CHAPTER 6
Recommendations and Implementation

Naturally Functioning Ecosystems and Beneficial Uses

Results of monitoring for water quality and the analysis of upslope conditions provide the basis for a series of action plans to address sediment and other problems facing watersheds within the Lower Van Duzen River Basin. Through the course of a two and a half year study, turbidity and suspended sediment data have been collected at nine sites on eight tributaries of the Van Duzen River, and at two sites on the main stem Van Duzen River itself. Additionally, data have been collected on dissolved oxygen, conductivity, pH, and temperature at most of these sites. High resolution aerial photography and an abundance of digital topological data have added to the bulk of knowledge available on the condition of the watersheds throughout the lower basin. Although our study was brief in duration (roughly two years), using the available documents, reports, and additional literature published on the Van Duzen Basin and other systems, has helped formulate a series of strategies to address the problems facing these watersheds, and provide for future endeavors to restore these streams to a more pristine state.

Naturally functioning aquatic ecosystems should maintain diversity and complexity of stream functions and processes to support the native species, populations, and communities that have adapted to these systems (Stillwater Sciences 2001). Within the Van Duzen River Basin, this approach should include requirements for maintaining salmon, steelhead, and cutthroat trout populations in the river and its tributaries. This approach should involve evaluating limiting factors for salmonids and how these factors are affected by in-stream flows, the physical habitat, and water quality, including sediment and temperature. Only by understanding the impacts of these factors can a realistic and cost-effective restoration plan be established to bring about a naturally functioning ecosystem.

Maintaining and restoring riverine systems highlights the need to identify key processes and characteristics that exist in the natural (unmanaged) ecosystem, and the development of various methods for restoring some or all of these key elements (Orr 1997). Healthy riverine systems will by their very nature foster healthy and desirable cold water species like salmon and steelhead. Of course, restoration of the riverine ecosystem has benefits beyond those directly related to salmon, including maintenance or enhancement of native fish species and other aquatic organisms, amphibians and terrestrial species that utilize riparian habitats floodplain flood storage capacity, and human aesthetic and recreational enjoyment of a river with high quality water and a well-developed riparian corridor. All of these uses can be considered beneficial because they represent increased complexity in the system and thereby greater stability and ultimately, sustainability.

The following goal was quoted on the State of New Hampshire Environmental Sciences Water Division website: “To ensure that ... lakes and ponds, rivers and streams, coastal waters, groundwater and wetlands are clean and support healthy ecosystems, provide habitats for a diversity of plant and animal life, and support appropriate uses.” Virtually all state departments of water resources hold similar goals and ideals. Unfortunately, the potential for ideals and reality are often far apart, especially when state and federal governments are usually caught in between concerns for environmental quality on one side, and economic development and the generation of revenue for private industry on the other. Too often agencies find themselves trying to compromise between industry-driven resource harvesting and efforts to maintain and restore habitat.

In the midst of pressures from industry it is difficult to insure protection of sensitive ecosystems, and even more difficult to demonstrate that protection measures are working. Water quality protection activities include programs such as erosion control measures required for construction, agriculture, and logging activities, as well as successful permit programs regarding industrial and municipal discharge. Reducing pollution from non-point sources is an area of increasing importance, but often inadequately addressed.

The TMDL

One of the major characteristics of an unhealthy system like the Lower Van Duzen River Basin is the transport and accumulation of sediment, and high turbidity, which lead to loss of habitat (e.g., shallowing of the stream channels), siltation of spawning gravels, and impairment of feeding ability by juvenile salmonids. The degree to which these effects take place is proportional to the amount of sediment yield, delivery, and load carried by streams and deposited into the stream channel. A total maximum daily load (TMDL) report was prepared by Pacific Watershed Associates for Tetra Tech and submitted to the public in 1999 for the purpose of establishing upper limits on acceptable rates of sediment delivery in the Van Duzen River Basin. Follow-up monitoring (in a simple and straightforward process) is required to ensure that the implemented TMDL results in the attainment of the targeted water quality standard.

The EPA recommends using a ten-year rolling average for estimating sediment load allocations to account for large inter-annual variability in sediment loading and long-term timeframes in which beneficial use impacts occur and change in the Van Duzen River Basin (USEPA 1999). Our study suggests it should not require decades to determine the condition of a watershed. As the average lifecycle of salmon is 4 years, which also represents, relatively speaking, how quickly these populations can become extinct, we do not have decades to determine whether these streams are meeting daily load limits. The purpose of a TMDL is to allow us to set limits or thresholds that apply to these watersheds on a year to year basis, and to be able to confidently assess their condition at any point in time, not after decades. Annual rainfall records provide excellent estimates of the relative severity of a given winter season, and this can even be estimated on a month to month basis.

