the Upper Subbasin. 24
Figure 8. EMDS canopy results for the Upper Subbasin by surveyed stream miles. 25
Figure 9. Primary Pools in the Upper Subbasin. 28
Figure 10. EMDS pool depth results for the Upper Subbasin by surveyed stream miles. 29
Figure 11. Average pool shelter ratings from CDFG stream surveys in the Upper Subbasin. 30
Figure 12. Pool shelter in the Upper Subbasin. 30
Figure 13. EMDS pool shelter results for the Upper Subbasin by surveyed stream miles. 32
Figure 14. Large Woody Debris (LWD) in the Upper Subbasin. 33
Figure 15. Cobble embeddedness categories as measured at every pool tail crest in surveyed streams in the Upper Subbasin. 34
Figure 16. Cobble Embeddedness in the Upper Subbasin. 34
Figure 17. EMDS cobble embeddedness results for the Upper Subbasin by surveyed stream miles. 35
Figure 18. Locations of temperature monitoring sites in the Upper Subbasin. 36
Figure 19. Maximum weekly average temperatures recorded at sites in the Upper Subbasin. 37
Figure 20. Recommendation target issues by stream miles for the Upper Subbasin. 44

LIST OF TABLES

Table 1. Major streams in the Upper Subbasin....3
Table 2. Rock types in the Upper Subbasin....6
Table 3. Soil types in the Upper Subbasin....8
Table 4. Channel types in surveyed streams of the Upper Subbasin....9
Table 5. Vegetation of the Upper Subbasin....11
Table 6. Crown diameter of vegetation classified as primarily conifer forest in the Upper Subbasin....11
Table 7. Lower Van Duzen River Annual Extraction 1997-2005 (CHERT 2006)....15
Table 8. Documented fish presence in surveys from 1938 to 2006 in the Upper Subbasin....16
Table 9. Habitat observations made in the Upper Subbasin from 1938-2003....20
Table 10. Upper Subbasin streams surveyed by CDFG....22
Table 11. Upper Subbasin percent occurrence and percent by length of pool, run, riffle, and dry habitats....27
Table 12. Percent length of a survey composed of pools in the Upper Subbasin....28
Table 13. Mean percent of shelter cover types in pools for surveyed tributaries in the Upper Subbasin....31
Table 14. Maximum weekly average temperatures and maximum daily average temperatures collected in the Upper Subbasin....36
Table 15: NCRWQCB water quality objectives for the Eel and Van Duzen Rivers (NCRWQCB 2006d, EPA 1999)....38
Table 16 Culverts surveyed for barrier status in the Upper Subbasin (Taylor 2001)....40
Table 17. Comparison between historic habitat conditions with current habitat inventory surveys in the Upper Subbasin....41
Table 18. EMDS reach condition results for the Upper Subbasin....42
Table 19. Occurrence of stream habitat inventory recommendations for streams of the Upper Subbasin....44
Table 20. Top three ranking recommendation categories by number of tributaries in the Upper Subbasin....44
Table 21. Tributary salmonid refugia ratings in the Upper Subbasin....45
Table 22. Recommended actions for correcting barriers to fish passage....50
Table 23. Recommended actions to correct flow and water quality....50
Table 24. Recommended actions to correct erosion and sedimentation....51
Table 25. Recommended actions to correct riparian and instream habitats....51
Table 26. Recommendations for education, research, and monitoring....52

Upper Subbasin

The Upper Subbasin includes the watershed area along the Eel River from Barber Creek to Dean Creek at the town of Rio Dell, a distance of 7.5 miles. It also includes the Van Duzen River from its mouth to Cummings Creek, approximately 9 miles above its confluence with the Eel River (Figure 1). This assessment area encompasses the upper delta agricultural lands. Stream elevations range from approximately 40 feet at the confluence of the Eel River with Barber Creek to approximately 2,160 feet in the headwaters of the tributaries. This subbasin is the largest of the Lower Eel Basin at 75 square miles, 43% of the total basin area. This subbasin is mostly held in private parcels 40-500 acres in size with some sections owned by large timber companies and managed for timber production. Chinook, coho, steelhead, and Coastal cutthroat trout have each been documented in fish surveys of the Upper Subbasin.

Hydrology

The Upper Subbasin is made up of sections of six CalWater Units (Figure 1). There are 21 named tributaries (Table 1) and 64.3 permanent stream miles in this subbasin. The mainstem Eel River is a sixth order stream, the Van Duzen River is a fifth order stream using the Strahler (1964) classification. The tributaries are first through third order streams. Stream and river drainage areas range from less than one within the subbasin to the 430 square mile Van Duzen River Basin and the 3,684 square mile Eel River Basin, which extend well beyond the subbasin.

Table 1. Major streams in the Upper Subbasin.

Stream	Tributary to	River Mile	Drainage Area (square miles)	Stream Order	Permanent (miles) (in Subbasin)	Intermittent (miles)
Van Duzen River	Eel River	13.3	31.61	5	10.1	0.0
Barber Creek	Van Duzen River	3.0	5.58	3	4.9	0.0
Wolverton Gulch	Barber Creek	0.4	2.82	1	4.1	0.5
Yager Creek	Van Duzen	5.7	5.29	4	2.9	0.0
Wilson Creek	Yager Creek	0.6	2.06	2	2.4	0.9
Cuddeback Creek	Van Duzen	7.5	1.35	1	1.6	1.1
Fiedler Creek	Van Duzen	0.3	1.39	I	0.0	2.2
Cummings Creek	Van Duzen	8.7	5.12	1	3.3	2.6
Barber Creek	Eel River	13.4	1.82	1	2.9	0.5
Price Creek	Eel River	15.0	13.24	2	8.3	0.6
Sweet Creek	Price Creek	4.1	2.03	1	2.1	0.2
Muddy Creek	Price Creek	4.6	1.14	1	1.2	0.6
Oil Creek	Eel River	15.0	1.75	1	1.9	1.7
Howe Creek	Eel River	16.0	10.97	2	4.4	0.7
Atwell Creek	Howe Creek	1.5	4.37	1	3.8	0.6
Unnamed tributary (Crystal Creek)	Howe Creek	2.4	0.64	I	0.0	1.3
West Fork Howe Creek	Howe Creek	3.2	1.67	1	1.2	0.7
Slater Creek	Eel River	16.8	2.36	1	2.2	0.3
French Gulch	Eel River	19.7	0.20	I	0.0	0.6
Nanning Creek	Eel River	20.0	4.02	1	2.5	0.3
Tank Gulch	Eel River	20.3	0.38	I	0.0	1.1
Dean Creek	Eel River	20.9	1.16	1	1.7	0.5

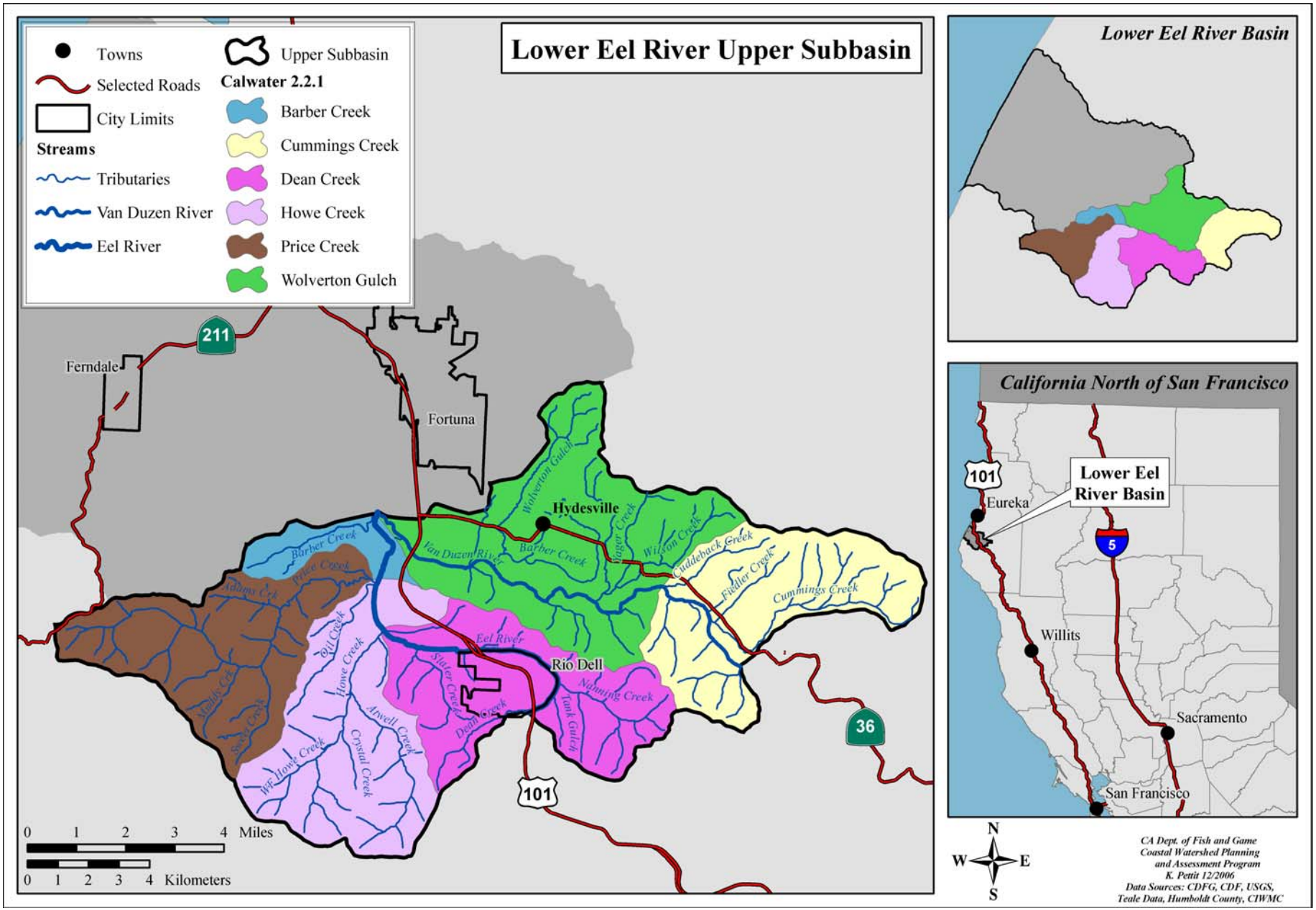

Figure 1. Upper Subbasin locator map and CalWater Units.

Although drainage issues were noted in the Hydesville area in the 1984 Humboldt County General Plan, no specific drainage plans were made. However, the following policies were developed:

- As development occurs throughout the planning area, storm water should be directed toward water courses without impacting adjacent parcels;
- Drainage plans should be required of development projects within the area of Hydesville;
- Drainage plans should be required to provide for the passage of storm water from upstream areas;
- Dedication of drainage easements to the County of Humboldt for the benefit of the general public may be required as a condition of a development permit;
- A community drainage plan should be prepared for the planning area with initial priority directed to establishing a specific drainage plan for the area.

The City of Rio Dell also calls for the preparation and adoption of a Drainage Master Plan that encourages on site retention, maintains current stream and drainage channel integrity, and reduces non-point pollution loads. The Rio Dell area has had sustained damage due to flooding in the past, largely to the lumber industry, railroad property, roads, and bridges. However, the majority of Rio Dell's developed land is currently outside of the 100 and 500-year floodplains (PlanWest 2006).

Rio Dell has the following policies (PlanWest 2006) related to hydrology and water resources:

- Identify improvements that can be made to municipal drainage facilities so they can better convey runoff and minimize flood impacts;
- Require new development projects to incorporate on-site drainage features such as retention and infiltration systems to reduce runoff and maximize infiltration;
- Use a combination of incentives, educational programs, and ongoing system audits to promote water conservation;
- New projects that affect the quantity and quality of surface water runoff shall be required to allocate land necessary for detaining post-project flows and/or for incorporating measures to mitigate water quality impacts related to urban runoff. To the maximum extent feasible, new development shall not produce a net increase in peak storm water runoff;
- New project designs shall minimize drainage concentrations, maximize permeable surfaces (such as unpaved parking areas) and maintain, to the extent feasible, natural site drainage conditions;
- The quality of runoff from urban and suburban development shall be improved through use of appropriate and feasible mitigation measures including, but not limited to, artificial wetlands, grassy swales, infiltration/sedimentation basins, riparian setbacks, oil/grit separators, and other best management practices (BMPs);
- Wetlands and drainage courses shall be carefully examined.

Geology

Compositional Overview

The Upper Subbasin is more geologically diverse than the other subbasins (Table 2). This subbasin is composed of five different rock types (Figure 2) (USGS Geology of the Cape Mendocino, Eureka, Garberville, and Southwestern part of the Hayfork 30 x 60 Minute Quadrangles and Adjacent Offshore Area, Northern California geologic map of California). Although this is the most varied subbasin, all of the rock types are sedimentary. The Wildcat group is the most abundant surface lithology. It occupies 47.79% of this subbasin. The rest of the basin consists of 19.2% Coastal Belt mélange, 12.55% river terrace deposits, 11.3% alluvium, 4.05% Yager terrane, and 1.14% Coastal Belt sandstone.

Ancient, uplifted, unconsolidated floodplain deposits of Eel and Van Duzen rivers make up a sizeable amount of the Upper Subbasin. Remnants of these floodplain deposits form a series of terrace deposits in the vicinity of Rio Dell, Scotia, Hydesville, and Carlotta. A series of smaller terrace deposits are scattered along the Eel and Van Duzen rivers. These terraces have been uplifted from just above the current floodplain to hundreds of feet above the current floodplain.

Hydesville is situated on the gently sloping surface of the Rohnerville formation which is a Pleistocene aged terrace. The hills above Hydesville are made of the Hookton formation, which consists of poorly

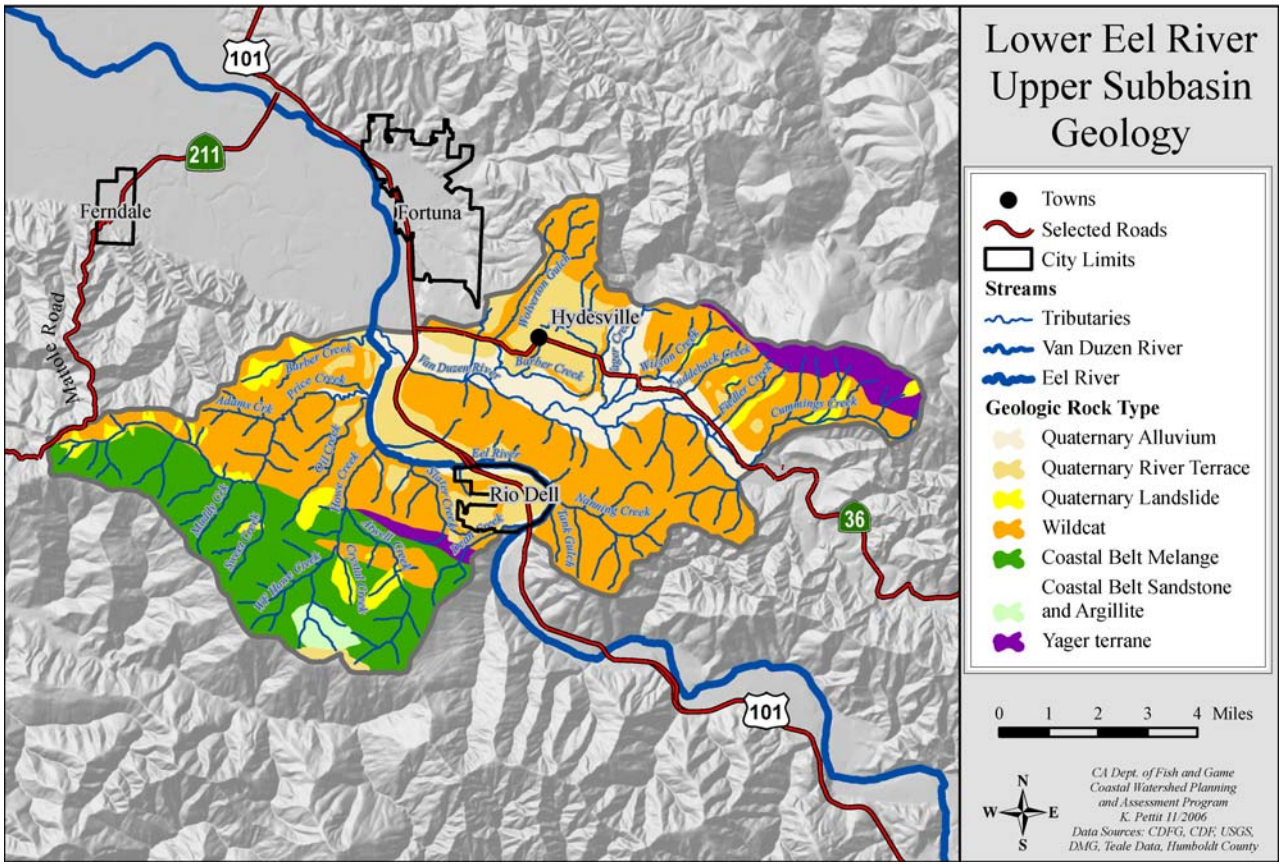

Figure 2. Geology of the Upper Subbasin.

consolidated marine through river sediments. To the northeast of the Hookton and Rohnerville formations have been juxtaposed against the sedimentary bedrock of the Wildcat group by the Little Salmon fault. Uplift of these terraces has corresponded with incision by the streams leaving steeply incised canyons that have exposed conglomerate and sandstone of the underlying Carlotta formation. The terraces, when steeply perched, are susceptible to small-scale, frequent slope failure, which introduces sediment to streams (Reynolds, Mills, Mensch 1981). Increased sediment deposition from erosion of these terraces can restrict upstream migration of salmonids during periods of low water (PALCO 2002). In addition to contributing to slope instability, the friable nature of local soils contributes to enhanced gullying in grassy areas (Brown and Ritter 1971).

To the northeast the Yager fault has juxtaposed the Wildcat with the Yager terrane. The Yager terrane is composed of marine sandstone through claystone that was deposited upon the continental slope around 34-55 million years ago. The sediment that makes up these deposits came from as far away as Idaho (Underwood and Bachman 1986). Although much harder than the Wildcat, the Yager terrane is more

Table 2. Rock types in the Upper Subbasin.

Rock Type	% of subbasin	Description
Alluvium	11.3	Unconsolidated river sediments within the active influence of streams.
Landslides	7.47	Unconsolidated, poorly sorted river sediments that have been uplifted above the active stream influence.
Terrace deposits	12.55	Unconsolidated, poorly sorted river sediments that have been uplifted above the active stream influence.
Wildcat Group	47.79	A series of 5 formations; 4 consisting of poorly cemented, fine-grained, shallow marine sediments and one consisting of courser, poorly consolidated, predominately nonmarine sediment.
Yager Terrane	4	Moderately-well consolidated, locally sheared, sandstone, argillite, and conglomerate.
Coastal Belt Sandstone	1.14	Well consolidated, locally sheared, metasandstone, meta-argillite, and conglomerate.
Coastal Belt mélange	19.2	A pervasively sheared argillaceous matrix containing mappable blocks of varying rock types.

brittle and therefore has many areas where the bedrock has become sheared and broken. Furthermore, the Yager terrane contains interbeds of argillite (claystone) that disintegrate when repeatedly wetted and dried. These argillite interbeds and shear zones are susceptible to enhanced erosion, landslides, and debris flows. In the southern portion of this basin the Russ fault has bound a sliver of the Yager terrane between the Wildcat and the Coastal terrane.

The Wildcat Group as a whole is made up of soft, poorly cemented fine sediments. Rapid rates of uplift and the "soft" nature of these rock types have allowed the stream channels to incise steep canyons. These formations have been steeply tilted, folded, and uplifted. Furthermore these rock types have a relatively high porosity allowing them to absorb water during winter storms. When they become saturated they tend to fail along their steeply dipping bedding plains. Of the Wildcat Group the Rio Dell formation is one of the most susceptible to landsliding. Landsliding is most common in zones between mudstone and sandstone beds during super saturation. A few sizable landslides were mobilized in the 2005/2006 storm season along the banks of the Eel River, near Scotia, which contributed fine sediment to the river. These slides serve as a good example of how the Wildcat sediments react to over saturation (Figure 3).

Landslides

Like the other Lower Eel River subbasins, the Upper Subbasin is mantled with unstable soils. Meadows and grasslands in the Upper Subbasin are often a result of unstable ground and are thus susceptible to surface erosion, headword erosion, and gullying.

The southernmost extent of the Upper Subbasin is made up of the Coastal terrane. The Coastal terrane consists mainly of sandstone, argillite, and minor conglomerate forming highly sheared mélange and sandstone with interbedded argillite. The mélange formed as deep oceanic sediments and bits of oceanic crust tectonically mixed with sediments washing off of the continent in a subduction trench that existed here roughly 65-40 million years ago. The sandstone was likely deposited above the mélange and was not as tectonically mixed before lithification. As the active subduction zone stepped westward towards its present position the Coastal terrane was uplifted and translated to its current position. The Coastal terrane is susceptible to shallow landslides in the inner gorge areas and to deep seated landslides and earthflows.

Figure 3. Photos of landslides on the Eel River, near Scotia following 2005/2006 storms.

Earthquakes and Faults

The Ferndale Fault, the Russ Fault, and the Little Salmon Fault cut across this subbasin. All of these faults disrupt bedrock and are capable of producing earthquakes that are large enough to trigger landsliding and/or liquefaction of the land within it. The Cascadia Megathrust and the San Andreas Fault have historically caused earthquakes that may have altered the morphology of this subbasin.

Soils

The Upper Subbasin contains a small variety of similar, loamy soils, which developed upon soft, sedimentary Wildcat Group geology as well as on ancient, uplifted, unconsolidated Eel River terrace deposits and on floodplains (Table 3). These soils are also composed of a silt/clay mixture as well.

Table 3. Soil types in the Upper Subbasin.