The goal of TMDLs in California and the Pacific Northwest should be to bring about the recovery and protection of beneficial uses, including the recovery and protection of salmon and steelhead, and the habitats and aquatic ecosystems that support them (Orr et al. 2000). Achieving this goal should also meet the regulatory requirements of the Clean Water Act regarding nonpoint source pollution relating to sediment or temperature criteria, and that success will only occur if there is general support for the process and the science among responsible agencies, local stakeholders and landowners, and concerned NGOs. After over two years of studying water quality and conditions in the Lower Van Duzen River Basin, it can be said with reasonable assurance that the goals of the TMDL, specifically the protection of beneficial uses and water quality have not been met in the past, and are not being met currently.

Several problems with the current TMDL process of estimating average annual sediment load (including use of a 10-year rolling average) were described by Orr et al. (2000):

(1) Annual sediment load is highly variable. It is generally the rarer climatic events (i.e., those with greater than 10-year recurrence intervals), that have a major influence on salmonid habitats.

(2) The source of the sediment remains largely unknown. Identifying potential sources and then implementing BMPs to avoid or mitigate erosion and sediment delivery at the source is the key to developing cost-effective and implementable plans to attain water quality objectives.

(3) A long time series of sampling (over decades) is required to estimate accurately the mean or trends. Because of the natural variability in sediment delivery, it may take several decades of monitoring before trends in mean annual sediment load can be accurately estimated.

(4) A total annual sediment load target does not differentiate between coarse and fine sediments and may fail to provide protection and restoration of healthy salmonid populations and properly functioning aquatic ecosystems. It is possible that the amount of chronic, fine sediment input from roads will be deleterious to salmonids and other aquatic organisms during dry periods even though the total sediment load is below the annual sediment load target.

Rare climatic events are undoubtedly responsible for the greatest loss of in-stream habitat (i.e. shallowing of the channel) and thereby, elevated temperatures throughout the basin. However, regular storm events can have dramatic effects in an impaired watershed by increasing stream turbidity and infiltrating spawning gravel with silt that suffocates salmon eggs, as well as inhibiting the fitness (ability to feed) and survival of juvenile salmonids through the effects of chronic turbidity (Trush 2005, Klein et al. 2008). These occurrences of these phenomena are also supported by the fourth point above, and are easily measured by TTS stations such as our station on Cummings Creek.

While it is difficult to accurately quantify the amount of course and fine sediment delivered from hillslopes to streams, specific sources can be located and classified as to type. Some of these include bank erosion along road cuts, surface erosion from tractor yarded clear cuts and other logging roads, skid trails, mass wasting including earth flows emanating from past timber harvests, bank failures within the channel migration zone, and failed culverts. The difficulty with land based reconnaissance is in relating these known sources of sediment to actual quantifiable sedimentation in the streams, and understanding the time lag between yield, delivery, and stream degradation. Therefore, it is difficult to draw clear or direct associations (correlations) between sediment sources and stream degradation. Although it will require extended periods of time to accurately estimate trends in sediment loading of a given stream, it should not require decades to make these estimates. Annual sampling over a few years during average rainfall should provide a reasonable first estimate of the condition of these streams and their watersheds.

According to the Environmental Protection Agency, the overriding implementation need throughout the basin is for resource managers and agencies to conduct assessments to identify and prioritize controllable sources of sediment, especially problematic roads, and to implement appropriate prevention and control measures in a timely manner (USEPA 1999). Efficacy of this implementation will depend on how well problematic roads are identified and what is meant by “appropriate” control measures. Ideally (according to EPA), implementation of prevention and restoration activities will be prioritized by subwatersheds containing the greatest biological (fisheries) benefit, in accordance with strategies described by Bradbury et al. (1995).

Fortunately, our project has compiled considerable data on the ecological conditions of the 22 planning watersheds within the lower basin. While conditions of the catchment areas (including management related processes) have been correlated to water quality, our recommendations for conservation and restoration of these habitats is based on and referenced to the 22 planning watersheds described previously in Chapter 3. Planning watersheds are more uniform in size, are easily quantifiable, and are located more appropriately for designing restoration projects than the catchment areas described in Chapter 4.

Turbidity and sediment can then be assessed based on the severity of the season. While the timing of winter storms varies considerably throughout the season, the frequency and severity of these storms can be considered proportional to the amount of sediment loading. Obviously, wetter seasons represent years with more intense storm events, which lead to greater rates of sediment loading. These wetter years can then be used as reference points, relative to dry years in determining how the streams are doing relative to the TMDL. However, if the TMDL has been adequately established, any year that surpasses this limit should be considered an indicator that sediment yields are too high. Of course, the TMDL should never be fixed estimate, and can and should be modified with time and as more information is acquired regarding the watershed.