Soil Type	% of Upper Subbasin	Composition
Vandamme-Tramway-Irmulco-Hotel-Dehaven	36	Loam/clay/gravelly loam
Tramway-Irmulco-Empire	31	Loam
Riverwash-Loleta-Ferndale-Bayside	20	Loam/silt loam/silty clay loam
Timmons-Rohnerville-Hookton-Carlotta-Arcata	10	loam/silty clay loam/fine sandy loam
Yorktree-Kneeland variant-Kneeland-Kinman	4	Loam/gravelly loam/clay loam

Fluvial Geomorphology

The overall geomorphology of the Upper subbasin may be described by moderately steep tributaries with steeply incised valleys draining into a relatively low (~2-3%) gradient main stem. The Eel River along this reach has meandered and migrated back and forth within the valley and has, in the recent geologic past, entrenched itself in a series of large river floodplain/terrace deposits bordering the main stem. Rio Dell, Metropolitan, and Alton reside on these deposits. Similarly, Carlotta resides on the floodplain/terrace deposits of the lower Van Duzen River.

During large winter storms tributaries within the soft mudstones and sandstones of the wildcat to the south and semi-consolidated to non-consolidated terrace deposits to the north naturally erode and flush out large amounts of sediment into the main stem.

Within the Upper Subbasin the main stem of the Eel River acts as a sediment transport as well as sediment deposition reach. This section of the river has a general gradient of about 2 – 3%. During large storm events it has acted like a depositional reach causing some aggradation of the channel as well as over-bank deposition. This section of the river deposits and/or transports sediments due to the stream gradient, the amount and energy of flow, and the availability of sediment. In the last few years the river has cut down and exposed bedrock in several places within this reach. The majority of the tributaries that feed this section of the Eel River act as sediment source and sediment transport reaches. Large storm events tend to trigger more erosion and input more sediment to the streams. The sediment pulses from these storms migrate downstream but tend to affect the stream for tens of years. Anthropogenic land use can increase the rate of erosion and sediment input to the streams greatly and take upwards of a century for the stream to naturally flush out the sediment pulse.

The morphology of individual streams within a system when taken in a fluvial geomorphologic context can be used to help understand the current as well as past fluvial regime changes. Some basic morphologic stream patterns have been defined by D.L. Rosgen, Rosgen channel types (see Middle Subbasin Figure 5).

The most recent (1991 to 2002) stream surveys of 22 reaches in the tributaries of the Van Duzen River and Eel River within the Upper Subbasin found A, B, C, F, and G Rosgen channel types (Table 4). Type A reaches flow through steep V- shaped valleys, do not have well-developed floodplains, and have few meanders. Type B stream reaches are wide, shallow, single thread channels. They are moderately entrenched, moderate to steep gradient reaches, which are riffle-dominated with step/pool sequences. Type B reaches flow through broader valleys than type A reaches, do not have well-developed floodplains, and have few meanders. Type C stream reaches are wide, shallow, single thread channels. They are moderately entrenched, low gradient reaches with riffle/pool sequences. Type C reaches have well-developed floodplains, meanders, and point bars. Type F stream reaches are wide, shallow, single thread channels. They are deeply entrenched, low gradient reaches and often have high rates of bank erosion. Type F reaches flow through low-relief valleys and gorges, are typically working to create new floodplains, and have

frequent meanders. Type G, or gully stream reaches, are similar to F types but are narrow and deep. With few exceptions, type G reach types possess high rates of bank erosion as they try to widen into a type F channel. Type G reach types are found in a variety of landforms, including meadows, developed areas, and newly established channels within relic channels (Flosi, et al. 1998).

Table 4. Channel types in surveyed streams of the Upper Subbasin.

Stream	Reach	Length (feet)	Channel Type
Van Duzen River	Not surveyed		
Wolverton Gulch	1	12,981	F4
Wilson Creek	1	716	C5
	2	1,765	B2
Cummings Creek	1	10,572	B4
Price Creek	1	10,235	F3
	2	12,895	G4
	3	6,094	B6
	4	7,077	B4
Adams Creek	1	3,308	B6
	2	693	A3
Sweet Creek	1	4,746	B4
Muddy Creek	1	3,261	F4
	2	869	G4
Oil Creek	1	2,127	G3
	2	2,742	F6
Howe Creek	1	17,016	F4
	2	3,959	A3
Atwell Creek	1	12,612	F4
Crystal Creek	1	2,600	G4
West Fork Howe Ck	1	2,342	A3
Nanning Creek	1	7,600	C3
Dean Creek	1	5,091	B6

Vegetation

The predominant vegetation cover type as described by the U.S.F.S. CALVEG data is coniferous forest at approximately 52%, which is more than any other Lower Eel subbasin (Figure 4, Table 5). Vegetation of the Redwood Alliance and Redwood – Douglas-Fir Alliance are the primary vegetation within this classification at 39% and 36%, respectively. Crown diameters of Upper Subbasin woodlands primarily composed of coniferous vegetation range in size from sapling to large, which is described as greater than 40 feet in crown diameter. Like in the Middle Subbasin, most of the redwood forests are composed of trees classified as medium, or between 24 to 40 feet in crown diameter (Table 6). Conifers are prevalent throughout the subbasin, and occupy nearly all areas except the low lands within the Eel River and Van Duzen River floodplain and urban areas including Hydesville and Rio Dell. The vegetation cover type classified as “mixed” is the third most abundant vegetation in this subbasin, and describes forests and woodlands where conifer is the primary vegetation and hardwoods are present secondarily. Conifer forests and these mixed conifer forests, when combined, are the major vegetation in the Upper Subbasin, making up nearly 64% of the total vegetation.

Herbaceous vegetation, primarily composed of annual grasses, is the second most abundant vegetative cover making up 14% of the total. This vegetation is found in small patches along the Van Duzen River, some of the low-lying lands on the mainstem Eel River, and along the southwestern margin of the subbasin along Bear River Ridge. Agriculture in the Upper Subbasin is the fourth most abundant vegetation land use classification composing 11% of the subbasin. However, pastures used for grazing of livestock may not be included in this vegetation designation since land use is often difficult to remotely ascertain. For this reason, it can be assumed that areas mapped as annual grasslands may also be agricultural in nature and the overall percentage of agricultural lands is more likely to be greater than 20%. This figure is still considerably less than the other subbasins within the Basin study area. Agricultural lands in this subbasin are primarily located in the low-lying areas near Metropolitan and Hydesville. This depiction of

vegetation in the Upper Subbasin is an accurate display of the reduction in herbaceous and agricultural lands with increased distance from the Eel River mouth.

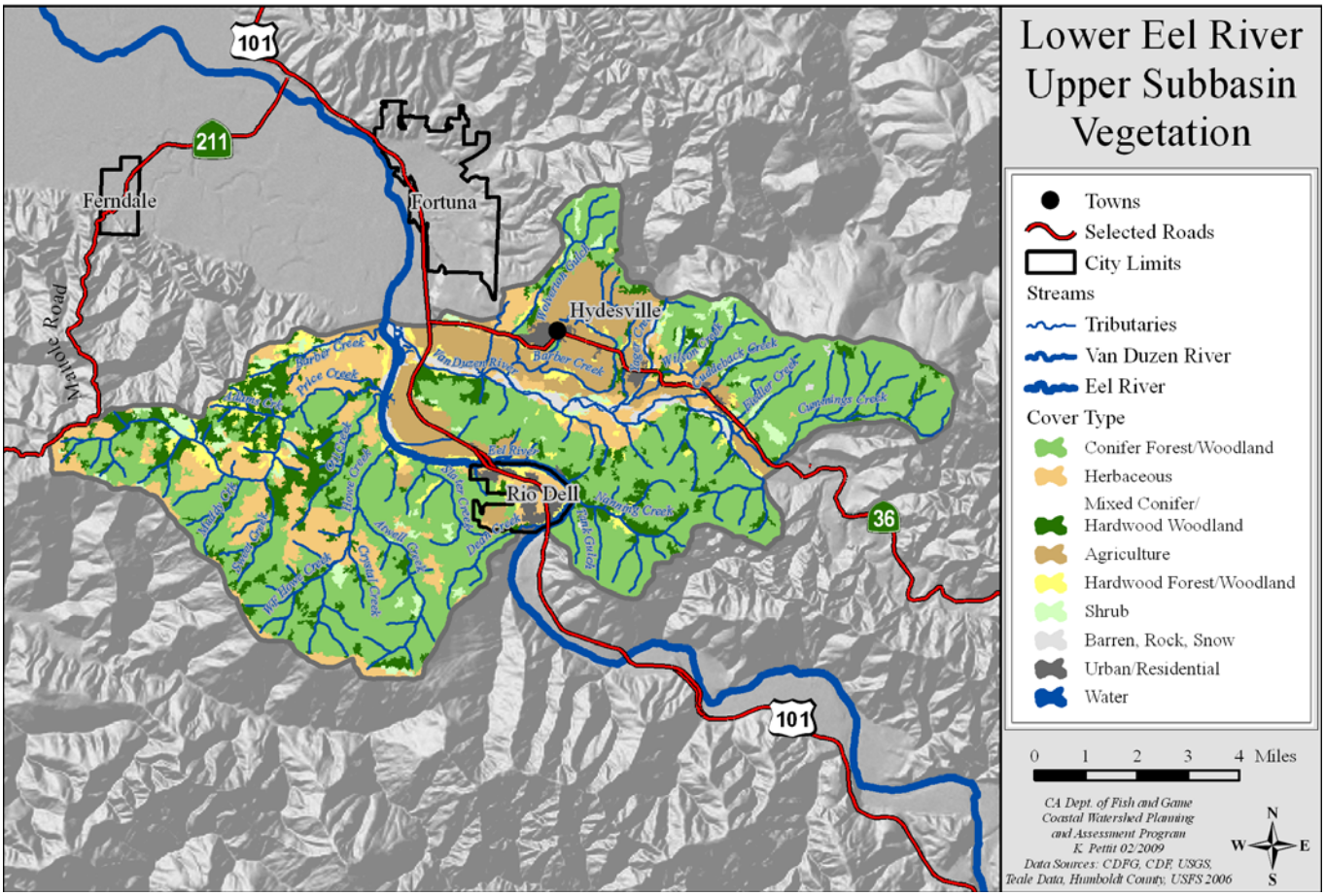

Figure 4. Vegetation of the Upper Subbasin.

Table 5. Vegetation of the Upper Subbasin.

Vegetative Cover Type	Percent of Subbasin	Primary Vegetation Type	Percent of Cover Type
Conifer	52	Redwood Alliance	39
		Redwood – Douglas-Fir Alliance	36
		Douglas-Fir – Grand fir Alliance	18
		Pacific Douglas-Fir Alliance	6
		Sitka Spruce – Redwood Alliance	1
		Sitka Spruce Alliance	<0.5
		Sitka Spruce – Grand Fir Alliance	<0.5
Herbaceous	14	Annual Grass/Forb alliance	100
		Nonnative/Ornamental Grass Alliance	<0.5
Mixed (conifer stand with hardwood)	12	Douglas-Fir – Grand fir Alliance	37
		Redwood - Douglas-Fir Alliance	29
		Redwood Alliance	20
		Pacific Douglas-Fir Alliance	8
		Sitka spruce – Grand Fir Alliance	6
		Sitka spruce Alliance	<0.5
Agriculture	11	Agriculture	100
Hardwood	4	Red Alder Alliance	95
		Black Cottonwood Alliance	3
		California Bay Alliance	1
		Mixed Riparian Hardwoods Alliance	<0.5
		Tan Oak (Madrone) Alliance	<0.5
		Willow Alliance	<0.5
Shrub	3	North Coastal Shrub Alliance	33
		Blueblossom Alliance	28
		Salal-California Huckleberry Alliance	22
		Willow (Riparian Scrub) Alliance	15
		Coyote Brush Alliance	3
Barren	2	Barren	100
Urban	2	Urban	100

Data from CALVEG, USFS
These statistics exclude the classification of water and may not = 100% due to rounding.

Table 6. Crown diameter of vegetation classified as primarily conifer forest in the Upper Subbasin.

Conifer Alliance	Size Range	Most abundant by area
Redwood	Sapling to Large	Medium
Redwood - Douglas-Fir	Sapling to Large	Medium
Douglas-Fir - Grand Fir	Sapling to Large	Small
Pacific Douglas-Fir	Sapling to Medium	Small
Sitka Spruce - Redwood	Sapling to Medium	Small
Sitka Spruce	Small to Medium	Medium
Sitka Spruce - Grand Fir	Sapling to Medium	Small

Land and Resource Use

Historic Land Use

Prior to Euro-American settlement, the Upper Subbasin was home to Native American people of the Wiyot, Kittel or Nongatl, Wailaki, and Lassics tribes. These people lived in villages or in groups of smaller satellite settlements located around central village sites. The people utilized acorns as a staple food, and also ate other vegetable foods, wild game, and depended on harvests of salmon and steelhead along the main river channels and tributaries. In winter and spring the villages were situated near the river where the people could cooperatively harvest salmon and lampreys. During the summer they moved to meadows located in higher grounds, but not far from the rivers. Their way of life required freedom to move throughout their territory with the seasonal changes in abundance of natural resources (Baxter 1981). Many

of these small groups failed to survive the impact of Euro-American settlers of the mid 19th century.

The Van Duzen River was named in 1850 in honor of James Van Duzen. Van Duzen was one of the eight members of the Gregg-Wood party that were the first Euro-Americans to reach the Humboldt Bay coast by traveling overland from the gold mining areas of the upper Trinity River. Continuing their journey, the Gregg-Wood party left Humboldt Bay and traveling south were soon in need of food. The group came upon a river and nearby found two Wiyot tribesmen that shared baskets full of lampreys with the hungry travelers. The members of the Greg-Wood Party then camped along the river just below the Van Duzen confluence and feasted on "eels" (lamprey), for two days. The group named that river the Eel River (Wood 1932) for its abundance of "eels." The Eel River delta was called "Weeoot" by the Wiyot tribe, which referred to the immense quantities of salmon obtained from the Eel (Humboldt Times September 23, 1854).

As Euro-Americans moved into the area in the 1850s, they settled on the same sites that native tribes had used for decades as seasonal village sites or hunting and gathering grounds (CDPR 1981). To the settlers that occupied newly claimed land year round, the native people seemed as intruders upon their return to long-established seasonal sites. Conflicts over land soon lead to bloodshed and the eventual demise of the native peoples' way of life. The changes brought about by permanent farms and grazing of domesticated livestock depleted many of the wild food sources needed by native people. A few Native Americans were welcomed into early settler homes but most were gathered and sent to Fort Baker located approximately 14 miles east of Bridgeville prior to permanent delivery to a reservation in Round Valley. Others were hunted down and killed while some were sold into slavery. Their historic homeland was quickly claimed by the Euro-American settlers.

Early settlers started homesteads and began logging and farming cleared land. Several small communities sprang up throughout the subbasin.

Henry Brown Cuddeback and wife Martha homesteaded Cuddeback Creek in 1853. A Post Office was established in 1895 and merged with nearby Carlotta in 1914.

Settler John Hyde gave a section of his land to a group of settlers in 1858, which then grew into the community of Hydesville. The town grew quickly, encompassing a Masonic Hall, a school, livery stable, hotel, blacksmith's shop, and general store, all by 1859 (Roberts 1943). A Post Office was established in 1861.

The Rio Dell bluffs and prairie land were discovered by settlers in the 1840s. A local farmer, Lorenzo D. Painter, started the small community of Eagle Prairie in the early 1870s in the area (McCormick 1981). The communities of Wildwood and Belleview grew up nearby. These three communities eventually merged and formed present day Rio Dell. Rio Dell was incorporated in 1965 (Steinberg 2002).

Across the Eel River from Rio Dell and just outside of the Upper Subbasin, the company mill town of Scotia began with the construction of a mill in the area known as Forestville, established in 1863 by Henry Weatherby and A.W. McPherson. The town name officially became Scotia in 1888, and a Post Office was established that same year. Scotia and Rio Dell have always had close ties, first connected by ferries and after 1914 by railroad and road bridges (PlanWest 2006).

Outside of the small towns, historic livestock grazing utilized the native prairies and meadows. The native, perennial prairie bunch grasses that grew there were well suited for year round livestock grazing. To develop more livestock grazing lands, trees surrounding grasslands were often "ringed" and left to die. As sheep and cattle consumed or overgrazed much of the deep rooted bunch grasses, unstable soil was exposed and weaker, short rooted annual grasses moved in. Present gullies and slumping landscape appear to be recent features related to livestock grazing and the associated loss of deep rooted prairie grasses (Kelsey 1977).

Forest Management

Timber cutting began in the subbasin in the mid 1800s with the clearing of land by early settlers for farming, livestock grazing, and for wood products. The first saw mill was built by George and John Cooper along Yager Creek near Hydesville in 1854. The Cooper's mill was powered by a water wheel that received water via over a mile of ditches. The mill operated for only a few years and was abandoned soon after the death of George Cooper who was shot in a territorial battle with natives (Roberts 1943).

The timber industry continued to grow and soon became a major land use. Early logging was done with hand saws, steam donkeys, cable systems, and rail systems.

Atwell Creek was logged from 1920 to 1960, facilitated by the construction of a railroad trestle across the Eel River and the continuation of the railroad up the Howe and Atwell watersheds (HartCrowser 2004). By 1928, 200 million board feet had been removed from the areas that could be reached by a steam donkey (Hackett 2002). Cummings Creek watershed was logged through the 1930s and into the 1950s (Matson 2000). The Hammond Lumber Company railroad was constructed in 1934 in the Cummings Creek watershed and expanded up the creek in 1950 so that timber could be directly loaded onto flatcars (Matson 2000).

By the 1940s, land use in the Upper Subbasin, particularly Howe Creek and nearby tributaries, was beginning to change. First, a waning market infrastructure and demand for timber provided incentive to turn timberland into grazing land (Hackett 2002). Second, the timberlands that remained in use were subjected to increased disturbance as WWII technology moved into civilian industries; timber was more readily cleared and skidded downhill with bulldozer in watercourses became a common practice (Hackett 2002). Despite the limited local demand for timber, lands were still taxed to include the value of standing timber, providing further incentive to convert to grazing land.

Along with the rush to harvest timber from the Lower Eel and Van Duzen's forests came a tremendous disturbance to the basin's soils from clear cuts, building and use of an extensive network of logging roads, and the use of tractors over the landscape to move cut logs to truck landings. A review of air photos showed that a large amount of the basin's forests were cut by the 1960s. The timber boom removed trees that were an integral part of the riparian and stream ecosystem and damaged intricate root systems that helped resist erosion of unstable soils. In addition, miles of tractor skid trials and haul roads caused significant ground disturbance that contributed to hillslope instability and soil erosion.

The major flood events of 1955 and 1964 occurred during a period of intensive land use, primarily related to timber harvest. These floods exacerbated the impacts of extensive logging that had largely gone unregulated until the early 1970s. These factors caused much of the basin to destabilized, which in turn, produced large-scale soil erosion and sedimentation into the area's streams (CDFG 1997).

Current Land Use

The Upper Subbasin is currently mostly held in private parcels 40-500 acres in size with some sections owned by large timber companies and managed for timber production. Two other major land uses in the subbasin are gravel mining and grazing. There are two principal communities, Hydesville and Rio Dell.

Hydesville is located in the lower Van Duzen River watershed off of Highway 36 about three miles east of Highway 101. It is an unincorporated community of about 1,209 residents. Planning for this community is carried out by Humboldt County as part of the county General Plan process. The General Plan is currently being updated and the last available plan is from 1984. Hydesville falls within the Carlotta/Hydesville Planning Area and there is a specific Carlotta/Hydesville Area Community Plan. The major plan proposals and underlying principles of this plan specific to Hydesville are:

- To maintain the present level of resource protection for timberlands and provide additional zoning protection for agricultural lands on the Van Duzen River flood plain and the Yager Creek Valley;
- Reserve additional land suitable for industrial development in the vicinity of the existing lumber mills along Yager Creek;
- Preclude and/or limit the extent of additional residential development in high hazard areas (flooding and geologic fault rupture corridors);
- Direct residential development to existing urbanizing areas;
- Provide for adequate housing sites for the area's future growth;
- Planned residential densities in Hydesville are to be compatible with the continued use of on-site wastewater disposal systems.

Water is provided to about 450 connections in Hydesville by the Hydesville County Water District. Water is supplied from two, twelve inch wells located on District owned land near Yager Creek. These wells have pumps which are rated at a total of approximately 360 gallons per minute. The estimated average daily use for the entire District is approximately 100,000 gallons per day, and estimated existing maximum day demands are 300,000 gallons per day. The system is operating at approximately 58% of source capacity. The District is also planning to increase capacity by building an additional well. Sewer services are not provided by the District (HLAFC 2008), residents use individual septic tanks

and leach fields (General Plan 1984).

Hydesville is a designated Urban Development Area. Most of the working residents of Hydesville commute to Fortuna, Eureka, or Arcata. There is a designated industrial area adjacent to existing sawmills on Highway 36 at Yager Creek (General Plan 1984).

Rio Dell is a small incorporated city of approximately 3,174 residents, located between Scotia and Fortuna just off of Highway 101. A Draft General Plan for the City was released in 2006. This plan covers the area of Rio Dell as well as neighboring Scotia.

Two main implementation Measures laid out in the General Plan related to water resources are:

- The City shall prepare and adopt a Water and Wastewater Master Plan that addresses build out identified in the General Plan;
- The City shall prepare and adopt a Drainage Master Plan that encourages on site retention, maintains current stream and drainage channel integrity, and reduces non-point pollution loads.

Proposed General Plan landuse and zoning within the Rio Dell City limits and within the Upper Subbasin (thus excluding Scotia) include Community Commercial, Neighborhood Center, Public Facility, Rural, Suburban, Town Center, and Urban Residential.

Rio Dell has the following policies related to Biological Resources:

- Ensure that environmentally sensitive habitat areas (ESHAs) such as the Eel River corridor, streams and drainage channels with riparian habitat, and forested areas that could potentially support sensitive species, are buffered to protect against any significant disruption of their habitat values;
- Maintain water quality in the City watersheds such as Dean Creek.

Forest Management

Timber harvest activities since 1991 have occurred in every tributary watershed except for Barber Creek in the Van Duzen Basin. Multiple areas have been entered two or three times, and one area in the Cummings Creek watershed has been entered six times since 1991. Each year, an average of 2.6% (>1,200 ac) of this subbasin was included in timber harvest plans with treatments ranging from selection cuts to clear cuts.