Our view of the TMDL is that although it underestimates the proportion of management-related sediment delivery throughout the basin, an approved set of criteria should be established and this information should be available to all interested stakeholders, landowners, and organizations. These criteria, however, should be clearly and simply stated and easily measurable from year to year. The purpose of setting criteria is that regulatory agencies need to be aware of current conditions if the TMDL is to have any value to the public and its concerns regarding water quality. Therefore, the first recommendation of this plan is for the State of California to adopt a TMDL for the Van Duzen River as well as for the entire Eel River Basin, and establish a means for monitoring sediment load on an annual or bi-annual basis. Our experience indicates that the most efficient and probably most cost-effective method for monitoring watersheds for sediment is through the use of the turbidity threshold station (TTS). Use of TTS stations along with a simultaneous analysis of upslope sediment loading, such as that performed by PWA will immensely aid in our ability to differentiate between course and fine sediment delivery. Use of spatial information such as aerial photography and other GIS data will help interpret and visually present the results of these estimates.

Turbidity threshold sampling stations provide the most consistent method for sampling in-stream sediment throughout the season. While this method does not directly quantify the amount or the source of sediment delivered from the hillsides (i.e., mass wasting such as landslides and earth flows, surface erosion, and management versus natural), simultaneous measurements of upslope sediment delivery (similar to the data collected by PWA 1999), along with in-stream measurements of discharge, turbidity, and suspended sediment would provide sufficient information to correlate suspended sediment loads to the total source and amount of upslope sediment yields.

Once correlation constants are established, agencies and/or non-profit organization and/or timber companies (as well) can engage in continuous monitoring of stream conditions, and determine on an annual basis whether TMDL criteria are being met. When used in conjunction with spatial data such as high resolution aerial photography, satisfactory estimates that quantify amounts and sources of sediment can be made on an annual basis. It would be of great value to have a cooperative monitoring program involving state agencies (including CA Department of Fish & Game, Department of Forestry, and the Regional Water Quality Control Board), non-profit organizations (e.g., Friends of the Eel River, Salmon Forever, and Humboldt Watershed Council) and timber companies (such as Humboldt Redwood Company), that would operate a series of TTS stations throughout the lower basin.

Implications of the Forest Practices Act

The vision of the Strategic Plan of the California Water Board is: A sustainable California made possible by clean water and water availability for both human uses and environmental resource protection. The stated mission is: To preserve, enhance, and restore the quality of California's water resources, and ensure their proper allocation and efficient use for the benefit of present and future generations (CA State Water Board 2008). Towards that goal, the Z'berg-Nejedly Forest Practices Act (FPA) and the California Forest Practice Rules (CFPRs), which established in 1973, was intended by the legislature of California to acknowledge the need for long term watershed protection, including fish and wildlife, and directed the State Board of Forestry (BOF) to adopt regulations to guard against any deleterious effect on the beneficial uses of the states waters. This directive absolutely applies to the streams and watersheds within the Lower Van Duzen River Basin, and makes resource preservation and restoration a requirement where water-related resources are impaired.

The FPA fairly well establishes that regulations need to be established and specifically enforced with regard to timber harvest operations in watersheds that exhibit threatened and/or impaired conditions. Section 4551 states that "the board shall adopt forest practice rules and regulations ... to assure the continuous growing and harvesting of commercial forest tree species and to protect the soil, air, fish, and wildlife, and water resources, including, but not limited to streams, lakes, and estuaries." This statement was interpreted by the California Attorney General's office in 2009 to mean that the Board of Forestry should view the forests of the State of California as a complete ecosystem, and not simply a producer of high quality lumber, and that forest stands have value in their own right as a public resource. Moreover, the Board is required to protect water quality and watersheds, and a part of that process should include restoration efforts. The public resources code also requires the Board to adopt regulations to protect the beneficial uses of water and to control timber operations that threaten or have the potential to cause deleterious effects on these beneficial uses.

In agreement with the California Attorney General's office, it is our feeling that the FPA and CFPR do not satisfactorily ensure for the protection of salmonid species in Northern California, or their respective watersheds and steam habitats. Best management practices have made great strides towards achieving the goals and policies advocated above. However, our results show that these practices to do not go far enough to bring about the desired results, and need to be enhanced and further improved if the safeguards described earlier are ever to be achieved.

Expected Load Reductions (Element 2)

The EPA suggests that 30% load reductions could be achieved in the Lower Van Duzen River Basin if TMDL recommendations are used as targets for rehabilitation of these watersheds However, expectations with regard to some watershed conditions could probably be more flexible in their estimates of targeted outcomes (Table 6-1). It is reasonable to expect that some environmental indices might readily show more than 30% improvement, while others possibly less. We believe that in a ten-year period, following aggressive protocols, and rehabilitation and restoration efforts, 50% improvement could be realized in many cases.

Load reductions and other improvements in watershed conditions provided in Table 6-1 are estimates based on either expectations proposed in the TMDL report (PWA 1999, USEPA 1999), or perceived reasonable expectations based on data recovered during the project and personal observations of current conditions. These values or future improvements in these values will represent useful and best estimate targets and project goals for implementation of the watershed plan. These estimates or goals will be fundamental in determining the ultimate success of current or the recommended improved best management practices, should they be incorporated into protocol and policies relating to timber management.

Table 6-1. Estimates of potential load reductions and/or improvements for key parameters of water quality and habitat in the Lower Van Duzen River Basin.

Duration Necessary to Verify Conditions	Indicator of Watershed Health	Estimated Average in the Lower Van Duzen River Basin	Percentage Improvement Required to Achieve Minimum Threshold	Target for all streams after Recommended Actions	Source or Reference
Short to Medium Term: 10 to 20 Years	1) Stream Habitat survey, Large Wood (per stream mile)	1	> 50%	> 3	Chapter 2, Table 6-3
	2) Estimated sediment delivery (yds^3/mi^2/year)	1,257	50%	630	Chapter 1, USEPA (1999)
	3) Average Turbidity (NTU)	165	50%	85	Chapter 4
	4) Suspended Sediment (tons/mi^2/ year) - TTS Station	1,661	50%	830	VDWP Monitoring Report Oct. 8, 2008
	5) Cummulative hours above 25 NTU	1,100	50%	550	TTS Report Cummings Creek
	6) Turbidity at an Exceedence of 10	55	50%	28	TTS Report Cummings Creek
	7) Average Weekly and MWAT (C) - HOBO Temps	18	10%	16.2	VDWP Monitoring Report Oct. 8, 2008
	8) Macro-Invertebrates - Index of Biol. Diversity	70	10%	77	VDWP Macro-Invertebrate Report
Long Term: 20 to 50 Years	1) Road Density - aerial photo recon (miles/mile^2)	7.8	45%	4	Chapter 3
	2) Road-stream crossing density (per stream mile)	1.56	36%	1	Chapter 3
	3) Proportion Riparian Zone (Canopy > 80%)	0.25	50%	0.50	Chapter 3
	4) Percent Pools	30	50%	45	CDFG (2004)

Improving Best Forest Management Practices

Experts in the field have stated that sediment delivery from timber harvesting activities can be controlled by 50 to 75% of historic levels by eliminating harvest on steep and unstable slopes, applying streamside buffers, and minimizing soil disturbance through modified silvicultural prescriptions (PWA 1999, Spence et al. 1996, USDA 1994). For the Lower Van Duzen River Basin, the EPA recommends that 90% of the erosion on roads and skid trails be controlled, and control of 75% of the erosion caused by timber harvesting is necessary in order to achieve the loading reduction estimates (30%) for the lower basin. This level of sediment control was said to be justified because of the relatively high contribution from management-related sources (36%) compared to the middle and upper sub basins, and the importance of the lower basin tributaries for salmon and steelhead spawning and rearing habitat.

Evidence has been presented in the previous chapters providing testimony as to the impaired conditions of the streams in the Lower Van Duzen River Basin. This chapter is designed to provide recommendations for projects leading to the restoration of these streams and their respective watersheds, which will ultimately restore the beneficial uses of water and facilitate the return and successful establishment of salmonid populations in these areas.

However, isolated restoration projects alone would be a waste of money and effort, and will ultimately fail if the conditions that caused the degradation of these watersheds are not corrected first. This means that regulations must be in place and that responsible agencies (i.e., CA Department of Forestry) are on board to assure that improved Best Management Practices will followed to the letter of the law by all operators (large and small) that harvest timber in watersheds throughout the state, and especially in the Van Duzen and Eel River Basins.

Improved Best Management Practices should differentiate between the three major levels upon which recommendations can be applied. These levels are as follows.

Management Measures (Element 3)

Changes or modifications of state policy are recommended to affect and restrict activities that cause and increase sediment delivery to streams, such as re-evaluation and changes in logging mandates and protocol. These modifications should be considered Basin Wide recommendations and are as follows:

a) Increase the width of no-harvest riparian zones to 300 feet on fish-bearing streams. Increase width of no-harvest riparian zones to 150 feet on non fish-bearing streams, but 300 feet on all streams where geology is unstable and therefore unsuitable (e.g., Wildcat group), irrespective of fish presence.

b) Establish limitations on the logging on steep slopes. No logging should occur on slopes greater than 50%, and of course, no logging during the rainy season.

c) Eliminate all logging road construction (absolute ban on all tractor and skid roads) within the Lower Van Duzen River Basin, and throughout the Pacific Northwest.

d) Eliminate all harvesting of old-growth trees, especially Redwood, and foster a management strategy that favors multi-aged forest complexity.

e) Eliminate all clear cutting as an acceptable silvicultural practice, in favor of a multi-age harvest method, which will lead to greater forest stand complexity.

f) Eliminate all use of tractor yarding as part of acceptable timber harvest methods.