The Pacific Lumber Company completed a watershed assessment of their timberlands in 2002 and 2004 which included parcels in the Upper Subbasin. Among their findings was the indication of Cummings Creek watershed as a major sediment source within the Van Duzen River watershed, delivering 17,200 tons per year. In addition, it was calculated that there was an 8% increase in peak flows during 2 year hydrological events (commonly referred to as bankfull events). This is indicative of decreased water storage in soil and vegetation due to timber harvest.

Gravel Mining

Instream gravel mining in this subbasin occurs in the Lower Van Duzen River. The County of Humboldt Extraction Review Team (CHERT) monitors and makes recommendations on three sites that extract over 5,000 cubic yards (cy) annually. As mentioned in the basin assessment section of this document, more than 40 other sites in the Van Duzen River of at least 1,000cy in extracted volume are on file with CDFG. Estimates for the volume extracted before CHERT began monitoring are unavailable, but are most likely similar to trends in the Lower Eel River and have probably decreased significantly. Currently, an average of 113,057cy/yr is taken out of the Lower Van Duzen River (Table 7).

Three separate studies have addressed channel bed elevation changes in the Van Duzen River. Kelsey found that the Van Duzen River has aggraded since 1941, though his study site ended upstream of where ours begins (Kelsey 1977). Humboldt County determined that the river had downgraded at the Highway 101 Bridge across the Van Duzen River by 10 feet between 1941 and 1992 (Humboldt County 1992). The U.S. Army Corps of Engineers, seeing some slight aggradation in the Van Duzen River since 1968, concluded that these changes were not evidence of an impact by gravel mining (USACOE 1999).

Threats to salmonids come largely from the loss of a confined single-thread low flow channel at the mouth of the Van Duzen River at the start of adult migration. Additionally, a minimal low flow channel implicates a loss of deep holding pools for adult and juvenile migration, and loss of cover, suitable temperature, and complex habitat for juvenile salmonids. Fish stranding in wetland pit mines should also be monitored as this has been an issue for other subbasins in the study area.

Residual effects of aggradation due to the 1964 flood

and early mining operations have left the mouth the Van Duzen River in a state that, without the intervention of land managers, would not support the early fall upstream migration of adult salmonids in most years. In 1996, the same year that CHERT began recommendations, 38 adult Chinook salmon died stranded on shallow, braided riffles in the lower half mile of the river. Braiding and channel widening had reduced the depth too much for the fish to continue upstream. In 2001, another 136 fall Chinook perished under the same conditions. Since 2001, a low flow channel has been maintained by seasonally creating a single thread channel in the lower two to four miles of river during gravel mining operations. Additionally, high gradient "barrier" culverts are installed by CDFG in the fall to prevent fish entry into the Van Duzen River until stream flows increase to about 150 cfs. Once flows increase to this point, stranding should not be a concern for the next four miles of aggraded channel, and the culverts are removed (S. Downie, personal communication). In the Army Corps of Engineers' Letter of Permission (USACOE 2003), bar skimming as a technique is disallowed in the lower two miles of the river, and trench, alcove, or wetland pit mining are the alternative and preferred methods. By utilizing these methods creatively, current gravel mining operations actually improve the functionality and shape of the low flow channel and facilitate fish passage. These measures have effectively prevented any salmon mortalities since the 2001 stranding event.

Table 7. Lower Van Duzen River Annual Extraction 1997-2007 (CHERT 2008).

Year	Recommended Volume (cy)	Extracted Volume (cy)	Percent of Recommended Volume Extracted
1997	120,000	81,600	68%
1998	119,100	103,700	87%
1999	159,900	108,800	68%
2000	194,800	121,300	62%
2001	161,700	85,600	53%
2002	202,500	167,400	83%
2003	175,100	123,000	70%
2004	179,045	92,610	52%
2005	159,090	123,170	77%
2006	134,910	104,750	78%
2007	152,773	113,184	74%
Totals	1,758,918	1,225,114	70%
Averages	159,902	111,374	70%

Fish Habitat Relationship

Fishery Resources

Other than anecdotal accounts, fish presence has been documented in the Upper Subbasin by observations made during stream surveys since 1938. However, stream survey efforts were neither specific nor standardized until 1990 when the *California Salmonid Stream Habitat Restoration Manual* (Flosi et al. 1998) was published. Most observations in stream surveys are not quantitative and have limited use.

Surveys prior to 1990 observed Coho salmon in Wolverton Gulch, Cuddeback, Fiedler, Cummings, and Howe Creeks in the past (Table 8). Since 1990 they have been detected in Cummings, Oil, Howe, and Atwell Creeks. In recent years, Chinook spawning has been observed in Wilson, Cuddeback, Fiedler, Cummings, Price, and Atwell Creeks, which matches observed historical presence. Steelhead trout were historically found in 13 creeks. In recent years, steelhead and have been detected in 10 streams: Wolverton Gulch, Wilson, Cummings, Price, Oil, Howe, West Howe, Atwell, Nanning, and Dean Creeks. Cutthroat trout were collected from Barber Creek in 1950 and represented the southernmost population for the species. More recently, they were observed in Wolverton Gulch at the Highway 36 Bridge (S. Downie personal communication).

Table 8. Documented fish presence in surveys from 1938 to 2006 in the Upper Subbasin.

Stream	Date Surveyed	Source	Survey Method	Fish Observations				Fish Comments
				Coho	Chinook	Steelhead	Salmonids	
Barber Creek (Eel)	1950	DeWitt 1952	Angling			x	x	Coastal cutthroat trout collected and abundant
	02/21/1973	CDFG 1973	Electrofishing			x		Below concrete falls steelhead and roach were collected
Barber Creek (Van Duzen)	07/15/1965	CDFG 1965	Streamside observation				x	Salmonids up to 3 inches in length
	07/02/1984	Franklin and Mitchell (1984)	Electrofishing			x		Largest steelhead collected in this 300 foot survey were in a HWY 36 culvert pool.
	01/23/1988	CDFG 1988	Electrofishing					Approximately 0.25 mile above HWY 36 culvert.
Wolverton Gulch	06/12/1963	CDFG 1963	Streamside observation				x	Trout observed
	circa 1965	CDFG	Streamside observation				x	Unidentified salmonids up to 8 inches, many 1 inch salmonids
	04/24/1978	CDFG 1978	Electrofishing	x				One inch coho observed 0.25 mile above Rohnerville Road. This is the only confirmed sighting of coho in Wolverton Gulch.
	07/02/1984	Franklin and Mitchell (1984)	Electrofishing			x		Steelhead, trout observed below HWY 36 culvert
	11/08/1993	CDFG 1993	Electrofishing				x	Stickleback observed
	02/07/1994	CDFG 1994	Spawning survey				x	Landowner observed steelhead spawning in creek. CDFG warden observed one redd.
	1994 (winter)	CDFG 1994	Streamside observation				x	S. Downie (CDFG) and M. Rose (CCC) observed cutthroat trout at Hwy 36 Bridge
	5/8/1997	CDFG Stream Inventory	Electrofishing			x		1+ and 2+ year classes of steelhead present.
	10/15/1997	Harris (1997)	Unknown				x	Unidentified yoy, 2+ salmonids, and threespine stickleback observed
	11/3/1997	CDFG Stream Inventory	Electrofishing			x		Steelhead yoy present and one steelhead 6.5mm FL. 3-spined stickleback and Pacific lamprey ammocoetes observed
	06/06 and 13 /2001	CDFG NCCCSI 2005	Electrofishing				x	California roach, threespine stickleback, trout, unidentified salmonids observed
	07/23/2002	CDFG NCCCSI 2005	Electrofishing				x	Lamprey spp., trout, threespine stickleback, sculpin spp. observed
	07/07/2003	CDFG NCCCSI 2005	Electrofishing				x	Lamprey spp., trout, threespine stickleback observed
Wilson Greek	9/6/1991	CDFG Stream Inventory	Electrofishing			x		Steelhead ranged in size from 71 to 305 mm FL. Stickleback also observed
	12/07/2001	Froland (2001 a/b)	Spawning survey		x			One spent Chinook adult
	06/05/2001	CDFG NCCCSI 2005	Electrofishing				x	Trout observed
	07/25/2002	CDFG NCCCSI 2005	Electrofishing				x	Trout observed
	06/17/2003	CDFG NCCCSI 2005	Electrofishing				x	Trout, threespine stickleback observed
Cuddeback Creek	06/27/1940	Shapovalov (1940)	Fish rescue	x		x		Coho and steelhead rescued from Cuddeback Creek and released into Van Duzen mainstem
	06/13/1963	CDFG 1963	Streamside observation				X	Unidentified salmonids from 1 to 6 inch in length found only 0.75 mile from mouth
	03/19/1987	CDFG (1987)	Spawning survey			x		Steelhead observed by locals, only redd observed by CDFG warden approximately 0.25 mile above HWY 36 crossing
	07/08/1988	CDFG 1988	Electrofishing			x		
	06/14 and 07/17/2001	CDFG NCCCSI 2005	Electrofishing				x	Trout observed
	12/06 and 07/2001	Froland (2001 a/b)	Spawning survey		x			Spawning Chinook and redds observed near mouth
	10/21/2002	CDFG NCCCSI 2005	Electrofishing				x	Trout observed
	12/17/2002	Froland (2002)	Spawning survey		x			Chinook observed spawning just downstream of HWY 36 crossing
	06/19 and 09/25/2003	CDFG NCCCSI 2005	Electrofishing		x		x	Chinook, Sacramento pikeminnow, trout observed.
Fiedler Creek	05-07/1951	Hallock et al (1952)	Seine	x				

Stream	Date Surveyed	Source	Survey Method	Fish Observations				Fish Comments
				Coho	Chinook	Steelhead	Salmonids	
Fiedler Creek	12/15/1964	CDFG (1964)	Spawning survey		x			Chinook observed spawning from mouth to HWY 36 bridge
	05/27/1965	CDFG (1965)	Streamside observation				x	1.5 to 4 inch unidentified salmonids observed just below HWY 36 bridge
	07/19/1965	CDFG (1965)	Streamside observation				x	Unidentified salmonids approximately 2 inch in length observed in lower 2/3 of stream. Residents note that juvenile salmonids die in stream each summer
	07/03/1967	CDFG (1967)					x	1.5 inch salmonids were observed from mouth to approximately 0.75 mile above HWY 36
	02/05/1987	CDFG (1987)	Spawning survey			x		Steelhead and steelhead redds observed approximately 400-500 ft above HWY 36
	06/05 and 06/2001	CDFG NCCCSI 2005	Electrofishing				x	Trout observed
	12/07/2001	Froland (2001 a/b)	Spawning survey		x			Chinook observed spawning approximately 50 and 100 feet above HWY 36 culvert. CDFG warden notes that some of these Chinook were "42 inch fish in a 36 inch wide stream!"
	07/22/2002	CDFG NCCCSI 2005	Electrofishing				x	Trout observed
	08/13/2003	CDFG NCCCSI 2005	Electrofishing				x	Trout observed
Cummings Creek	08/16/1938	CDFG (1938)	Streamside observation			x		Many 1.5 to 2.5 inch steelhead observed
	07/06/1949	Murphy (1950)	Fish rescue			x		900 yoy steelhead rescued from unknown location
	05 to 07/1951	Hallock (1952)	Seine	x				Coho yoy and 1+
	01/14/1952	CDFG (1952)	Streamside observation					No fish observed due to high water
	07 to 08/1952	Kimsey (1953)	Fish rescue	x				Fish rescued from Cummings Creek planted into Strongs Creek
	06/1961	CDFG (1961)		x		x		
	01/29/1962	CDFG (1962)	Streamside observation					
	12/15/1964	CDFG (1964)	Spawning survey		x			Chinook observed
	03/07/1966	CDFG (1966)	Streamside observation					No fish observed from HWY 36 crossing to 0.5 mile upstream
	02/05 and 07/1985	CDFG (1985)	Streamside observation			x	x	Steelhead, juvenile salmonids and roach observed during survey of 0.25 mile below HWY 36 to 2 miles above the HWY.
	03/15/1985	CDFG (1985)	Spawning survey					Redds observed
	1987	Brown and Moyle (1987)	Combination of the following: electrofishing, seining, snorkeling	x		x		California roach observed
	12/15/1987	CDFG (1987)	Spawning survey	x	x			Redds observed
	12/31/1987	CDFG (1987)	Spawning survey		x			Redds observed
	12/01 and 09/1988 and 01/17/1989	CDFG (1988)	Spawning survey		x			Chinook and redds observed
	04/19/1989	CDFG (1989)	Streamside observation		x	x	x	Juvenile Chinook, unidentified salmonids and 1+ steelhead observed, as well as redds
	06/26/1989	CDFG (1989)	Electrofishing	x		x		
	01/12 and 25/1990	CDFG (1990)	Spawning survey				x	One unidentified live fish observed
	9/3 and 6/1991	CDFG Stream Inventory	Electrofishing			X		Ranged from 36 to 170 mm FL.
	02/04/1992	CDFG (1992)	Spawning survey					Redds observed.
	12/17, 21/1992 and 01/05, 12/1993	CDFG (1992)	Spawning survey		x		x	Live Chinook and carcasses, unidentified salmonids; redds observed
	07/07/1993	Preston (1993)	Electrofishing	x		x		

Stream	Date Surveyed	Source	Survey Method	Fish Observations				Fish Comments
				Coho	Chinook	Steelhead	Salmonids	
Cummings Creek	08/02/1994	Preston (1994)	Electrofishing			x		
	11/28/1994 and 02/07/ 03/01/1995	CDFG (1994, 1995)	Spawning survey				x	Unidentified skeletons and redds observed
	11/28 to 03/01/1995	CDFG (1995)	Spawning survey				x	One unidentified skeleton, redd observed.
	01/08/1996	CDFG (1996)	Spawning survey					
	12/19/1997	CDFG (1997)	Spawning survey					
	10/19/1998	PALCO (1998)	Electrofishing			x		
	09/02/1999	PALCO (1999)	Electrofishing			x		
	12/8/1999 and 01/05/2000	CDFG (2000)	Spawning survey					
	09/06/2000	PALCO (2000)	Electrofishing			x		
	05/30/2001	CDFG NCCCSI (2005)	Electrofishing, direct observation				x	Trout observed
	09/13/2001	PALCO (2001)	Electrofishing			x		
	12/2001	Froland (2001)	Spawning survey		x			
	06/06 and 17/2002	CDFG NCCCSI (2005)	Direct observation		x		x	Chinook and trout observed
	06/17/2003	CDFG NCCCSI (2005)	Direct observation		x		x	Chinook, trout, Sacramento pikeminnow observed
	10/28/2003	PALCO (2003)	Electrofishing			x		
Price Creek	11/23/1964	Rinehart (1964)	Spawning survey		x			Chinook observed 2.5 miles from mouth. No carcasses. Stream survey from mouth to 4 miles upstream
	12/29/1966	CDFG (1966)	Spawning survey					.
	1975, 1976	Brown (1980)	Electrofishing, direct observation			x		California roach, Sacramento sucker, sculpin spp., threespine stickleback observed
	03/02, 03, 05/1981	Ganz-Haggard (1981)	Streamside observation			x		Only 1 steelhead observed in last 1 mile of stream. Water very murky, visibility was low.
	12/10/1986	Froland (1986)	Streamside observation					No fish data recorded. Anecdotal comment that fish population is "a shadow of its past productivity."
	12/14/1987	Donker (1987)	Spawning survey					No fish observed. Landowner notes that he hasn't seen a run of salmon since the 1964 flood.
	07, 08, 10/1995	USFS raw data	Electrofishing			x		California roach, threespine stickleback, coast range sculpin, Pacific lamprey observed
	07-08/ and 10/1995, 06-07/1996, 05/1997	Harvey, White, Nakamoto (2002)						California roach, threespine stickleback, sculpin spp. observed
	10/05/1998	CDFG (1998)	Electrofishing			x		Pikeminnow spp., sculpin spp., roach spp., sucker spp., stickleback, lamprey spp. observed
	7/27/1999	CDFG Stream Inventory	Electrofishing			x		0+, 1+, 2+, and 3+ size classes of steelhead present. California roach, threespine stickleback, Sacramento suckers, Sacramento pike minnow, and sculpin observed
	07/10, 12/2001	CDFG NCCCSI (2005)	Electrofishing				x	Trout, lamprey spp., sculpin spp., threespine stickleback, sucker spp., Cyprinid spp., observed
	07/23, 24/2002	CDFG NCCCSI (2005)	Electrofishing				x	Trout, Sacramento pikeminnow, sculpin spp., sucker spp., threespine stickleback, lamprey spp. observed
	08/11 and 10/06/2003	CDFG NCCCSI (2005)	Electrofishing		x		x	Chinook, trout, Sacramento pikeminnow, sculpin spp., threespine stickleback, lamprey spp., California roach observed
Sweet Creek	08/15/1938	CDFG (1938)	Streamside observation			x		1.5 to 3 inch steelhead common

Stream	Date Surveyed	Source	Survey Method	Fish Observations				Fish Comments
				Coho	Chinook	Steelhead	Salmonids	
	03/06/1981	CDFG (1981)	Streamside observation					
Oil Creek	06/15/1977	CDFG (1977)	Streamside observation			x	x	Steelhead fry and one 4-5 inch salmonid
	06/08/1990	CDFG (1990)	Electrofishing	x		x	x	Yoy salmonids, coho, steelhead, sculpin spp., lamprey spp. observed
						x		Sticklebacks observed
	10/15/1999	CDFG Stream Inventory	Electrofishing			x		0+, 1+, 2+, and 3+ size classes of steelhead and sculpin observed
	10/30/2002	CDFG Stream Inventory	Electrofishing	x		x		Yoy, 1+, and 2+ steelhead year classes observed
Howe Creek	1952	Kimsey (1952)						Salmon mortality at mouth
	1975, 1976	Brown (1980)	Electrofishing, direct observation	x		x		California roach, sculpin spp., threespine stickleback, Sacramento sucker observed
	01/22/1980	CDFG (1980)	Streamside observation					Residents noted large 1979 runs of coho, Chinook, and steelhead. No observations made on this survey
	12/14/1987	Moody (1987)	Streamside observation					Land owner states no salmon run in 12 years
	9/15/1998	CDFG Stream Inventory	Electrofishing			x		Steelhead ranged in size from 50 to 174 mm. Sacramento pikeminnow observed
	10/15/1999	Yoshioka (1999)	Electrofishing	x		x		One coho juvenile, steelhead yoy, 1+ and 2+ observed
	01/19 and 02/01/2001	CDFG (2001)	Spawning survey				x	Unidentified live fish and carcass, redds observed
	07/11,12/2001	CDFG NCCCSI (2005)	Electrofishing				x	Trout, threespine stickleback, lamprey spp., sculpin spp. observed
	08/21/2001	CDFG (2001)	Electrofishing			x		Lamprey spp. observed
	07/22, 23/2002	CDFG NCCCSI (2005)	Electrofishing				x	Trout, threespine stickleback, lamprey spp., sculpin spp., sucker spp. observed
	08/07/2003	CDFG NCCCSI (2005)	Electrofishing				x	Trout, threespine stickleback, Sacramento pikeminnow, lamprey spp., sculpin spp. observed
West Fork Howe Creek	9/15/1998	CDFG Stream Inventory	Electrofishing			x		Steelhead ranged in size from 50 to 120mm FL
Atwell Creek	1975, 1976	Brown (1980)	Electrofishing, direct observation			x		Sculpin spp., threespine stickleback observed
	01/22/1980	CDFG (1980)	Streamside observation					Redds observed
	7/23/1993	CDFG Stream Inventory	Electrofishing			x		Ranged from 30 to 185mm FL. Other species: stickleback, sculpin, Pacific lamprey ammocoetes
	10/14 and 15/1999	CDFG Stream Inventory	Electrofishing			x		0+, 1+, and 2+ steelhead age classes present. Sculpin also present
	07/09 and 11/2001	CDFG NCCCSI (2005)	Electrofishing				x	Trout, threespine stickleback, sculpin spp., lamprey spp. observed
	07/22/2002	CDFG NCCCSI (2005)	Electrofishing	x	x		x	Coho, Chinook, trout, threespine stickleback, sculpin spp. observed
	07/02/2003	CDFG NCCCSI (2005)	Electrofishing	x			x	Coho, trout, Sacramento pikeminnow, sculpin spp., threespine stickleback observed
Nanning Creek	08/16/1973	CDFG (1973)	Electrofishing			x		"resident rainbow trout" in excellent condition
	08/23/1973	CDFG (1973)	Electrofishing, streamside observation			x		Possibly resident rainbow trout.
	1975, 1976	Brown (1980)	Electrofishing, direct observation			x		Sculpin spp. observed
	6/30/1992	CDFG Stream Inventory	Electrofishing			x		Steelhead ranged from 50 to 155 mm FL
	Summer 2001	PALCO (2001)	Electrofishing					No fish observed
Dean Creek	8/25/1992	CDFG Stream Inventory	Electrofishing			x		Steelhead ranged from 82 to 160 mm FL

NCCCSI= North Coast California Coho Salmon Investigation - Bill Jong personal comm.

Habitat Overview

Historic Conditions

Stream surveys were conducted by CDFG as early 1938; however, stream survey efforts were neither specific nor standardized until 1990 when the *California Salmonid Stream Habitat Restoration Manual* was published. Most observations in the historic stream surveys are not quantitative and have limited use in comparative analysis with current habitat inventories. Furthermore, the majority of streams within the subbasin were not surveyed prior to the floods of 1955 and 1964, which greatly exacerbated the detrimental effects of land use practices on these streams; therefore, a clear picture of overall historic stream habitat conditions and salmonid populations is lacking in this subbasin. Nevertheless, data from these stream surveys provide a snapshot of conditions at the time of survey (Table 9).

The earliest stream surveys in this subbasin were conducted in 1938 on five creeks. These surveys generally indicated good spawning and pool conditions, except for fair conditions on Price Creek. Additionally, debris and pollution from logging were noted in Cummings Creek. Surveys were conducted on six creeks from 1949 to 1970. Silty conditions were noted in the lower reaches of Barber Creek (Van Duzen), Fiedler, Cummings, and Price Creeks and Wolverton Gulch.