If enacted, these measures combined will significantly lower the amount of course sediment in streams that causes loss of habitat, significantly lower the amount of fine sediment in streams that reduces fitness and survival of juvenile salmonids, and significantly lower the amount of silt in the streams that smothers salmon eggs and results in the mortality of thousands of salmon young. At this point in time, no reasonable estimates of cost can be offered for the implementation of these measures, as they primarily represent modifications in policy and protocol. See the section on Budget and Sources for estimates of costs for On-the-Ground and Instream Measures that follow.

On-the-Ground Measures (Upslope Conditions)

Physical changes on the land are recommended to improve upslope conditions in the watersheds. These changes should be considered Planning Watershed Specific, and would apply to the 18 planning watersheds that received a road density rating of extremely high (road density greater than 4.7 miles of road per square mile of watershed – see Chapter 3). These modifications relate to the physical remediation of upslope conditions and are as follows:

a) Decommission all inactive, failed, or damaged roads, wherever possible.

b) Redesign and modify problematic roads to eliminate the channeling of water and sediment into streams.

c) Repair, replace or decommission failed or problematic culverts, and where possible replace with concrete and/or steel bridgework.

In-Stream Measures (Restoration)

Physical changes or modifications to the stream are recommended to remedy and restore integrity of in-stream processes. These modifications should be considered Planning Watershed Specific and are as follows:

a) Restoration of in-stream habitat (e.g., shallow pools, loss of channel depth) through the deployment of large wood and/or large boulders in and near shallow pools, especially in salmon-bearing streams of current and historic significance.

b) Restoration of channel migration zone integrity and protection against bank erosion (e.g., placement of boulders with cabling and wing deflectors to hold banks in place and prevent channel bank cuts).

c) Restoration of the riparian zone (e.g., planting riparian tree species including willow, cottonwood, and alder), to increase stream bank integrity and the lowering of stream temperatures.

Potential for Improvement

Best management practices (BMPs) have been described in detail on many state-sponsored websites, where timber harvest plays a significant role in the economy and revenues of those states. Most of the protocols described in detail are carefully crafted to insure that sediment delivery to streams is minimized. However, most of these BMPs do not fully acknowledge the level of influence some of these logging practices have on stream integrity. It is our contention that logging practices need to be further modified, as least in the Pacific Northwest, where forests are still part of the wild landscape and are an integral component of wilderness throughout this part of the country. This type of forest wilderness is in contrast to the forest plantations of the South, where forests are planted as monocultures and harvested as crops.

In the Pacific Northwest the Van Duzen Basin is a good example of slopes that are too steep to treat forests in the manner described above. To ensure that sedimentation is minimized, it is important that structural complexity is maximized in our forests. Maximization of complexity requires that forest stands exhibit a wide range of age groups, and although Redwoods tend to dominate in the Redwood forest, in a natural state there is always a mixture of species that comprise the vegetation component, which also contributes to complexity. Therefore in the simplest of terms, healthy watersheds require healthy forests, which thereby require a maximum of structural, age, and species complexity. By facilitating and encouraging this complexity, best forest management practices will thereby minimize the levels of sediment delivery to streams, thereby minimizing the negative impact on these systems, and maintain stream integrity for successful salmonid reproduction and survival.

Best management practices need to include the elimination of all clear cutting on all forest lands in the Pacific Northwest. Our data and other investigations have shown that clear cutting results in an increase in sedimentation over other methods such as selective logging, which is endorsed in this document and by our project participants. However, of the three yarding methods (tractor, cable, and helicopter) used with various silvicultural methods, tractor yarding has a significantly greater effect on the production of sediment in streams than either of the two other methods, especially when associated with clear cutting. Elimination of clear cutting will encourage and foster greater age complexity of our forests. However, for age complexity to be fully realized and used to it maximal benefit, these forest ecosystems need to be left alone for longer periods of time. In other words, they should be re-entered much less often and be allowed to rest. These periods of rest need to be extended well beyond the time elements currently deployed by most companies.

The above recommendations need to be incorporated into timber harvest protocols. These improvements to best management practices must be adopted by the California Department of Forestry (CDF), which is the agency responsible for approving timber harvest plans. For too long CDF, in our opinion, has for the most part, given blanket approval for the vast majority of harvest plans submitted to that agency. In many cases these harvest plans were severely flawed, and should have been recommended for modification at the very least and in many cases, turned down for approval. In the future, harvest plans that include clear cutting or tractor yarding, or any of the other problematic scenarios described above (e.g., logging on slopes greater than 30%, especially on the Wildcat group), should be denied. Any logging on Wildcat geology should only be approved under the strictest of guidelines and be restricted to slopes less than 10%, be highly selective, involve no tractor yarding (helicopter only), and assign stream buffers of 100 yards for all Class 1 streams and 50 yard buffers for all Class 2 and Class 3 streams. However, the history of CDF has unfortunately, been one of cooperation rather than regulation. The CDF needs to become more of a regulatory agency, and use much more critical scrutiny when reviewing timber harvest proposals.

Logging should be severely restricted on steep slopes (> 30%), within 150 feet of any stream, on Wildcat geology, and should be eliminated. Timber Harvest management should work toward fostering more mature forest stands. Slower harvest rates will lead to greater tree maturity and greater complexity and thus stability of the forest ecosystem, reduced sedimentation rates, and cooler temperatures in the streams. Forests should be harvested less frequently than is currently practiced, and left alone for longer periods of time, with no less than 40-year intervals, and preferably 60 to 80 year intervals. Ultimately, timber companies will benefit from longer intervals between harvests, because trees will be larger when harvested and bring greater financial return for a given amount of work expended. In other words, if enough time is allowed for forests to mature, longer intervals between re-entry times will significantly maximize forest complexity while maximizing profits and minimizing environmental damage.

If our forests are to reach or approach full health, periods of rest need to be extended, preferably to at least 40-60 years. With sufficient rest periods, forest complexity will improve dramatically which will then be realized as reduced sedimentation in the streams. With greater rest periods, average tree sizes will increase dramatically, which will be beneficial results not only for the watersheds, but also for timber companies, which when practicing selective cable or helicopter logging, will realize significantly greater revenues returns for the same number of trees harvested because the average tree size (as well as age) will be significantly larger, and selective cutting will have proportionately less impact on the integrity and complexity of the forest.

If tractor and skidder yarding practices are allowed to continue, then additional focus should also be placed on small timber operations that might tend to slip below the radar of regulatory agencies, and may incur fewer restrictions or less robust monitoring of their operations. For the benefit of watersheds in general, timber harvesting of Redwood should not be allowed on holdings of less than about 100 acres. Holdings of less than this size would tend to be logged by smaller companies with limited budgets which in turn would more likely emply cheaper harvest methods than larger more economically viable companies. For example, small companies, or private individuals logging small areas would tend to forgo aerial yarding methods and opt for cheaper tractor or skidder harvesting to maximize profit. If no legal restrictions on tractor yarding exist, only the larger, more publicly visible companies would opt for aerial harvesting methods over tractors and skidders, thus creating an opportunity for abuse by the smaller companies. A simpler solution to the problem is to eliminate the option of using tractor yarding any further throughout north coastal California, especially in the Redwood ecozone of the Lower Van Duzen River Basin.

We have witnessed firsthand the use of tractors by private individuals, where the previous owner, a larger company had employed cable harvesting. Evidence in this document and others (Haggens et al. 1986) clearly shows the negative impacts that tractor yarding and skid road building have on watersheds throughout the northern part of the state, as well as in Oregon and Washington (Harr and Nichols 1993). The Van Duzen River Basin is a textbook example of the impact this kind of timber harvest has on the land, the streams, and the cold water species that depend on these streams for their survival. It may be time to change the timber harvest paradigm and to acknowledge that a more environmentally compatible and sustainable method is needed. That method is the elimination of clear cutting and tractor yarding in all watersheds.

We have also witnessed re-entry into the same forests on a rotation of as little as every 4 to 5 years using tractor yarding methods on steep slopes (> 50%). Re-entry into these watersheds on such small intervals should be disallowed and not authorized by CDF. At the very minimum, forests should be harvested (irrespective of silvicultural method) no more frequently than a 30 year rotation. Every time a forest is entered, the result will be greater and greater compaction of the soil and earth adjacent standing trees. Compaction of soil leads to reduced ability of that soil to absorb water, thereby resulting in greater and more frequent oscillations between flooding and drought. Soil compaction is the antithesis of forest complexity, and will inevitably lead to slower tree growth rates, greater rates of sediment delivery to streams, and reduced species complexity in the forest ecosystem.

Upper Van Duzen River Watershed Recovery Actions

The USFS (1998b) has substantial holdings in the upper Van Duzen River watershed that are in Late-Successional Reserve status and the management proposed for this area is geared towards ecosystem restoration and maintaining or restoring late seral conditions. Areas targeted for restoration are the headwaters of the South Fork (Little Van Duzen) and the West Fork (USFS 1998b).