Three streams were surveyed in the 1970s. Poor habitat in Barber Creek (Eel) was described as impacted by cattle. Spawning conditions in Oil Creek and Nanning Creek were poor. Eight streams were surveyed in the 1980s. Siltation was noted on Wolverton Gulch, Barber (Van Duzen), Cuddeback, Cummings, and Price Creeks.

Additional habitat observations separate from habitat inventories were conducted on six streams in the 1990s and 2000s. PALCO observations of habitat during electrofishing on Cummings Creek noted shallow pools.

Table 9. Habitat observations made in the Upper Subbasin from 1938-2003.

Stream	Date Surveyed	Source	Habitat Comments	Barrier Comments
Barber Creek (Eel)	02/21/1973	CDFG 1973	Generally lacking in good fish habitat. Substrate is mostly mud and fines, some good spawning gravel. Banks are clear of brush and trees due to agricultural production. Water is degraded by cattle in entire stream except headwaters	Low flow barrier at mouth during summer, 6 ft vertical concrete falls approximately 100 yards from mouth is year –round barrier.
Barber Creek (Van Duzen)	07/15/1965	CDFG 1965	Depths range from 3 in. to 3 ft., substrate composed of silt in the lower reaches and fine rubble to fine gravel upstream, spawning areas, shelter and canopy are abundant	No impassable barriers
	07/02/1984	Franklin and Mitchell (1984)	Average pool depth 8 in., 95% canopy, no spawning gravel, heavily silted substrate due to erosion from livestock grazing, logging	
	01/23/1988	CDFG 1988	Shelter from woody debris and undercut banks, dense riparian overstory. Stream flows through pasture lands	Culvert requires modification for fish passage
Wolverton Gulch	06/12/1963	CDFG 1963	Spawning conditions are poor; substrate is heavily silted, tannin-dyed water, average depth from mouth to headwaters 3 to 2 ft., respectively. Domestic sewage likely draining into stream from outhouse	The many log jams in creek are probably not barriers to fish migration. Three culverts observed obstructed by heavy sediment.
	circa 1965	CDFG	Depths range from 2 in. to 3 ft., bottom of heavily silted coarse gravel, low gradient.	No obstructions observed
	07/02/1984	Franklin and Mitchell (1984)	Erosion causing heavy siltation of stream, average pool depth was 5 in., 80% canopy, pasture land borders stream section	
	10/15/1997	Harris (1997)	Headwaters of creek. Fairly good fish habitat, low to moderate embeddedness, however high volume of fines in channel (fines increase upstream), low LWD abundance (predominantly hardwood), pools mostly less than 3 ft deep, less than 70% canopy (increasing to 95% upstream).	
Cuddeback Creek	06/13/1963	CDFG 1963	In lower 0.75 mile of creek: poor shelter, shallow pools (<3 in), sandy substrate creates poor spawning area. From 0.75 mile from mouth: shelter improves, pools are deeper (4 to 5 in), spawning gravels improve	Low flow barrier during summer, and subsurface flow.
	03/19/1987	CDFG (1987)	Lower reach of stream dries up in summer	
	07/08/1988	CDFG 1988	Stream bottom moderately silted, subsurface flow in areas	
	12/06 and 07/2001	Froland (2001 a/b)	Muddy water, landowner known to cross creek in this area with heavy equipment	
Fiedler Creek	12/15/1964	CDFG (1964)	Little spawning gravel, turbid water	No barriers observed
	05/27/1965	CDFG (1965)	Large quantities of debris: tree branches, cans, bottles, and wood.	
	07/19/1965	CDFG (1965)	Pools varied in depth from 3 to 10 in., heavily silted fine gravel in lower 0.5 mile, coarse gravel and fine rubble from 0.5 to 1 mile from mouth. No flow at mouth	
	02/05/1987	CDFG (1987)	Average depth was 0.5 to 1 ft, excellent spawning gravel	

Stream	Date Surveyed	Source	Habitat Comments	Barrier Comments
Cummings Creek	08/16/1938	CDFG (1938)	Pool and shelter are good, debris and pollution observed from logging activities	Log jams that divert entire flow
	01/14/1952	CDFG (1952)	Average depth 3 ft., substrate is mostly gravel and rubble, , good spawning areas are numerous, numerous pools	Numerous log jams obstruct stream, no comment on fish passage ability
	06/1961	CDFG (1961)	Good spawning areas, lower reaches of stream go dry in summer, average depths range from 4 to 8 ft., high levels of urban trash in stream, siltation of stream bottom increases from mouth to headwaters	Several log jams and culverts obstruct the stream, no comment on fish passage ability
	01/29/1962	CDFG (1962)	Flows too low to pass through culverts	Four culverts surveyed that were not barriers to fish migration
	12/15/1964	CDFG (1964)	Good spawning gravel available, though some heavily silted	Log jams observed that were not barriers to fish migration
	03/07/1966	CDFG (1966)	Good spawning gravel	Several log jams forming passable, and one impassable barrier
	02/05 and 07/1985	CDFG (1985)	High amounts of sand and silt in creek from erosion of streambanks due to road crossings, cattle, several large log jams. Lower reaches of stream are highly aggraded, and flowing subsurface. Spawning habitat ranged from poor to fair, canopy cover ranged from 10% to 95%. Moving upstream,	Several low flow and probable barriers predominantly composed of LWD observed on Cummings Creek, complete barriers observed on Cummings Creek tributaries
	12/15/1987	CDFG (1987)	Bank erosion contributing fines to stream, log debris accumulation	No observed obstructions defined as fish passage barriers
	12/31/1987	CDFG (1987)	Cattle impacting stream, causing increased sediment and reduction in riparian vegetation	Fences in stream retaining debris, could pose fish migration barrier.
	12/01 and 09/1988 and 01/17/1989	CDFG (1988)	High levels of silt in creek downstream of HWY 36 bridge, most redds observed upstream of this location	Wire fences crossing stream are not impeding salmon migration
	04/19/1989	CDFG (1989)	Bank erosion, low canopy, little shelter and shallow pools in areas detailed for enhancement. Good available spawning gravels	
	01/12 and 25/1990	CDFG (1990)	Spawning habitat considered fair, cows accessing stream	Fences crossing stream may hinder fish passage
	09/03/1991	CDFG (1991)	Good woody debris, and shelter cover	Fish observed upstream of massive log and tire jam
	02/04/1992	CDFG (1992)		Redd observations made above “old tire jam:
	07/07/1993	Preston (1993)	0.5- to 1.5- foot deep pools and scours above HWY 36 culvert	
	10/19/1998	PALCO (1998)	Canopy = 95-100%, shelter rating = 70-90%, average pool depths ≤1 foot	
	09/02/1999	PALCO (1999)	average pool depths < 1 foot	
	09/06/2000	PALCO (2000)	High amounts of LWD on banks, shelter ratings = 20-60%, average pool depths < 1 foot	
	09/13/2001	PALCO (2001)	High amounts of suspended sediment, electrofishing occurred upstream of major LWD. Shelter ratings = 10-75%, average pool depths < 1 foot	
	10/28/2003	PALCO (2003)	Low flow, high gradient, streambanks are highly eroded, fine sediments in pool, large cobble and boulders, shelter coverage ranged from 30% to 70% per surveyed unit	Stream below Hwy 36 is diverted and flat gradient. Often braided with subsurface flows which block fish passage.
Price Creek	08/15/1938	CDFG (1938)	Pools and shelter described as fair.	
	Pre 1951	CDFG	Bottom described as rock and gravel, lower reach of stream goes dry in summer	
	11/23/1964	Rinehart (1964)	Rains made water very muddy and visibility very poor.	
	03/02, 03, 05/1981	Ganz-Haggard (1981)	From mouth to 5.5 miles upstream: Canopy averaged 50 to 80%, channel width averaged 30 to 40 ft., stream bottom heavily silted, gravel 15 to 40%. Due to logging and grazing, high levels of bank erosion.	
	12/10/1986	Froland (1986)	Flows are low probably due to riparian diversions on stream.	
	12/14/1987	Donker (1987)	Numerous slides and other bank erosion observed.	
Sweet Creek	08/15/1938	CDFG (1938)	Survey conducted 100 yards above mouth: spawning area described as good, pools 3.5 feet deep and described as good, pool shelter good.	
	03/06/1981	CDFG (1981)	Very unstable banks, heavily impacted from cattle grazing, canopy averages 50-80%, pool depths ranged from 1.5 to 2 ft., gravel is available at 30-40% average	Several log jams with associated debris accumulations create possible barriers to fish migration
Oil Creek	1938	CDFG (1938)	Survey conducted 100 yards above mouth. Pools = 3 inches deep, good spawning areas	No barriers observed
	06/15/1977	CDFG (1977)	Stream is heavily silted and lacks spawning gravel. Mouth to 200 feet upstream is only available spawning area. Pool shelter (in the form of logging slash) is adequate. Iron pyrite seepage	
	06/08/1990	CDFG (1990)	Good spawning and rearing habitat, canopy averaged 55% over entire survey (from mouth to 1.3 miles upstream)	Several debris accumulations encountered
Howe Creek	08/16/1938	CDFG (1938)	Pools described as good, shelter is good	
	01/22/1980	CDFG (1980)	Shade canopy averaged 20% from mouth to forks, increased to 70% upstream, stable banks, suitable spawning areas	No fish passage barriers encountered
	12/14/1987	Moody (1987)	Atwell Creek, and unnamed tributary contributing silt to stream	Bridge and concrete platform combination may pose threat to fish passage

Stream	Date Surveyed	Source	Habitat Comments	Barrier Comments
	10/15/1999	Yoshioka (1999)	Cover rating =5%, water clarity =excellent.	
Atwell Creek	01/22/1980	CDFG (1980)	Shade canopy averaged 80%, numerous suitable spawning areas, generally stable banks, active slide contributing fines to stream	No barriers to fish passage observed in this 0.5 mile survey
Nanning Creek	08/16/1973	CDFG (1973)	Water depth from 1 inch to 1 foot, stream width 1-2 feet. 5- 6% gradient. Stream bottom: gravel 15%, sand 50%, silt 35%. Shade canopy = 85%. "an excess of slash" in stream and tributaries, "lots of brown algae."	
	08/23/1973	CDFG (1973)	New and old logging slash in creek; log jams, and railroad piers and timbers throughout the drainage. 25% of creek is littered with old logs and debris. Trash on banks	8-10 foot falls 0.25 mile above the mouth serves as a barrier to fish migration.
	12/27/1979	CDFG (1979)	Spawning gravel cemented in sand and silt, stream bottom "extremely unstable," with high levels of fines above and below stream obstructions. Few suitable spawning areas, none in tributaries. Stable streambanks, shade canopy averages 80%, stream gradient averages 2-3%	Many logjams serve as barriers to fish migration, gravel retention behind several. Stream flow obstructed by old logging roads. Removing obstructions would release large amounts of fines.
	Summer 2001	PALCO (2001)		12- to 15- foot fall at mouth.

Current Conditions

In the Upper Subbasin, CDFG fisheries crews conducted stream habitat inventories on fourteen streams totaling 30.3 miles between 1991 and 2002 (Table 10, Figure 5). These streams were chosen based on the known presence of salmonid species. Some of the surveyed area was limited by denied landowner access permission. Three streams, Oil Creek, Atwell Creek and Cummings Creek, each had two habitat inventories completed within a 5 year time frame.

Stream habitat inventory methods were conducted on these tributaries according to methods determined in the *California Salmonid Stream Habitat Restoration Manual* (Flosi, et al. 1998). Analysis of the Upper Subbasin streams' water quality and instream habitat conditions includes the following:

- Canopy density;
- Habitat type categories;
- Pools depth;
- Pool shelter;
- Large woody debris;
- Cobble embeddedness;
- Water quality;
- Water chemistry;
- Wastewater facilities.

Table 10. Upper Subbasin streams surveyed by CDFG.

Stream	Year of Survey	Survey length (miles)	Percent of permanent stream surveyed	Number of Reaches
Wolverton Gulch	1997	2.5	60	1
Wilson Creek	1991	0.5	23	2
Cummings Creek	1991	3.3	100	3
	1996	2.0	61	1
Price Creek	1999	6.9	82	4
Adams Creek	2002	0.8	69	2
Sweet Creek	1999	0.9	45	1
Muddy Creek	2002	0.8	65	2
Oil Creek	1999	0.5	26	1
	2002	0.8	42	2
Howe Creek	1998	4	86	2
Atwell Creek	1993	1.6	41	2
	1998	2.4	61	1
Crystal Creek	2002	0.5	38	1
West Fork Howe Creek	1998	0.4	40	1
Nanning Creek	1992	1.4	60	1
Dean Creek	1992	1	48	1

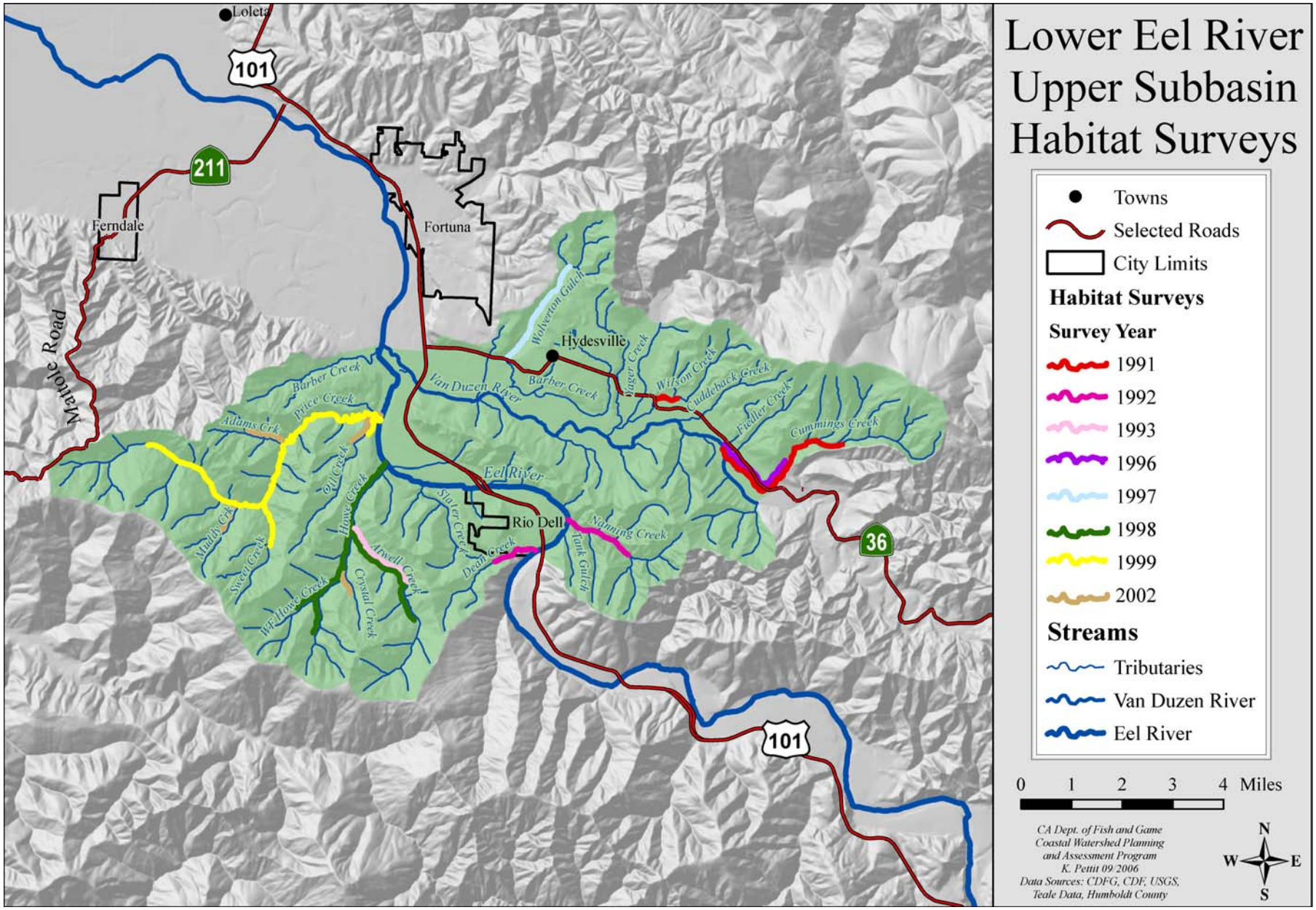

Figure 5. Habitat surveys conducted by CDFG on fourteen tributaries of the Upper Subbasin.

Canopy Density

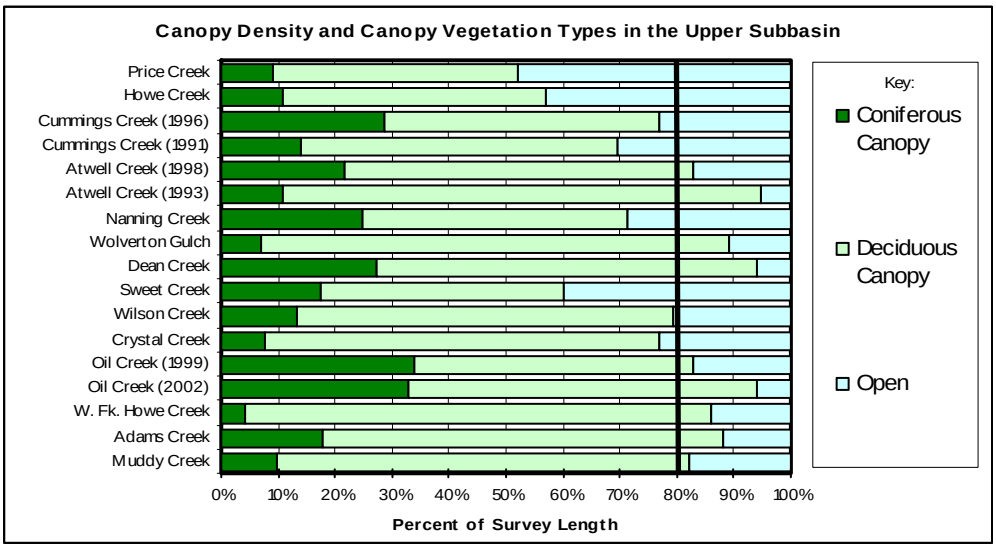

Figure 6. The relative percentage of coniferous, deciduous, and open canopy covering surveyed streams in the Upper Subbasin.

Averages are weighted by unit length to give the most accurate representation of the percent of a stream under each type of canopy. Streams are listed in descending order by drainage area (largest at the top).

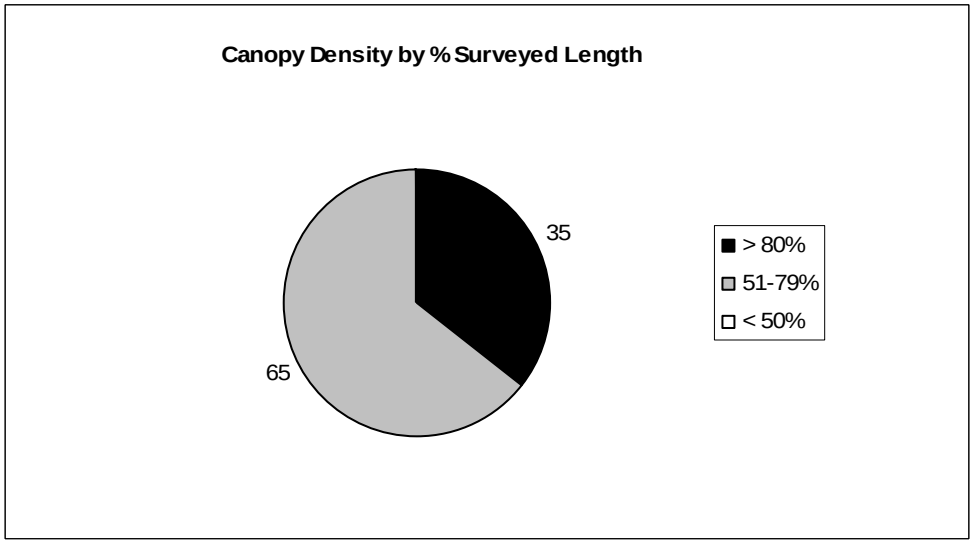

Figure 7. Canopy Density in the Upper Subbasin.

Significance: Streamside canopy density is a measure of the percentage of wetted stream that is shaded by riparian tree canopy. Near-stream forest density and composition contribute to microclimate conditions that help regulate air temperature, which is an important factor in determining stream water temperature. Stream water temperature can be an important limiting factor of salmonids. Generally, canopy density less than 50% by survey length is below target values and greater than 80% fully meets target values.

Findings: Canopy density measurements on seven of the 14 surveyed streams obtained values below the target value of 80%. On all streams the majority of canopy coverage was provided by deciduous trees. The 1993 Atwell Creek survey had the greatest canopy cover at approximately 95%. The lowest canopy densities of all the Lower Eel River subbasins were obtained in the Upper Subbasin, with three creeks near only 50% coverage. The overall Upper Subbasin EMDS canopy density condition truth score is moderately suitable, however, as poor canopy was found over long survey sections of streams, nearly 11 miles (approximately 1/3 of the total) is considered moderately unsuitable.