Erosion control and watershed restoration activities on federal land will assist with channel recovery downstream, but the reach of the upper mainstem near Dinsmore on private property should also get consideration for restoration. This alluvial valley reach became so aggraded as a result of the 1955 and 1964 floods that it has lost all channel definition and loses surface flow in summer (Kelsey 1980). A bioengineering project using wing deflectors and willows and/or cottonwoods would help restore riparian vegetation and help stabilize the channel. This type of project would require substantial cooperation from private land owners. A re-established channel in this alluvial reach could restore perennial surface flow and improve fish passage. Optimally the project would also improve surface and groundwater connections to create areas of cold water refugia suitable for juvenile steelhead rearing.

Moyle et al. (2008) noted the escalating problem with increased water diversion associated with rural residential development in northern California:

> In numerous watersheds including the Mattole, Mad, Van Duzen rivers and Redwood Creek, rural landowner water use for residential and agricultural purposes significantly curtail flows in the mainstem river. This reduces habitat availability and truncates migration patterns.

The degree to which rural development and agricultural activities impact the Van Duzen River are not well known at this time, but their impacts to the Eel River overall are likely high. In recent years, the lower Van Duzen River has become stagnant due to extremely low flows and this has promoted the proliferation of toxic algae (*Microcystis aeruginosa*). An untested hypothesis is that flow depletion and nutrient enrichment from rural development and agricultural activities have added to other cumulative effects such as logging to create this condition. If further study upholds this hypothesis, a water conservation education program for rural land owners, similar to the one promoted in the upper Mattole River by the Sanctuary Forest, should be considered for the Van Duzen River Basin.

The hydrology of meadow areas in the upper Van Duzen watersheds has been altered due to changes in grass species that were historically present, resulting in major problems with gully erosion (Kelsey 1980). Gullies not only contribute large amounts of sediment, they also lower the water table and reduce groundwater storage capacity. Gullies tend to downcut and advance up slope, but this process, known as head-cutting could be remedied with bioengineering. This technique uses check dams installed in gullies with willows planted to trap sediment. Small gullies lower on hillslopes can also be repaired using similar techniques. Roads disrupt meadow hydrology as well and new road construction across them should be avoided. Downspouts from culverts draining roads in meadows should be armored to prevent additional gully formation.

Any action of this nature would require preliminary study to validate the problem and to examine the feasibility of restoration.

Benefits of Intact Forests

The benefits of intact forests are many, and are especially beneficial to the watershed when forests are intact, mature, and healthy. Healthy forests minimize surface erosion, minimize erosional processes such as massive earthflows, land and mud slides, and debris torrents. Forests maximize flood control in the rainy season and maintain healthy stream flows in the dry season.

Healthy forests provide deep and continuous layers of leaf litter, duff (decaying leaf material transitioning into soil), and healthy, uncompacted top soil, all of which maximize the water holding capacity of the hillslopes – this capacity holds orders of magnitude more water on the hillsides, and prevents it from immediately reaching the streams, than that which occurs after clearing and scraping of the land such as from clear cutting. This capacity of healthy watersheds is often overlooked when considering the effects of timber harvesting versus intact forests, and the negative effects of these activities on stream discharge are more widespread than simply within the riparian zone. The amount of water and the rate at which this occurs often determines the amount of flow or discharge, which directly affects the amount of sediment carried into streams.

Water that is held on the hillslopes during the rainy season, is then available and contributes water to the streams in a controlled and continuous manner, and can make much more water available to the streams much farther into the dry season, than occurs after deforestation. Healthy forests also maintain cooler air and stream temperatures, which also minimize the amount of evaporation in the dry months.

Therefore, when all factors are considered, if watershed health, stream quality, and cold water beneficial uses are of high priority, there can be no doubt that concern and commitment to healthy intact forests, especially within the Redwood Forest ecosystem, must be of the highest priority.

Recommendations for Restoration on HRC Property

The legacy of cumulative effects damage inherited by HRC is considerable. Road densities are extremely high (> 5 mi./sq. mi.) and road-stream crossings are numerous (Table 3-2). Timber harvest rates since 1985 in the Van Duzen River and Yager Creek sub-basins often surpass 50% and some basins have been as high as 100% of the watersheds harvested during this period, far over prudent risk limits found by Reeves et al. (1993), which if surpassed, result in loss of habitat complexity and diminished salmon species diversity. The question now becomes whether HRC can improve watershed and channel conditions more toward their normal range of variability to allow salmon and steelhead recovery and maintain an economically viable operation.

Conservation Easements or Acquisition

One viable option for HRC is to sell its holdings in upper Lawrence Creek to a conservation organization, such as the Nature Conservancy or the North Coast Land Trust to establish refugia for Pacific salmon. Precedent for such action has been established in the Garcia River watershed (Conservation Fund 2007), where the Inman Creek sub basin will no longer be logged, and has been placed in a conservation easement managed by the Nature Conservancy.