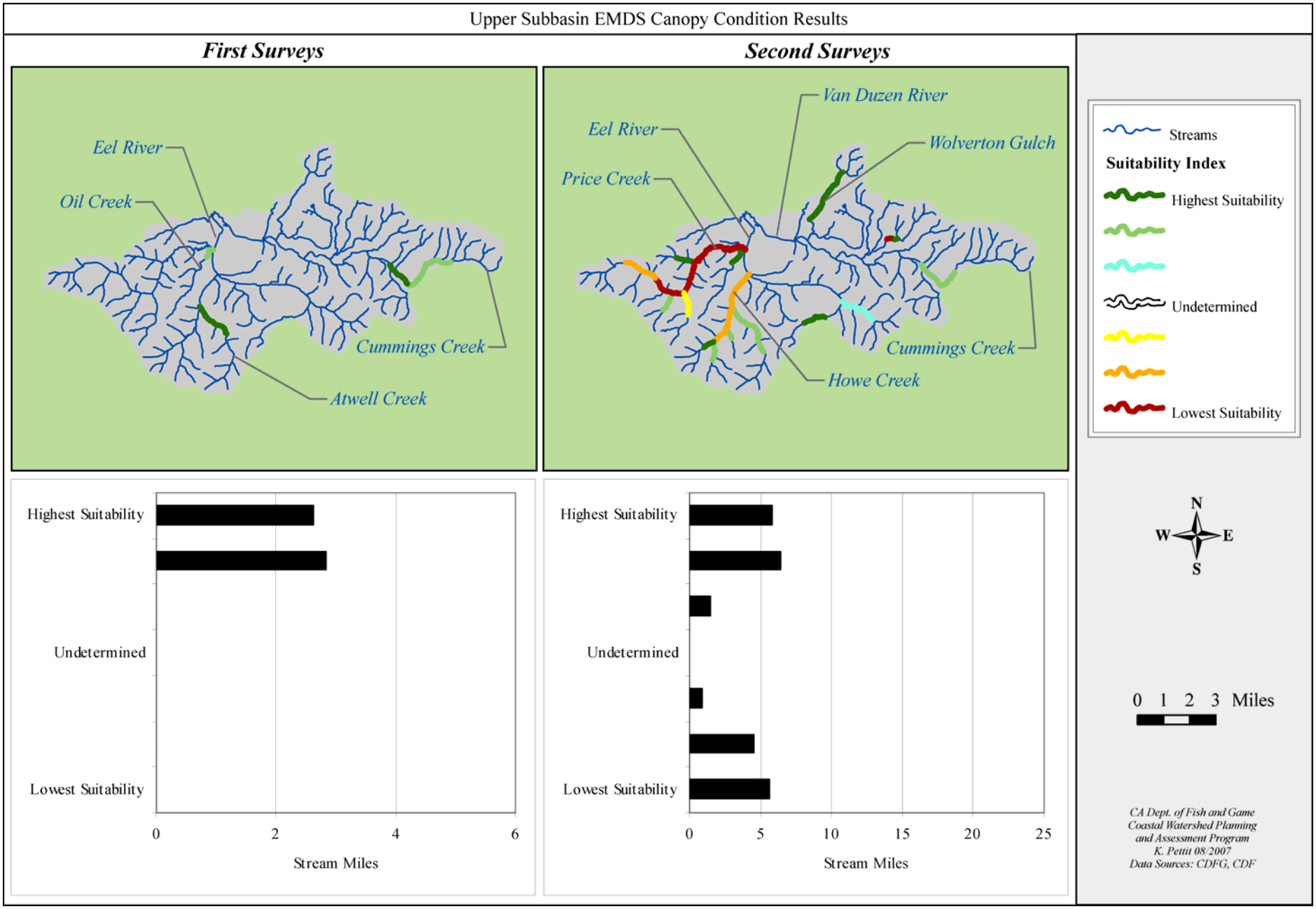

Figure 8. EMDS canopy results for the Upper Subbasin by surveyed stream miles. First surveys of Cummings, Atwell, and Oil Creeks were completed in

1991,199, and 1999, respectively. Second surveys for the same creeks were completed in 1996, 1998, and 2002, respectively.

Habitat Categories

Table 18. Upper Subbasin percent occurrence and percent by length of pool, run, riffle, and dry habitats.

Stream	Stream Order	Survey Length (miles)	Pool, Riffle, Run % Occurrence	Pool: Riffle: Run% total length	Dry % Total Length	Culvert % Total Length
Wolverton Gulch	1	2.5	47:11:40	30:4:64	1	1
Wilson Creek	2	0.5	49:50:31	4:86:10	0	0
Cummings Creek (1991)	1	3.3	34:41:24	11:36:26	27	0
Cummings Creek (1996)	1	2.0	32:34:33	18:24:57	1	0
Price Creek	2	6.9	22:45:33	12:57:30	0	0
Adams Creek	1	0.8	42:29:28	27:35:37	0	1
Sweet Creek	2	0.9	39:49:12	6:90:4	0	0
Muddy Creek	1	0.8	31:44:25	19:47:34	0	0
Oil Creek (2002)	2	0.5	39:34:26	42:28:31	0	0
Oil Creek (1999)	2	0.8	40:35:24	40:32:24	0	5
Howe Creek	2	4	18:46:36	6:65:29	0	0
Crystal Creek	1	0.5	2:48:48	1:74:25	0	1
Atwell Creek (1993)	1	1.6	28:40:31	20:36:42	1	0
Atwell Creek (1998)	1	2.4	28:40:32	18:39:43	0	0
West Fork Howe Creek	1	0.4	24:48:26	7:74:18	0	1
Nanning Creek	1	1.4	38:36:26	26:44:31	0	0
Dean Creek	1	1	28:38:27	19:44:31	5.81	0

Significance: Productive anadromous streams are composed of a balance of pool, riffle and run habitat and each plays an important role as salmonid habitat. Looking cumulatively at pool, riffle, and run relationships helps characterize the status of these habitat types and also provides a measure of stream habitat diversity and suitability for fish. A pool: riffle ratio of approximately 1:1 is suggested as a desirable condition for most wadeable, anadromous, fish bearing streams, but it is not applicable for evaluating salmonid suitability of all stream reaches and channel types (Rosgen 1996). However, pool: riffle relationships showing an over abundance of riffles or runs that may indicate aggraded channel conditions or lack of scour objects needed for pool formation.

Findings: Twelve of the surveyed tributaries had less pools by occurrence than riffles. Additionally, fourteen tributaries had less length in pools than in riffles. West Fork Howe, Crystal, Wilson, Sweet, and Howe Creeks all had less than 10% of their length in pools. Only Oil Creek and Wolverton Gulch had over 30% of their stream length in pools.

Five tributaries had dry habitat units, which obviously indicate poor conditions for fish and are further discussed in the Fish Passage Barriers section. Five tributaries had some of their length in culverts, which are also further discussed in the Fish Passage Barriers section.

Pool Depth

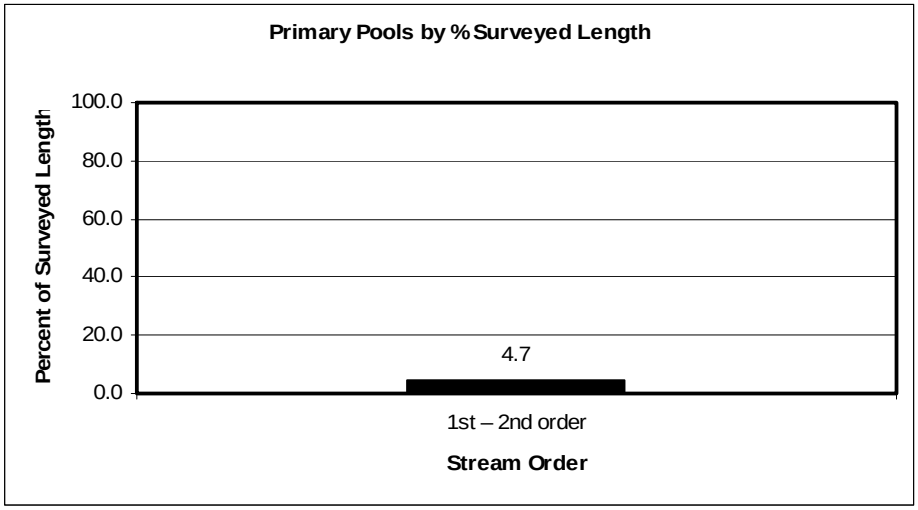

Figure 9. Primary Pools in the Upper Subbasin.

Table 12. Percent length of a survey composed of pools in the Upper Subbasin.

Stream	Stream Order	Percent all measured pools by survey length	Percent pools of depth <2' by survey length	Percent pools of depth 2' - 2.9 by survey length	Percent pools of depth 3' - 4' by survey length	Percent pools of depth > 4' by survey length	Percent pools within target range (>2') by survey length
Wolverton Gulch	1	29.59	22.63	6.71	0	0.25	6.96
Wilson Creek	2	4.23	4.23	0	0	0	0
Cummings Creek (1991)	1	11.48	8.43	3.05	0	0	3.05
Cummings Creek (1996)	1	18.16	14.96	2.82	0.38	0	3.2
Price Creek	2	10.98	7.11	3.21	0.56	0.1	3.87
Adams Creek	1	26.33	26.33	0	0	0	0
Sweet Creek	2	5.82	5.82	0	0	0	0
Muddy Creek	1	16.45	15.42	1.03	0	0	1.03
Oil Creek (2002)	2	41.24	22.55	14.49	3.27	0.93	18.69
Oil Creek (1999)	2	36.03	17.72	4.81	8.28	5.22	18.31
Howe Creek	2	5.88	3.14	2.16	0.41	0.17	2.74
Atwell Creek (1993)	1	20.62	12.36	6.99	1.27	0	8.26
Atwell Creek (1998)	1	17.82	8.08	8.61	1.13	0	9.74
Crystal Creek	1	1.08	1.08	0	0	0	0
West Fork Howe Ck	1	6.32	5.76	0.56	0	0	0.56
Nanning Creek	1	25.4	22.43	2.21	0.76	0	2.97
Dean Creek	1	18.64	15.6	2.59	0.45	0	3.04

Significance: Primary pools provide escape cover from high velocity flows, hiding areas from predators, and ambush sites for taking prey. Pools are also important juvenile rearing areas. Generally, a stream reach should have 30 – 55% of its length in primary pools to be suitable for salmonids. In first and second order streams, primary pools are those of greater than 2 feet deep.

Findings: None of the streams surveyed in the Upper Subbasin met target values for pool depth with only 5% of surveyed reaches being composed of primary pools. Oil Creek had the most primary pools by survey length, for both years with at only 18% However, Oil Creek also had some of the highest percentage of pools less than two feet in depth. On average, only about 7% of the surveyed area was composed of primary pools, which is well below the target values. Most of the pools in all of the surveyed streams were less than 2 feet in depth. Four streams, Adams, Crystal, Williams, and Sweet Creeks, contained no primary pools.

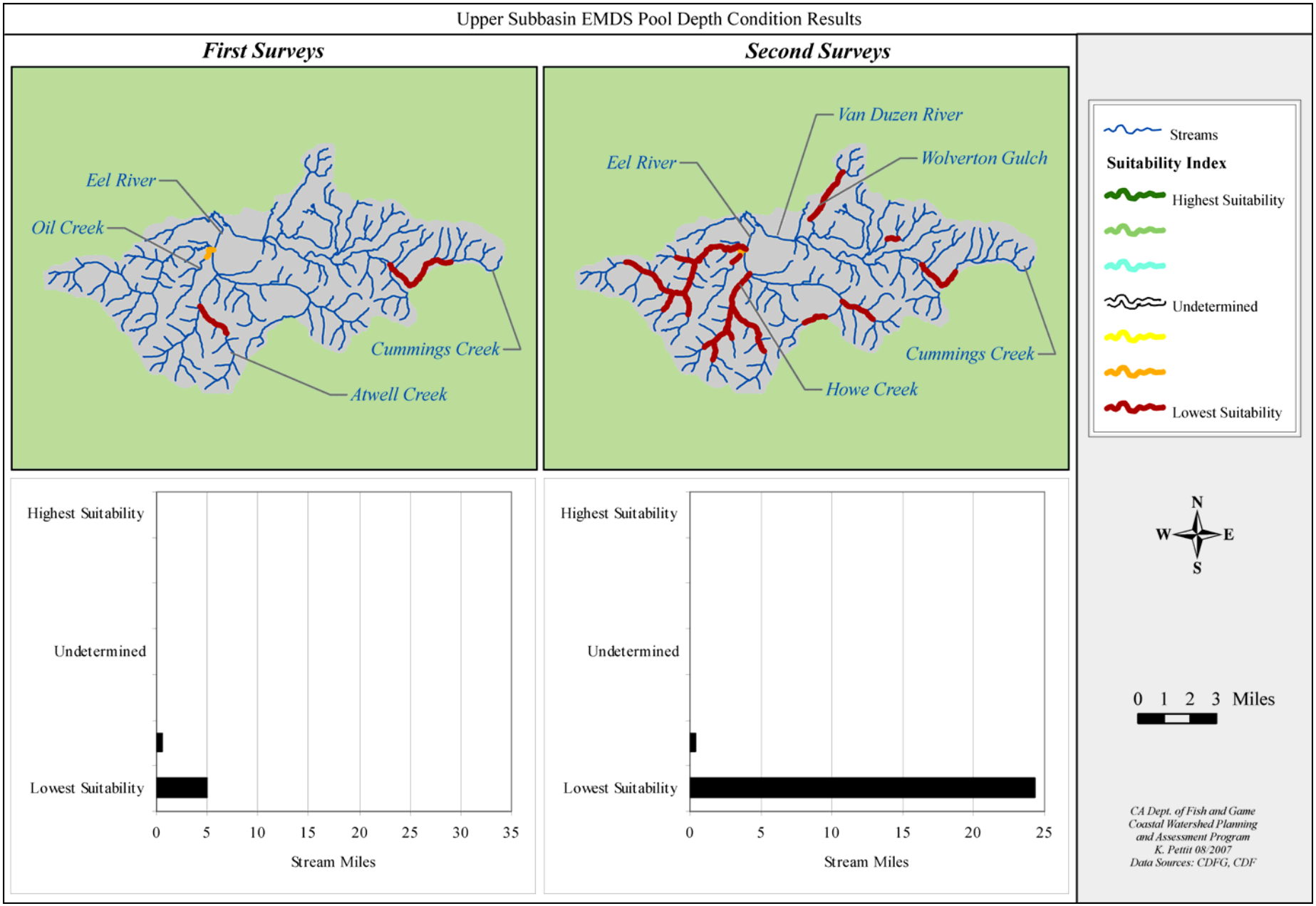

Figure 10. EMDS pool depth results for the Upper Subbasin by surveyed stream miles. First surveys of Cummings, Atwell, and Oil Creeks were completed in 1991,199, and 1999, respectively. Second surveys for the same creeks were completed in 1996, 1998, and 2002, respectively.

Pool Shelter

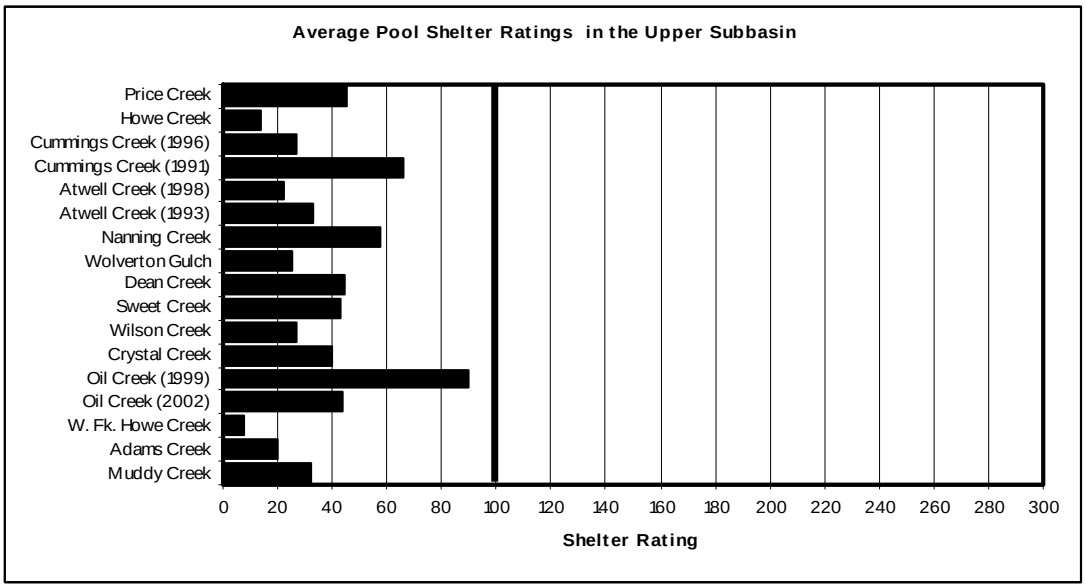

Figure 11. Average pool shelter ratings from CDFG stream surveys in the Upper Subbasin.
Streams are listed in descending order by drainage area (largest at the top).

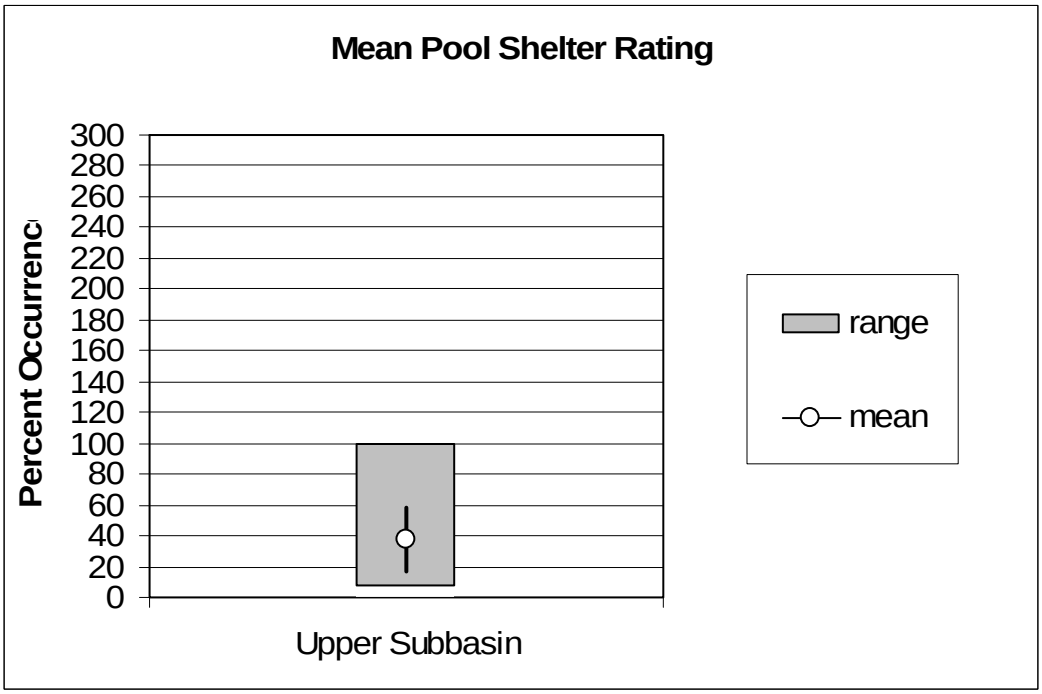

Figure 12. Pool shelter in the Upper Subbasin.

Error bars represent the standard deviation. The percentage of shelter provided by various structures (i.e. undercut banks, woody debris, root masses, terrestrial vegetation, aquatic vegetation, bubble curtains, boulders, or bedrock ledges) is described and rated in CDFG surveys.

Table 93. Mean percent of shelter cover types in pools for surveyed tributaries in the Upper Subbasin.

Stream	Undercut Banks	Small Woody Debris	Large Woody Debris	Root Mass	Terrestrial Vegetation	Aquatic Vegetation	White Water	Boulders	Bedrock Ledge
Wolverton Gulch	19.8	16.1	8.3	26.3	21.7	2	1.7	3.7	0.4
Wilson Creek	10.3	36.3	8.3	5.7	27	0	0	12.3	0
Cummings Creek (1991)	9.4	20.1	37.3	16.6	2.8	0	0.1	13.5	0
Cummings Creek (1996)	16	24	19	26	6	1	0	7	0
Price Creek	1.3	18.1	12.1	2.9	12.7	7.1	0.8	44	1
Adams Creek	13.8	2.5	7.5	6.25	1.3	0	0	68.7	0
Sweet Creek	1.3	18.8	12.5	12.5	0	0	3.8	51.3	0
Muddy Creek	7.94	5	8.24	0.88	2.06	0	7.94	57.35	10.59
Oil Creek (1999)	10	25.6	38.1	0	0.6	0	3.1	22.5	0
Oil Creek (2002)	8.3	7	69	3.3	0.7	0	1	10	0
Howe Creek	1.1	21.4	12.5	8.9	7.7	0.9	8.9	32.5	0
Atwell Creek (1993)	13	10	36	13	0	0	1	24	3
Atwell Creek (1998)	6.5	31	5	21	3	0	0	26.5	0
Crystal Creek	100	0	0	0	0	0	0	0	0
West Fork Howe Creek	5	0	7.5	0	0	0	23.8	63.8	0
Nanning Creek	4	8	55	3	4	0	2	22	2
Dean Creek	16.7	17.6	40.3	4.9	0.6	0.4	0.4	11.9	7.2

Significance: The pool shelter rating is a relative measure of the quantity and percent composition of small woody debris, root wads, boulders, undercut banks, bubble curtains, and submersed or overhanging vegetation in pool habitats. Pool shelter provides protection from predation and rest areas from high velocity flows for salmonids. Shelter ratings of 100 or less indicate that shelter/cover enhancement should be considered.

Findings: Pool shelter ratings for surveyed streams of the Upper Subbasin were all well below the target value of 100%. Shelter values of ≤30 are considered fully unsuitable. Seven surveyed reaches of Upper Subbasin streams obtained values considered fully unsuitable.

In addition to shelter complexity rating, instream shelter composition is also collected during habitat inventories. There are a total of nine cover types that are cataloged during habitat inventories. Boulders dominated the cover at over 50% in four stream of the Upper Subbasin, and were present in all streams but Crystal Creek. Small woody debris and large woody debris were also present in large quantities in a number of streams.

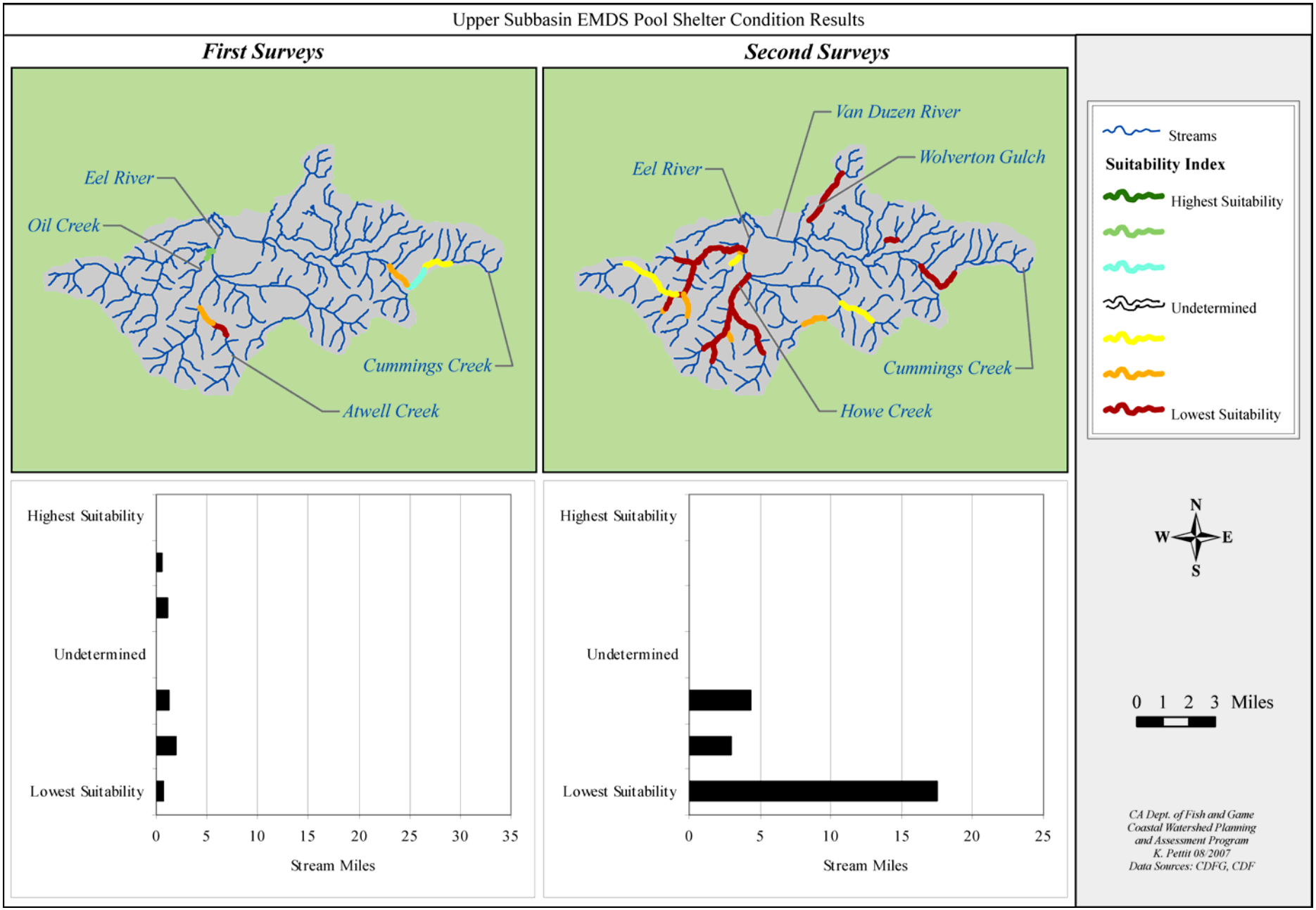

Figure 13. EMDS pool shelter results for the Upper Subbasin by surveyed stream miles. First surveys of Cummings, Atwell, and Oil Creeks were completed in 1991,199, and 1999, respectively. Second surveys for the same creeks were completed in 1996, 1998, and 2002, respectively.

Large Woody Debris

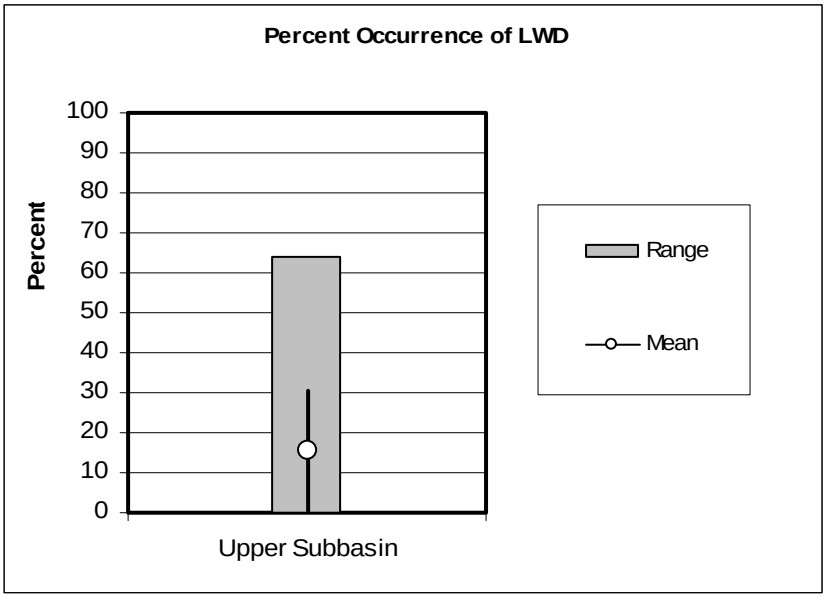

Figure 14. Large Woody Debris (LWD) in the Upper Subbasin.

Error bars represent the standard deviation. The percentage of shelter provided by various structures (i.e. undercut banks, woody debris, root masses, etc.) is described in CDFG surveys. The dominant shelter type is determined and then the percentage of a stream reach in which the dominant shelter type is provided by organic debris is calculated.

Significance: Large woody debris shapes channel morphology, maintains organic matter, and provides essential cover for salmonids. There are currently no target values established for the % occurrence of LWD.

Findings: Large Woody Debris measurements ranged from 0 to 64 in the surveyed streams of the Upper Subbasin. The average percent occurrence of LWD for the Upper Subbasin was 15.5. The dominant shelter type recorded in most stream reaches was boulders.

Cobble Embeddedness

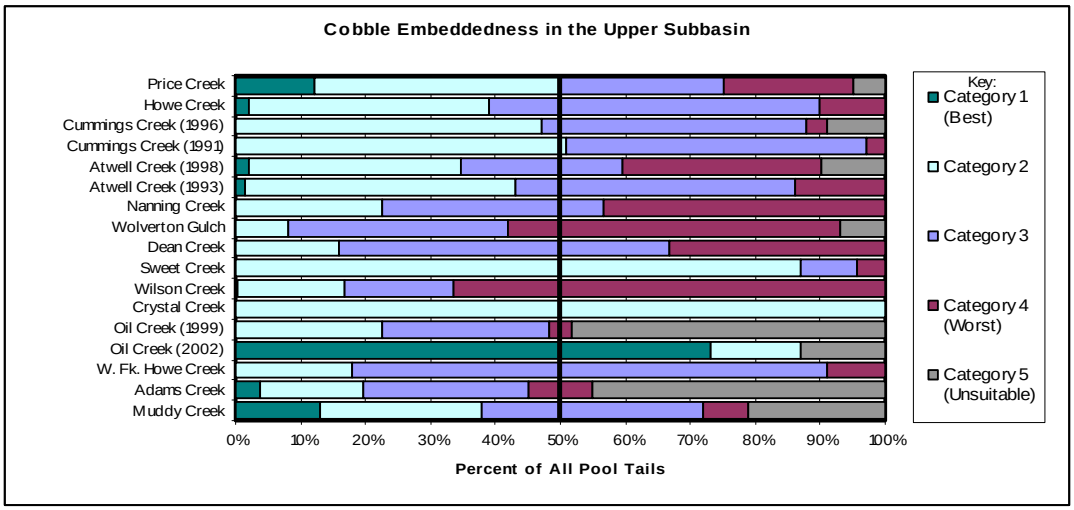

Figure 15. Cobble embeddedness categories as measured at every pool tail crest in surveyed streams in the Upper Subbasin.
Streams are listed in descending order by drainage area (largest at the top).

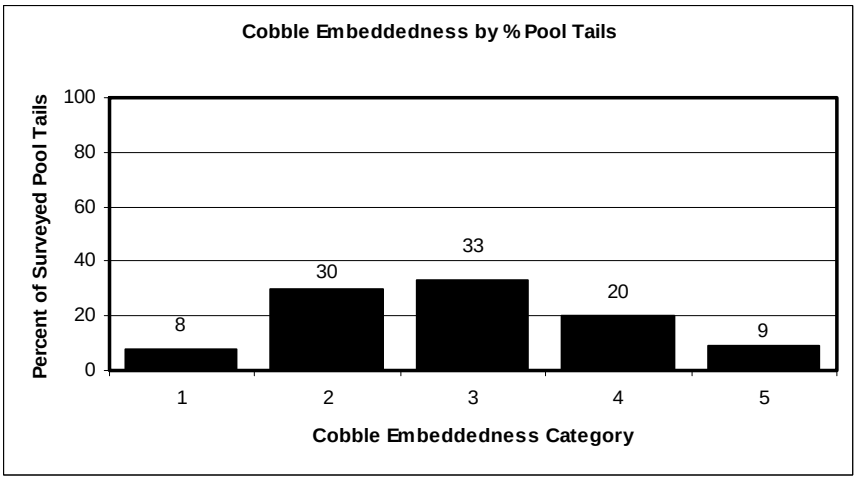

Figure 16. Cobble Embeddedness in the Upper Subbasin.
Cobble Embeddedness will not always sum to 100% because Category 5 (not suitable for spawning) is not included.

Significance: Salmonid spawning depends heavily on the suitability of spawning gravel; fine sediments decrease successful spawning and incubation. Cobble embeddedness is the percentage of an average sized cobble piece at a pool tail out that is embedded in fine substrate. Category 1 is 0-25% embedded, category 2 is 26-50% embedded, category 3 is 51-75% embedded, and category 4 is 76-100% embedded. Cobble embeddedness categories 3 and 4 are not within the fully supported range for successful use by salmonids.

Findings: Only Oil Creek (2002) met the target value for cobble embeddedness, with measurements reaching 73% in category 1. Embeddedness measurements also indicate suitable conditions in Crystal Creek and Sweet Creek, with 100% and 87% cobble embeddedness in category 2, respectively. Additionally, Price Creek, and Cummings Creek reached approximately 50% embeddedness in categories 1 and 2 in all surveys. The other surveyed streams indicated conditions that were unsuitable for successful salmonid spawning and incubation. For example, Wilson Creek had the highest value in category 4 at nearly 67%; approximately 83% of the surveyed stream was unsuitable for salmonids. Ninety-two percent of Wolverton Gulch carried unsuitable embeddedness measurements for salmonids, with 51% of its surveyed length falling in category 4.

The embeddedness measurements in Oil Creek 2002, which met the target value, are in stark contrast to the 1999 survey, when only 23% of the surveyed stream measured in categories 1 and 2. The other two creeks with multiple years of surveys, Atwell and Cummings Creeks, had similar results in both years.

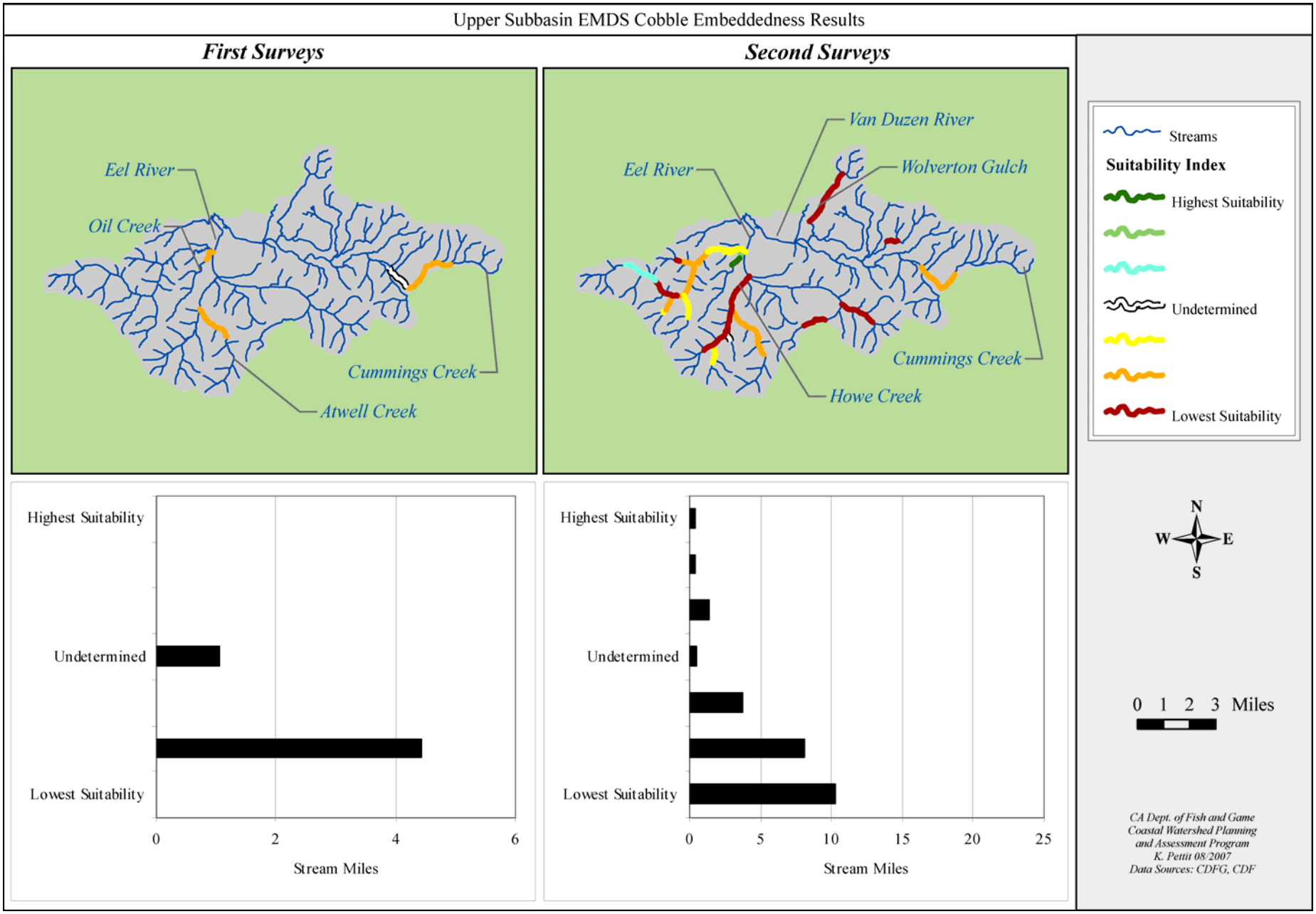

Figure 17. EMDS cobble embeddedness results for the Upper Subbasin by surveyed stream miles. First surveys of Cummings, Atwell, and Oil Creeks were completed in 1991,199, and 1999, respectively. Second surveys for the same creeks were completed in 1996, 1998, and 2002, respectively.

Water Quality

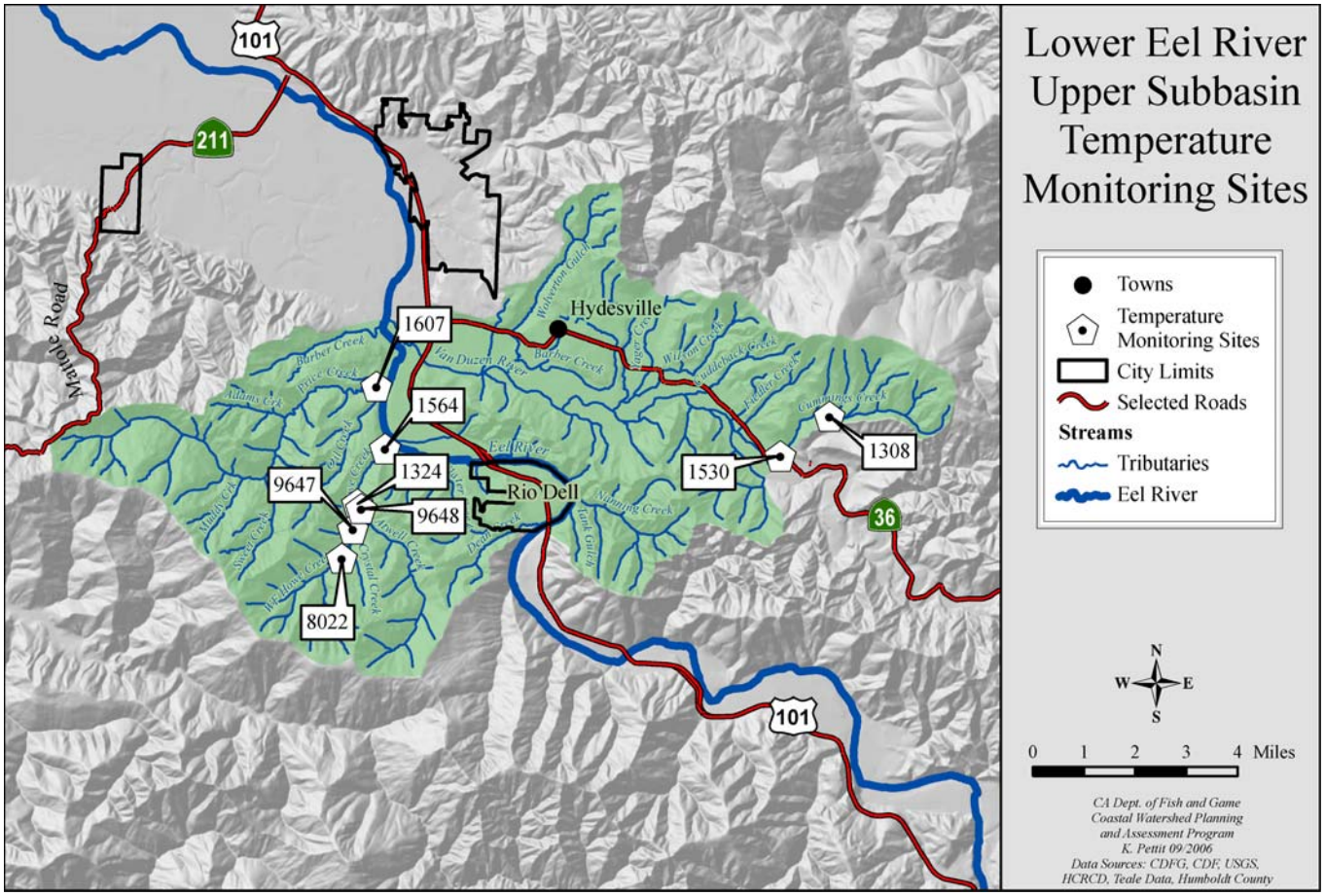

Figure 18. Locations of temperature monitoring sites in the Upper Subbasin.

Table 104. Maximum weekly average temperatures and maximum daily average temperatures collected in the Upper Subbasin.

Creek	Site	Max MWAT (°F)	MWAT Range (°F)	Max Daily Average (°F)	Years of Data
Fully Suitable (50-60°F)					
Cummings Creek	1530	60	59-60	61	4
Cummings Creek	1308	60	58-60	61	3
Howe Creek	8022	60	--	61	1
Somewhat Unsuitable (65°F)					
Howe Creek	9647	65	64-65	65	2
Moderately Unsuitable (66-67°F)					
Price Creek	1607	66	65-66	68	4
Howe Creek	1324	66	63-66	67	3
Howe Creek	1564	67	64-67	67	7

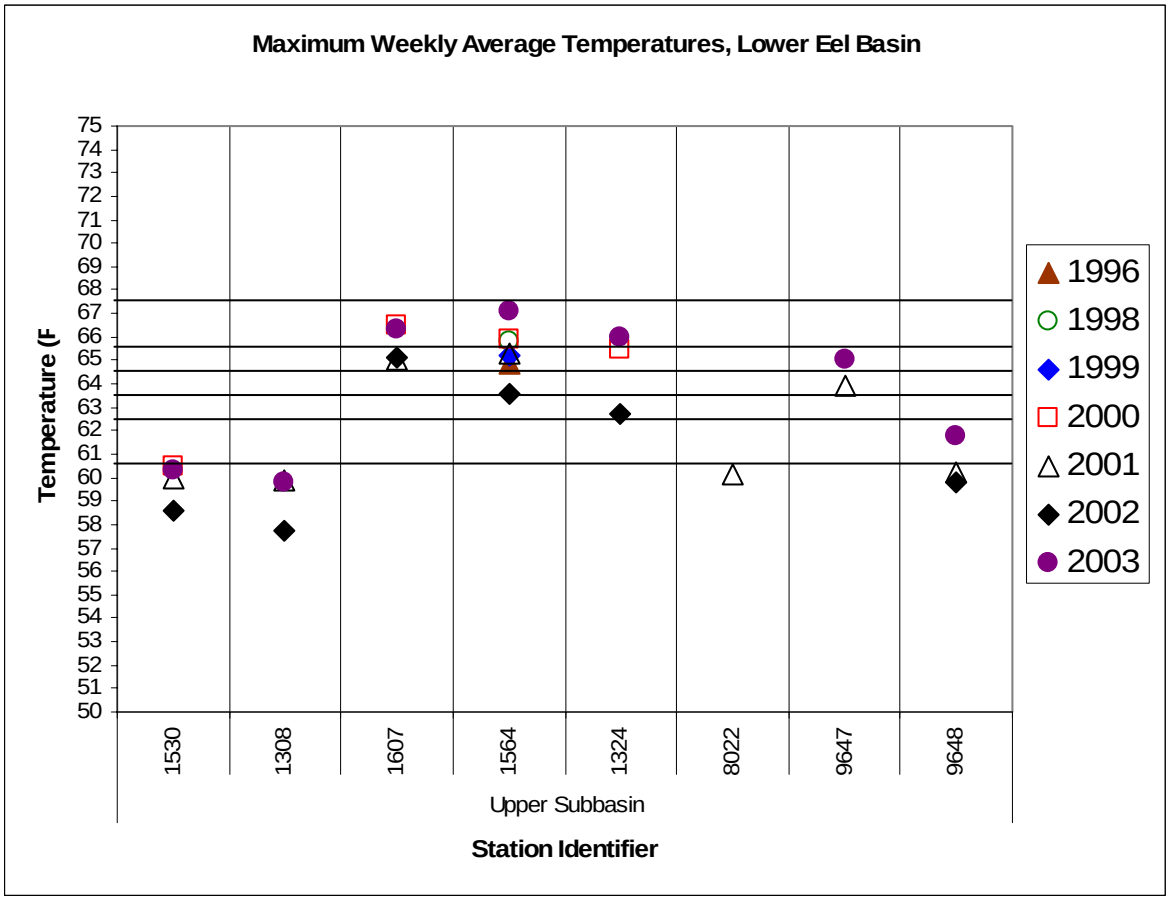

Figure 19. Maximum weekly average temperatures recorded at sites in the Upper Subbasin.

Significance: CWPAP considers suitability ratings for MWATs as: fully suitable at 50-60°F, moderately suitable at 61-62°F, somewhat suitable at 63°F, undetermined at 64°F, somewhat unsuitable at 65°F, moderately unsuitable at 66-67°F, and fully unsuitable at ≥68°F.

Findings: Eight locations within the Upper Subbasin were continuously monitored for water temperature (Figure 18). All temperature monitoring sites were located in tributaries, and no location recorded MWATs higher than 68°F, or seasonal maximum of over 75°F (Table 10, Figure 19). This subbasin had the highest number of locations with repeat sampling, at seven out of the eight sites. Additionally, the Howe Creek watershed had a total of 5 locations: four located on Howe Creek, and one on Atwell Creek.

Water temperatures were measured in Howe Creek over the longest period of record (one station recorded 7 years of data). Temperature monitors in this creek recorded MWATs that fell in several of the suitability categories. The only Howe Creek temperature monitor that measured MWATs considered fully suitable was deployed for one season only. This monitor was located the furthest upstream of any of the other three, which can explain its collection of cooler temperatures. The CDFG habitat inventory of Howe Creek confirms that canopy density increased in the upper reach of survey. The other Howe Creek monitoring sites (9647, 1324, and 1564 in order from upstream to downstream) recorded increasingly warmer temperatures, respectively. In general all sites were measured over the same months (June/July to September/October), which could support the view that these temperature differences are due to location along the stream from mouth to headwaters. However, as the sampling methodology of each location from year to year is not fully known, this comparison is difficult to confirm.

The Price Creek temperature monitor was also located close to the mouth of the stream, and logged MWATs that are considered moderately unsuitable.

Water Chemistry

Table 15. NCRWQCB water quality objectives for the Eel and Van Duzen Rivers (NCRWQCB 2006d, EPA 1999).

Parameter	Standard	
	Eel River	Van Duzen River
Dissolved Oxygen	Above 7.0 mg/L 100% of the time Above 7.5 mg/L 90% of the time Above 10.0 mg/L 50 % of the time);	Above 7.0 mg/L 100% of the time Above 7.5 mg/L 90% of the time Above 10.0 mg/L 50 % of the time)
Conductivity	Below 375 micromhos 90% of the time Below 225 micromhos 50% of the time	Below 375 micromhos 90% of the time Below 175 micromhos 50% of the time
Total Dissolved Solids	Below 275 mg/L 90% of the time Below 140 mg/L 50% of the time	Below 200 mg/L 90% of the time Below 100 mg/L 50% of the time
pH	Between 6.5 and 8.5	pH (between 6.5 and 8.5) (NCRWQCB 2006d)
Turbidity	Not applicable	Recommended at no greater than 20% above background levels (TMDL)

Significance: Water chemistry interacts with basic trophic levels affecting the production and availability of food for aquatic organisms. Nutrients are often limiting factors in the biological capacity of a stream yet a proper balance is needed to prevent eutrophication. Pollutants are a concern where they interfere with the biological function of aquatic organisms, or can be a threat to those that consume them. Large sources of nutrients and pollutants are commonly municipal and industrial wastewater facilities, storm runoff, and agricultural operations. Naturally occurring nutrients and heavy metals are often found in much smaller concentrations.

Findings:

Water Chemistry Studies:

The HCRCD studied water quality conditions in the Eel River in 1996 and 1997, including temperature and macro-invertebrate surveys. Macro-invertebrate communities are closely linked to water quality and are used to determine if a water body has been impacted and to what degree. Surveys were done once in the spring and once in the fall of 1996 on Price, Howe, and Cummings Creeks. Conditions of the macro-invertebrate communities generally improved on the fall survey due to seasonal changes. However, Price Creek had a high percentage of dominant taxa, a low Simpson Index rating, and a high Modified Hilsenhoff rating in both spring and fall, all of which put it in the “highly impacted” category.

Findings:

Wastewater Facilities:

While the Fortuna wastewater treatment facility discharges the highest volume of effluent in the Lower Eel River Basin, the cumulative discharge volume of the adjacent Rio Dell and Scotia wastewater treatment facilities in the Upper Subbasin is substantial. These facilities discharge into the Eel River between October 1st and May 14th, and during the summer they discharge effluent into gravel bar percolation ponds. Both have recently been re-permitted with stipulated alterations and upgrades.

The wastewater treatment facility in Scotia, owned by Humboldt Redwood Company (formerly Pacific Lumber), is permitted to discharge up to 0.7 mgd of effluent into the Eel River during winter months. The treatment system consists of screening, grinding, and grit removal, a primary clarifier, a redwood trickling filter, a secondary clarifier, a chlorine contact chamber, three treatment/polishing ponds, and a sludge digester. A Cease and Desist order was issued in 2006 for not removing 85% of suspended solids and biological oxygen demand (BOD) from influent. The influent had become dilute, making removal of 85% of suspended solids and BOD difficult. Under its new permit, the Scotia facility is required to conduct a "special study" to determine if effluent is moving from the percolation ponds on the Eel River gravel bar to the Eel River itself, and if so, the permit requires alternative action. This has already been shown to occur just downstream at the Rio Dell facility, so, in all likelihood, Scotia will need to find a new discharge site for its summer time effluent. Humboldt Redwood Company will have until 2010 to resolve the issues addressed in their new permit (NCRWQCB 2006a, 2006b).

In their Eel River Watershed Management Area document, the Water Board states that Scotia has "a municipal runoff problem and Humboldt Redwood Company has a permitted ash dump where Regional Water Board staff is currently taking action. There are also upland and in-stream quarries near Scotia that need investigation" (NCRWQCB 2005b).

The Rio Dell wastewater treatment facility serves the City of Rio Dell and is located at 475 Hilltop Drive in Rio Dell on the banks of the Eel River, and east of Highway 101. This facility is permitted to discharge up to 0.9mgd of effluent to the Eel River during winter months. The facility provides collection, sedimentation, biological treatment using rotating biological contactors, disinfection, and dechlorination of wastewater. Between May 15th and September 30th, the facility discharges effluent into a percolation pond, approximately 100 feet wide by 300 feet long on a thin gravel bar underlain by clayey soils. This design has allowed effluent to surface on the gravel bar and discharge directly into the river (NCRWQCB 2005a). Stipulations of the new permit require compliance with priority pollutant limitations for effluent. There are 126 priority pollutants recognized as having heightened detrimental effects on humans and aquatic organisms, four of these are a concern at this facility – copper, cyanide, dichlorobromomethane, and MtBE (a gasoline additive) (NCRWQCB 2007, Lisa Bernard personal comm.). According to the The City of Rio Dell website (http://www.riodellcity.com/home.html) the city has completed all the required environmental documents and are continuing to move forward with improvement projects to address all issues concerning the NCRWQCB's Cease and Order by achieving priority pollutant compliance.

Fish Passage Barriers

Potential fish passage barriers, specifically stream crossings were surveyed in the Upper Subbasin as a part of the coastal Humboldt County culvert inventory and fish passage evaluation conducted by Ross Taylor and Associates (2001) (Table 11). Criteria for priority ranking included salmonid species diversity, extent of barrier present, culvert risk of failure, current culvert condition, salmonid habitat quantity, salmonid habitat quality, and a total salmonid habitat score.

As a part of this inventory five stream crossing were evaluated in the Upper Subbasin. Two of these crossings are in the Barber Creek (Eel River) drainage: one at Grizzly Bluff Road and the other at Price Creek School Road. These both ranked in low-priority (#56, and 57 out of 67) for restoration work. The Grizzly Bluff Road culvert has a high jump from the culvert through the inlet and may be have velocity barriers within the culvert. The Price Creek School Road culvert is in poor condition and inadequately sized. This crossing is upstream of the box culvert and is a nearly complete barrier to juvenile fish due to velocity. There is also a six foot tall vertical concrete falls 100 yards upstream from the mouth of Barber

Creek (Eel) that poses a barrier to fish passage (CDFG 1973). However, the channel does have small steps in it that should allow adult salmonids access (CDFG 2007).

The other three crossings evaluated in the inventory are in the Wolverton Gulch draingage: two on River Bar Road and one on Rohnerville Road. All ranked low in priority (#48, 49, and 67 out of 67) for restoration work (CDFG 2005). The two most downstream culverts on Wolverton Gulch are most likely not barriers for migrating adult salmon; however the most downstream culvert is probably a barrier to juvenile salmonids. The most upstream culvert is not a barrier for adult salmon, but this culvert along with the upper downstream culvert is temporary barriers to juveniles due to velocity.

Additional fish passage problems on Upper Subbasin streams have been identified. Price Creek has several temporary small rock dams that have been constructed to facilitate water diversion (CDFG 1999). These dams block upstream and downstream migration by juvenile salmonids at observed flows. Furthermore, if the material forming the dams is too large, then it may impede salmonid spawning by covering pool tail-outs with particles that are either too large to be used as spawning substrate or are too large to be removed by typical autumn stream flows prior to the upstream migration by adult salmon.

The mouths of Dean, Cummings, and Fiedler Creeks have poor access for migrating adult salmon (CDFG 1992, 1996). There is a bedrock chute at the mouth of Dean Creek that poses a partial salmonid barrier (CDFG 2005).

A concrete box culvert where Blue Slide Road crosses Oil Creek may pose a fish passage barrier. Biological sampling conducted during the inventory of 2002 found coho salmon below but not above this culvert. Blue Slide Road also crosses Slater Creek, and this culvert is a total salmonid barrier (CDFG 2005). Other suspected passage problems occur at a culvert at stream mile 0.6 of Adams Creek (CDFG 2002).

Highway 36 crosses Barber, Fischer, and Wilson Creeks and an unnamed tributary to the Van Duzen River. All of these culverts were found to be partial barriers to salmonids (CDFG 2005).

Sometimes, large debris accumulations in streams can cause fish passage barriers. These are noted in CDFG stream inventories. Stream inventories in the Upper Subbasin found possible problems of this sort on Adams, Atwell, West Fork Howe, Dean, Nanning and Cummings Creeks and Wolverton Gulch.

Table 16. Culverts surveyed for barrier status in the Upper Subbasin (Taylor 2001).

Stream Name	Road Name	Priority Rank	Barrier Status	Upstream Habitat
Barber Creek (Eel)	Grizzly Bluff Road	56	Very high jump, lack of depth and possible velocity barriers within culvert.	Approximately 2.8 miles of poor salmonid habitat.
	Price Creek School Road	57	Not a barrier for adults. Nearly a complete barrier for juveniles due to excessive velocities over a wide range of migration flows.	Approximately 1.8 miles of likely poor salmonid habitat.
Wolverton Gulch	River Bar Road	48	Probably not a barrier for adults. Probably a barrier to juveniles due to excessive velocities at a range of migration flows.	Approximately 3.8 miles of poor salmonid habitat.
	River Bar Road	49	Probably not a barrier for adults. Temporary barrier to juveniles due to excessive velocities at the upper range of migration flows.	Approximately 3.8 miles of poor salmonid habitat.
	Rohnerville Road	67	Not a barrier for adults. Probably a temporary barrier to juveniles due to excessive velocities at the upper range of migration flows.	Approximately 2.7 miles of fair salmonid habitat.

Habitat Conclusions

Streams surveyed before 1990 and habitat inventories from 1991 to 2002 were compared to indicate changes between historic and current conditions. Data from older stream surveys provide a snapshot of the conditions at the time of the survey. Terms such as excellent, good, fair, and poor are based on the judgment of the biologist or scientific aid who conducted the survey. The results of historic stream surveys are qualitative and cannot be used in comparative analyses with quantitative data provided by habitat inventory surveys with any degree of accuracy. However, the two data sets can be compared to show general trends.

Where habitat data were available from both older stream surveys and recent stream inventories it appeared that habitat conditions degraded in five of

the eight streams (Table 17). Spawning habitat, pool habitat, and shelter decreased in Cummings and Sweet creeks while pool habitat and shelter decreased in Howe Creek. Pool habitat decreased in Wolverton Gulch and spawning habitat decreased in Atwell Creek.

Instream habitat conditions were generally poor in this subbasin at the time of more recent CDFG surveys (late 1990s and early 2000s). Surveyed reaches fell below target values and were evaluated as unsuitable for salmonids by EMDS for nearly all habitat characteristics, except canopy density (Table 18). The only exception occurring in Oil Creek, where embeddedness achieved a suitable rating in 2002 (pool shelter was rated suitable in 1999 but not during the 2002 survey). Pool quality and pool depth values were calculated to be the lowest suitability in 15 of the 17 surveys. Moreover, the majority of streams contained the lowest or next to lowest suitability rating for pool shelter and embeddedness.

These habitat factors are likely limiting factors to the salmonid populations in nearly all the surveyed streams within the subbasin. High sediment loads in these streams results in decreased pool size, shallow pool depths and highly embedded spawning areas.

Canopy density was suitable on all surveyed streams except for Sweet, Howe, and Price Creeks. Accordingly, water temperatures were found to be unsuitable for salmonids in Howe, Price Creeks, and Cummings Creek. Water temperature is likely a limiting factor for salmonids at these locations. It is important to note that current canopy density measurements do not take into account differences between smaller, younger riparian vegetation versus the larger microclimate controls that are provided by old and second growth forest canopy conditions.

Oil, Atwell, and Cummings Creeks have two years of survey data. Because these surveys are not replicates, they cannot be used to quantitatively compare values between years. However, these surveys do have some overlap in area. Comparison of these survey data can, therefore, provide some description of changes in habitat between years. For example, pool shelter for Oil Creek in 1999 is considered suitable, however, in 2002 these values fall to unsuitable levels. Embeddedness values in this same stream were unsuitable in 1999 and suitable in 2002.

Although macroinvertebrate data indicate that Price Creek is a highly impacted system, there is not enough data to determine whether water chemistry is a limiting factor in tributaries in this subbasin. Additionally, the NCRWQCB has identified several concerns at the Scotia and Rio Dell wastewater treatment plants, but no specific data exists to determine if water chemistry is impacting salmonids in the mainstem Eel River.

Table 17. Comparison between historic habitat conditions with current habitat inventory surveys in the Upper Subbasin.

Stream	Canopy Cover		Spawning Conditions		Pool Depth/Frequency		Shelter/Cover		Summary of Changes from Historic to Current
	Historic	Current	Historic	Current	Historic	Current	Historic	Current	
Wolverton Gulch	ND	Fully suitable	Poor	Fully unsuitable	2 to 3 feet deep	Fully unsuitable	ND	Fully unsuitable	Pool habitat decreased
Cummings Creek	ND	Suitable	Good	Unsuitable	Good	Fully unsuitable	Good	Fully unsuitable	Spawning habitat, pool habitat, and shelter decreased
Price Creek	ND	Unsuitable	ND	Unsuitable	Fair	Fully unsuitable	Fair	Fully Unsuitable	Pool habitat and shelter remained similar
Sweet Creek	ND	Unsuitable	Good	Unsuitable	Good	Fully unsuitable	Good	Fully Unsuitable	Spawning habitat, pool habitat, and shelter decreased
Oil Creek	ND	Fully suitable	Good	Suitable	3 inches deep	Unsuitable	ND	Fully Unsuitable	Habitat remained similar
Howe Creek	ND	Unsuitable	ND	Unsuitable	Good	Fully unsuitable	Good	Fully unsuitable	Pool habitat and shelter decreased
Atwell Creek	Averaged 80%	Suitable	Numerous	Unsuitable	ND	Fully unsuitable	ND	Fully unsuitable	Spawning habitat decreased
Nanning Creek	85% canopy	Suitable	15% gravel substrate	Fully unsuitable	1 inch to 1 feet deep	Fully unsuitable	ND	Fully Unsuitable	Habitat remained similar

*ND is no data available
Where multiple years of historic streams surveys were available, the oldest surveys were used.

Table 18. EMDS reach condition results for the Upper Subbasin.

Stream	Year	Canopy	Pool Quality	Pool Depth	Pool Shelter	Embeddedness
Muddy Creek	2002	++	---	---	--	-
Adams Creek	2002	+++	---	---	---	--
West Fork Howe Creek	1998	+++	---	---	---	---
Oil Creek	1999	++	--	--	++	--
	2002	+++	--	--	--	++
Crystal Creek	2002	++	---	---	--	U
Wilson Creek	1991	+	---	---	---	---
Sweet Creek	1999	-	---	---	--	-
Dean Creek	1992	+++	---	---	--	---
Wolverton Gulch	1997	+++	---	---	---	---
Nanning Creek	1992	+	---	---	-	---
Atwell Creek	1993	+++	---	---	--	--
	1998	++	---	---	---	--
Cummings Creek	1991	++	---	---	-	-
	1996	++	---	---	---	--
Howe Creek	1998	--	---	---	---	--
Price Creek	1999	--	---	---	--	--
Upper Subbasin		+	---	---	--	--

Key: +++ = Highest Suitability U = Insufficient Data or Undetermined - - - = Lowest Suitability

Restoration Projects

Far more restoration activity has been done in the Upper Subbasin than the other subbasins in the Lower Eel Basin. To date, 117 projects have been completed and another sixty are on-going. The three most common types of restoration projects are road and stream crossing upgrades, bank stabilization and livestock riparian exclusion, followed closely by installation of instream structures for the creation of complex habitat. Projects have been spread relatively evenly over the subbasin with a concentration in the Howe and Price Creeks basins largely related to the Howe Creek Ranch acquisition and conservation project. Specific projects are listed below along with an approximate number of that type of project (many projects have more than one component so these numbers may be an underestimate).

- Sediment and temperature improvement projects on the Van Duzen River conducted by the HCRCD;
- Erosion assessment on Carlotta tract of the Van Duzen River;
- Water quality control via animal waste improvement projects;
- Temperature and macro-invertebrate monitoring by HCRCD;
- The lower 10.5 miles of the Van Duzen River were flown to assess restoration potential and identify watershed problems;
- Barber Creek riparian planting;
- Yager Creek bank stabilization projects including boulder weir and willow mattresses (6 projects);
- Boulder and bio-engineered bank stabilization on the Van Duzen River (5 projects);
- Erosion assessment on Simpson Timber Company land in the Fiedler, Cuddeback, and Wilson Creek watersheds;
- "Salmon in the Classroom" curriculum at Hydesville, Cuddeback, and Rio Dell elementary schools.

Wolverton Gulch:

- Upslope management with tree planting and back stabilization;
- Barber Creek riparian vegetation restoration and livestock crossing upgrades (1,700ft on Wolverton Gulch and 300ft on Barber Creek);
- Fish passage improvement.

Cummings Creek:

- Instream structures and bank stabilization;
- Interpretive information and trail;
- Basin wide upstream erosion and prevention assessment and watershed planning;
- Road decommissioning and relocation;
- Road decommission monitoring;

- Stream crossing upgrades.

Price Creek watershed (including Grouse, Muddy, and Sweet Creeks):

- Livestock exclusionary fencing (9 projects) and riparian planting (3 projects);
- Off stream watering sites (8 projects);
- Storm proofing roads including an inner gorge roadway and road decommissioning and stream crossing upgrade or decommissioning (30 projects);
- Ortho-imaging for watershed planning;
- Salmon Limiting Factors assessment and restoration priorities for two ranches;
- Bank stabilization and instream structures (10 projects);
- Baffles installed on a culvert on Oil Creek;
- Stream crossing decommissioning on Sweet Creek.

Howe Creek watershed (including Crystal and Refuge Creeks):

- Bank stabilization (7 projects) and instream structures and maintenance (12 projects);
- Land acquisition for resource conservation;
- Livestock exclusionary fencing (15 projects) and tree planting (6 projects);
- Off stream watering sites (4 projects);
- Improve temporary stream crossings and culverts (7 projects) and storm proofing roads, stream crossings (14 projects);
- Culvert inventory;
- Livestock trail hardening (3 projects);
- Fish passage improvement.

More information such as date and specific location can be found on CalFish (www.calfish.org) or on the Natural Resources Project Inventory online database (www.ice.ucdavis.edu/nrpi/).

Two large scale restoration efforts have been conducted, one in Cummings Creek watershed and the other on Howe Creek Ranch which encompasses portions of both Howe Creek and Price Creek. The Cummings Creek Watershed Recovery Plan developed in 1996 out of a situation where a primary access road next to the creek had failed. In the interest of the residents' safety and the health of Cummings Creek, a watershed assessment was conducted to look at old logging roads and other sediment sources. Appropriate solutions were implemented through the Cummings Creek Watershed Advisory Council. In addition to the components in the list above, the creek was surveyed by CDFG for salmonid habitat twice and for spawning activity over several years. In 2000, turbidity and temperature stations were installed as well as permanent photo points and cross sections for monitoring purposes (Matson 2000).

The Howe Creek Ranch was bought from the Hackett family by a land trust, with the help of CDFG and the State Coastal Conservancy, with a permanent conservation easement in place. This allowed this 4,400 acre ranch to adopt Best Management Practices and create conservation enclaves. The goals of the easement include aquatic habitat restoration, upslope and riparian erosion control, and riparian protection via livestock exclusionary fencing and timber harvest buffers, while still maintaining a ranching and timber harvest economy. This experimental and progressive approach will hopefully become established throughout the region as a way to ensure future protection of aquatic resources.

Integrated Analysis

Analysis of Tributary Recommendations

In addition to presenting habitat condition data, all CDFG stream inventories provide a list of recommendations that address those conditions that did not reach target values (see the Fish Habitat section of this subbasin). A CDFG biologist selected and ranked habitat improvement recommendations for 17 surveys in the Upper Subbasin (Table 19). The tributary recommendation process is described in more detail in the Synthesis section of the Basin Profile.

In order to compare tributary recommendations within the subbasin, the recommendations of each stream were collapsed into five target issue categories (Table 20). The top three recommendations of each stream are considered to be the most important, and are useful as a standard example of the stream. When examining recommendation categories by number of tributaries, the most important target issue in the Upper Subbasin is Erosion/Sediment.

However, comparing recommendation categories in the subbasin by number of tributaries can be

confounded by the differences in the length of survey for each tributary. Therefore, the number of stream miles within the Upper Subbasin assigned to various recommendation categories was calculated (Figure 20). By examining recommendation categories by number of stream miles, the most important target issue remains Erosion/Sediment. Instream Habitat and Riparian/Water Temp are also in the top tier of recommended improvement activities. Because of the high number of recommendations dealing with these target issues, high priority should be given to restoration projects that emphasize sediment reduction, riparian vegetation planting, pools, and cover.

Table 19. Occurrence of stream habitat inventory recommendations for streams of the Upper Subbasin.

Stream	Survey Length (mile)	Bank	Roads	Canopy	Temp	Pool	Cover	Spawning Gravel	LDA	Livestock	Fish Passage
Muddy Creek	0.8		3			1	2				
Adams Creek	0.8	3	4			1	2	5	6		7
West Fork Howe Creek	0.4	4	5			3	2	1			
Oil Creek (1999)	0.5	1	2			4			3		
Oil Creek (2002)	0.8						2				1
Crystal Creek	0.5			2	1						
Wilson Creek	0.5	2			1	3	4				5
Sweet Creek	0.9	1		2		3	4				
Dean Creek	1.0	3	4			1	2		5		6
Wolverton Gulch	2.5	1	2			4	3	5	6	7	
Nanning Creek	1.4					2	1		3		
Atwell Creek (1993)	1.6	1				3	4		2		
Atwell Creek (1998)	2.4	1	2	5		3	4		6		
Cummings Creek (1991)	3.4	2	3			1	4		5		
Cummings Creek (1996)	2.0	2	1	5		4			3		
Howe Creek	4.0	1	2	5		3	4		6	7	
Price Creek	6.9	3	4	1		5	6			2	7

Table 120. Top three ranking recommendation categories by number of tributaries in the Upper Subbasin.

Upper Subbasin Target Issue	Related Table Categories	Count
Erosion / Sediment	Bank / Roads	19
Riparian / Water Temp	Canopy / Temp	5
Instream Habitat	Pool / Cover	18
Gravel / Substrate	Spawning Gravel / LDA	5
Other	Livestock / Barrier	2

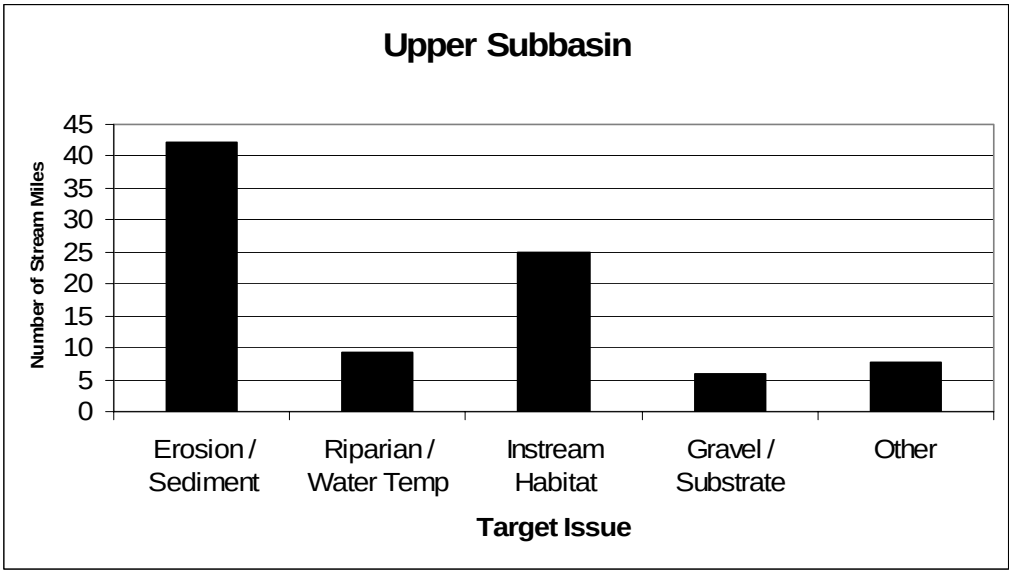

Figure 20. Recommendation target issues by stream miles for the Upper Subbasin.

Refugia Areas

The interdisciplinary team identified and characterized refugia habitat in the Upper Subbasin by using professional judgment and criteria developed for north coast watersheds (Table 27). The criteria included measures of watershed and stream ecosystem processes, the presence and status of fishery resources, forestry and other land uses, land ownership, potential risk from sediment delivery, water quality, and other factors that may affect refugia productivity. The team also used results from information processed by the EMDS at the stream reach scale.

The most complete data available in the Upper Subbasin were for tributaries surveyed by CDFG. However, many of these tributaries were still lacking data for some factors considered. Salmonid habitat conditions in the Upper Subbasin on surveyed streams are generally rated as medium potential refugia.

In the Van Duzen River tributaries, no stream received a refugia ranking high than medium potential. Four streams received this ranking and two streams were rated as low quality refugia. Half of the streams were considered data limited.

In the Eel River tributaries, Oil Creek was the only stream that ranked as high potential refugia and is considered the best salmonid habitat in this subbasin. The remaining streams were split between the medium potential and low quality refugia categories. The Howe Creek watershed contained all streams with medium potential, while the Price Creek watershed contained all streams with a low quality rating. Nearly all the Eel River tributaries that were evaluated were also considered data limited. The following refugia area rating table summarizes subbasin salmonid refugia conditions.

Table 21. Tributary salmonid refugia ratings in the Upper Subbasin.

Stream	Refugia Categories				Other Categories		
	High Quality	High Potential	Medium Potential	Low Quality	Non-Anadromous	Critical Contributing Area	Data Limited
Van Duzen Tributaries							
Barber Creek				x			x
Wolverton Gulch			x				
Wilson Creek			x				
Cuddeback Creek				x			x
Fiedler Creek			x				x
Cummings Creek			x				
Eel River Tributaries							
Barber Creek				x			x
Price Creek				x			
Unnamed tributary (Adams Creek)				x			x
Sweet Creek				x			x
Muddy Creek				x			x
Oil Creek		x					x
Howe Creek			x				Needs resurvey
Atwell Creek			x				
Unnamed tributary (Crystal Creek)			x				x
West Fork Howe Creek			x				x
Nanning Creek			x				x
Dean Creek			x				x

Key Subbasin Issues

- Sediment level in streams is high and creates a multitude of problems for fish habitat;
- Gravel mining practices have created a seasonal fish passage barrier at the mouth of the Van Duzen River that requires mitigation to prevent stranding of adult fish during fall migration;
- Accessibility to habitat is potentially blocked at various points in the subbasin;
- Urban and agricultural wastewater disposal poses a problem to aquatic ecosystems in the Mainstem Eel River;
- Water temperatures are stressful to salmonids in Mainstem Van Duzen and Eel Rivers and are unsuitable in some tributaries;

Responses to Assessment Questions

What are the history and trends of the sizes, distribution, and relative health and diversity of salmonid populations in the Upper Subbasin?

Findings and Conclusions:

- The Upper Subbasin has more tributaries and more streams sampled than the other Lower Eel subbasins. Stream inventories conducted by the CDFG on fourteen tributaries between 1991 and 2002, as well as other fish sampling data have documented the presence of Chinook, coho, and steelhead. Historical recorded data show that these salmonid species were being collected in fish rescue operations in the early 1940s;
- Prior to 1990, coho salmon were found in Wolverton Gulch, Cuddeback, Fiedler, Cummings, and Howe creeks. Since 1990, they have been detected in Cummings, Oil, Howe, and Atwell Creeks;
- Chinook spawning has been observed in Wilson, Cuddeback, Fiedler, Cummings, Price, and Atwell Creeks in recent years;
- Steelhead trout were historically found in 13 creeks. In recent years, steelhead and have been detected in ten streams: Wolverton Gulch, Wilson, Cummings, Price, Oil, Howe, West Howe, Atwell, Nanning, and Dean Creeks.
- Sacramento pikeminnow, which were first reported in the mainstem Van Duzen in 1988, have been observed in tributaries throughout the subbasin since the late 1980s (Brown and Moyle 1988);

What are the current salmonid habitat conditions in the Upper Subbasin? How do these conditions compare to desired conditions?

Findings and Conclusions:

<u>Flow and Water Quality:</u>

- Water quality is being impacted by cattle that have direct access to streams;
- The cumulative discharge volume of the Rio Dell and Scotia wastewater treatment facilities is substantial. These facilities discharge into the Eel River between October 1st and May 14th, and during the summer they discharge effluent into gravel bar percolation ponds. Both have recently been re-permitted with stipulated alterations and upgrades;
- Low summer flows may be stressful to salmonids, and dry or intermittent reaches on the Van Duzen River seasonally prevent connection to the Eel River;
- Turbidity levels are high during winter rains, which correspond to salmon spawning season.

Erosion/Sediment:

- Excessive sediment in stream channels has resulted in an overall loss of spawning, rearing, and feeding habitat for salmonids. High sediment levels are confirmed by embeddedness measurements in surveyed reaches;
- The Van Duzen River is usually isolated from the Eel River in late summer and early fall due in part to increased bedload deposition at the confluence;
- Livestock have unrestricted access to many tributaries, resulting in stream bank erosion;
- Soils (and bedrock) in streams of the Upper Subbasin are prone to erosion, and slides and streambank failures have been observed to contribute fines to the streams.

Riparian Condition/Water Temperature:

- Canopy cover is poor throughout the basin, and does not meet the target value of 80% coverage in eight of the 17 surveys of the subbasin. What canopy is available over streams is primarily made up of deciduous vegetation, as opposed to historically present coniferous vegetation;
- A 1998 study done by Humboldt County RCD showed maximum weekly temperatures above 20 degrees Celsius (68 degrees Fahrenheit) in the Eel River at the confluence with the Van Duzen River from July 1st through mid September, 1996, as well as in the Van Duzen River at the 101 bridge during that same timeframe;
- Sites monitored in Howe and Price Creeks in were found unsuitable, recording maximum weekly temperatures above 65 degrees Fahrenheit in June through October over several years.

Instream Habitat:

- High quality salmonid habitat is lacking in all surveyed reaches of the Upper Subbasin streams, and is evidenced by the low percentage of overall pool habitat by surveyed stream length, the high percentage of shallow pools and low levels of pool shelter cover;
- None of the surveyed streams met target values of pool depth. More shallow pools by survey length were encountered in this subbasin than in the Middle Subbasin;
- Lack of adequate pool shelter is a widespread issue in the subbasin. Every stream surveyed in this subbasin with the exception of Oil Creek has pool shelter values that were below suitable and none met target values. Sedimentation of coarse material can affect recruitment of large woody debris, and both fine and coarse sediment can fill in hiding places around shelter components such as boulders and logs;
- Limited historic stream surveys, prior to the impacts of extensive land use activities and the floods of 1955 and 1964, generally indicated good spawning and pool conditions, except for fair conditions on Price Creek.

Gravel/Substrate:

- Substrate embeddedness was very high on Wolverton Gulch, Wilson Creek, Dean Creek, Nanning Creek, and Westfork Howe Creek. With the exception of Oil Creek, all streams surveyed were poorly suited for spawning.

Refugia Areas:

- Salmonid habitat conditions on surveyed streams are generally rated as medium potential refugia. Oil Creek provides the best salmonid habitat of Eel River tributaries and was the only stream in the subbasin that received a high potential rating;
- Medium potential refugia areas that drain into the Eel River include Howe Creek and its tributaries, Nanning Creek and Dean Creek;
- Four out of the six tributaries of the Van Duzen River received a medium potential refugia category

rating. In general, the tributaries located in the eastern portion Van Duzen study area provided the best potential refugia of the Van Duzen tributaries.

Barriers and Other Habitat Issues:

- The mouth of the Van Duzen River, if left alone, creates a barrier to adult fish passage due to its broad, braided and shallow low flow channel. Cooperation between the CDFG and local gravel mining companies has led to the seasonal installation of high gradient "barrier" culverts which prevents adult salmon from entering the Van Duzen River and getting stranded in low flow conditions until higher flows supersedes the need for the culverts;
- Log debris accumulations occur on Cummings, Dean, Atwell, West Fork Howe, Adams, and Nanning Creeks, and Wolverton Gulch;
- Culverts on Adams and Oil Creeks may be barriers to fish passage;
- Barber Creek and Wolverton Gulch each contain several road crossings that are not problematic for adult fish, however, they are barriers for juvenile salmonid passage;
- Rock dams occur on Price Creek and may pose as barriers to fish passage;
- The mouth of Dean Creek is a perched sediment delta and potentially acts as a barrier to fish passage;
- Connectivity at the mouths and lower reaches of Feidler and Cummings Creeks and Wolverton Gulch may be an issue due to sedimentation.

What are the impacts of geologic, vegetative, fluvial, and other natural processes on watershed and stream conditions?

Findings and Conclusions:

- Soils and bedrock of the Upper Subbasin are easily eroded;
- The two most common geologic formations in this subbasin are the Wildcat Formation, which is comprised of uniformly fine sediment and is highly erosive, and the Coastal Belt Melange Formation, which is even more erosive but contains a wide range of sediment sizes from boulders to silt;
- Soils of the Upper Subbasin are susceptible to erosion, and slides from the stream banks and roads have been observed to contribute fines to the stream;
- Filling of pools by sediment is an issue in every creek surveyed in this subbasin. The majority of streams were of the lowest suitability in terms of pool depth and frequency;
- Uplift has increased the erosion potential of the area;
- Rapid incision rates of the mainstem and its tributaries have left very steep, high banks which increase its likelihood for rockfalls and landslides;
- Frequent landslides especially during heavy storm events and/or seismic events contribute a significant amount of fine sediments to the stream;
- Several faults cut through this basin weakening bedrock and increasing the potential for seismic triggering of landslides;
- Stream banks become saturated during seasonal heavy precipitation, and are extremely vulnerable to sliding during prevalent earthquakes;
- Kelsey (1977) posits that the Van Duzen River has aggraded significantly since the 1964 flood upstream of, but likely applying to this study area;
- Climatic models predict warmer summers and milder winters, which would have an effect on stream flows (less summer flows), stream water temperatures (higher water temperatures), and water quality (reduced water quality). Any combinations of these factors would be detrimental to portions of the salmonid life cycle.

How has land use affected these natural processes?

Findings and Conclusions:

- Seasonal flooding is increasingly common throughout this subbasin. Disturbance of the basin's already unstable soils by land use activities has altered runoff rates;
- In 2003, Rio Dell's wastewater treatment facility received a 'cease and desist' order from the Regional Water Quality Control Board for problems arising from sludge removal and summer discharge into the Eel River through gravel bar percolation. The city has completed all the required environmental documents (2009) and is continuing to move forward with improvement projects to address all issues concerning the NCRWQCB's Cease and Order by achieving priority pollutant compliance.
- Livestock grazing operations occur in 11% of subbasin. Wastes from the beef and dairy cattle industry have affected the water quality of many of the subbasin's streams;
- Bar skimming had been the preferred method of gravel extraction on the Lower Van Duzen River up until 1996. This method has been shown to widen channels thus creating a shallow, braided reach;
- In 2001, 136 adult migrating Chinook salmon were stranded at the mouth of the Van Duzen River likely exacerbated by years of widening of the low flow channel from gravel mining and aggradation;
- Since 2003, the lower four miles of the Van Duzen River are purposefully blocked to salmonids by three temporary culverts. A single threaded channel is also dug through the lower stranding reach. This ensures that migrating adult salmonids do not get stranded in the shallow water conditions that exist until rains have created sufficient flows for upstream passage;
- The building of roads throughout the subbasin has created fish passage barriers in some of the tributaries of the Van Duzen River and Eel River (see Barriers and Other Habitat Issues);
- Logging has occurred (1989-2005) in both the Wildcat Formation and the Coastal Belt Melange Formation. Some areas have been entered more than once, and different yarding and harvesting methods have been used across the subbasin; these methods influence the impact logging can make on a watershed;
- Riparian vegetation has been cleared through past timber harvest activities. Canopy cover over surveyed streams of this basin was predominantly composed of deciduous vegetation. Smaller trees adjacent to streams result in a reduction in the recruitment potential of large woody debris.

Based upon these conditions trends, and relationships, are there elements that could be considered to be limiting factors for salmon and steelhead production?

Findings and Conclusions:

Based on available information for this subbasin, it appears that salmonid populations are limited by:

- Low summer flows;
- Fish passage barriers;
- High levels of fine sediments in streams;
- Loss of habitat area and complexity;
- A shortage of areas with suitable spawning gravel in tributaries;
- High summer water temperatures;
- Competition with Sacramento pikeminnow.

What watershed and habitat improvement activities would most likely lead toward more desirable conditions in a timely, cost effective manner?

Barriers to Fish Passage:

Table 2132. Recommended actions for correcting barriers to fish passage.

Streams	Recommended Actions XXX: Highest Priority			
	Continue efforts to identify and alleviate fish passage impediments at culverts or other road crossings.	Improve fish passage by modifying debris accumulations.	Improve fish passage by building fishways at sediment deltas that may impair anadromous fish migrations.	Monitor and, if necessary, remove rock dams to improve fish passage
Price Creek				X
Adams Creek	X	X		
Oil Creek	X			
Atwell Creek		X		
West Fork Howe Creek		X		
Dean Creek		X	X	
Nanning Creek		X		
Van Duzen River			XXX	
Wolverton Gulch	XXX	X	X	
Fiedler Creek	XX		X	
Cummings Creek		X	X	

Flow and Water Quality:

Table 23. Recommended actions to improve flow and water quality.

Streams	Recommended Actions XXX: Highest Priority			
	Insure that water diversions used for domestic or irrigation purposes bypass sufficient flows to maintain all needs of fishery resources.	Reduce water temperatures	Plant willows, redwoods, alder or fir trees to help reduce water temperature in areas with insufficient shade.	Remove excessive contributions of wastewater to aquatic ecosystems
Eel River		XX		XX
Price Creek	XX	X	XX	
Howe Creek	X	X	X	
Van Duzen River	XXX	XX		
Cuddeback Creek	XX			
Fiedler Creek	XX			
Cummings Creek		XX	X	

Erosion and Sediment Reduction:

Table 24. Recommended actions to correct erosion and sedimentation.

Streams	Recommended Actions XXX: Highest Priority				
	Continue to identify and reduce sources of sediment delivery to stream channels from road systems.	Re-vegetate exposed stream banks and/or install structures to increase bank stability.	Modify debris accumulations to prevent further erosion of stream banks.	Build livestock exclusionary fencing along creeks and create offsite watering areas	Install instream structures that enhance natural sorting of spawning gravels
Price Creek	XX	X		XX	
Adams Creek	XX		X		X
Sweet Creek	XX	X			
Muddy Creek	XX				
Howe Creek	XX	X		X	
West Fork Howe Creek	XX		X		X
Atwell Creek	XX		X		
Crystal Creek	XX				
Dean Creek	XX		X		
Nanning Creek	XX		X		
Van Duzen River		XX			
Wilson Creek	XX				
Wolverton Gulch	XXX	XX	X	X	
Cuddeback Creek	XX	XX			
Fiedler Creek	XX	XX			
Cummings Creek	XX	XX	X		

Riparian and Instream Habitat:

Table 25. Recommended actions to correct riparian and instream habitats.

Streams	Recommended Actions XXX: Highest Priority				
	Increase depth, area or shelter complexity in pools, by adding LWD or combinations of boulders and LWD.	To increase the number of pools, design and install pool forming structures.	Increase shelter complexity in flat water units by adding LWD.	Consider thinning hardwoods to increase growth of conifers where riparian forest is strongly dominated by hardwoods and shade canopy will not be adversely affected.	Consider planting barren nearstream areas with alder, willow, redwood, or fir trees to increase streamside shade canopy and allow for LWD recruitment.
Price Creek	X	X		X	X
Adams Creek	XX				
Sweet Creek	X	XX			X
Muddy Creek	XX	X		X	
Howe Creek	XX	XX			X
West Fork Howe Creek	XX	XX		X	
Atwell Creek	XX	X			
Crystal Creek	X	XX		X	
Dean Creek	XX	X			
Nanning Creek	X				
Van Duzen River	X				X
Wolverton Gulch	XX	X	X	X	XX
Wilson Creek	XX	XX			
Cummings Creek	XX	XX	X	X	X

Education, Research, and Monitoring:

Table 26. Recommendations for education, research, and monitoring.

Streams	Recommended Actions XXX: Highest Priority	
	Conduct retrospective surveys of habitat improvement structure effectiveness to assess need for project maintenance.	Water quality and temperature monitoring should be conducted over several years to characterize conditions in streams
Eel River		XX
Price Creek	X	XX
Howe Creek	X	XX
Van Duzen River		XX
Cuddeback Creek		XX
Fiedler Creek		XX
Cummings Creek	XX	

Subbasin Conclusions

More biological and habitat surveys were conducted on streams of the Upper Subbasin than in the other subbasins in this Lower Eel assessment due to the higher number of streams containing salmonids within the subbasin. These studies describe deterioration in habitat due, in part, to the introduction of high levels of sediment. Soils in this subbasin are highly susceptible to erosion and have entered the streams through land used activities and many road related and stream bank slides.

The geologic composition and climatic environment of the area aggravate these erosive conditions with soils entering streams during periods of heavy saturation. Salmon spawning areas have become heavily silted and are therefore unproductive in many of the studied streams. While not conclusive, measured water temperatures in some streams neared stressful conditions when compared to suitable salmonid habitat criteria. Additionally, there are several possible barriers to fish passage on streams in the form of culverts and dry reaches. These barriers have limited the movement of adult and juvenile fish and decreased the overall amount of habitat available to salmonids in the subbasin.