Roads

Spence et al. (1996) recognized the need to "minimize road density" when implementing a conservation plan for Pacific salmon. Decommissioning roads in general, as well as road-stream crossings and roads near streams needs to be targeted in high priority watersheds. Targets would include reducing road density to less than 2.5 mi./sq. mi. (NMFS 1995), reducing stream crossings to fewer than 1.5 per mile of stream (Armentrout et al. 1998), and the removal and relocation of streamside road segments (Spence et al. 1996). Road decommissioning and removal of road-stream crossings have proven effective in reducing landslides and preventing channel damage during major floods (Harr and Nichols (1993). Removal of streamside roads will allow reconnection to floodplains resulting in increased habitat complexity, creation of slow edgewater habitats suitable for winter rearing, increased water storage capacity and potential improved connections to cooling groundwater (Spence et al. 1996).

In addition to reducing road densities, consideration should be given to reducing the width of roads and their hydrologic foot print. Logging roads can be narrowed to the width of a single truck, and contoured with the hillside, especially if logging yields are reduced and truck traffic is radio-controlled. If near stream roads cannot be decommissioned, then they should be heavily rocked or paved to prevent continuous pumping of fine sediment into streams. The shallow landslide stability model (SHALSTAB, Dietrich et al. 1998) could be used to determine road segments that cross unstable terrain. Those segments should be prioritized for decommissioning, especially if they are in high priority watersheds. Even if road networks are reduced through decommissioning, HRC needs to develop a maintenance schedule that detects incipient road failures and provides tactics to prevent them in the future (Spence et al. 1996).

The Mendocino Redwood Company, sister company of HRC, has won cooperative grants to decommission roads, crossings, and landings in the South Fork Garcia River Basin, and has improved habitat conditions and the prospect for coho salmon restoration there (Bell 2007). Similar decommissioning efforts are needed in Shaw Creek, Corner Creek, Fish Creek, and other key tributaries of Lawrence Creek so that successful Chinook spawning can be maintained and refugia for that species established. Efforts to maintain and restore Chinook will benefit coho salmon in the Lawrence Creek sub-basin, if there are sufficient metapopulations of fish in the Eel River Basin or nearby Humboldt Bay tributaries to supply colonists in the future. Any steps taken to enhance habitat for Chinook will also likely benefit winter steelhead.

Timber Harvest

Tractor clear cut logging (favored by PL after 1985) created significant problems with surface erosion and soil compaction. Logging on steep slopes triggered debris slides that elevated sediment yield to streams, but slide materials lacked large wood that would meter sediment (PWA 1998). This increased torrent damage to downstream reaches. Riparian logging was also common and early seral conditions contributed to low canopy levels and decreased thermal buffering needed to maintain cold water for salmon and steelhead as well as the shortage of large wood in stream channels.

Reeves et al. (1995) indicated that logging rotations of 150-200 years would mimic natural processes in Oregon coastal watersheds, which is clearly not realistic for a commercial timber company. An alternative discussed above would be to sell land to a conservation group or to sell an easement that would delay timber harvest and thereby create temporary refugia. Another option would be to employ timber harvest methods that promote forest health and have low ground disturbance, such as full suspension cable logging. Selective logging would need to target smaller diameter trees for several decades, using thinning from below to re-establish stand variability and to promote forest age that trends towards late-seral conditions with which Pacific salmon co-evolved.

In riparian zones, no large conifers within at least one site potential tree height should be logged until shade and microclimatic conditions that maximize thermal buffering have been achieved. Headwater streams, dubbed Class III streams by the California Department of Forestry (CDF), need no-entry buffers of at least 100 feet or to the height of the inner gorge on all HRC property in the Van Duzen River Basin. This would reduce sediment yield as well as avoiding compaction and diminished groundwater storage in these areas that are very sensitive to disturbance. Headwater areas often have high landslide risk as well, so restricted logging will help with large wood recruitment during future storm events.

Although commercial harvest of conifers in riparian zones should be reduced, HRC should also use thinning techniques on hardwoods to help accelerate succession to conifers. This treatment is needed throughout the lower Van Duzen and Yager/Lawrence watershed, but should be a priority in upper Lawrence Creek and its tributaries. Hardwood colonization after logging or channel damage from torrents helps stabilize banks and provide shade. However, hardwoods may remain dominant for decades and full stream temperature buffering effects needed to restore the normal temperature regime will require re-establishment of redwoods at low elevation and Douglas fir higher in the watershed.

Instream Channel Enhancement

Placement of instream structures is generally ineffective in the presence of flashy peak flows or highly mobile bedload conditions in a watershed (Frissell and Nawa 1992). For example, Hopelain (1995) found a very high failure rate for structures in Grizzly Creek in 1992-1993. Consequently, installation of large wood in mainstem channels is not recommended, but should be considered in smaller streams that are more stable and that have less hydraulic energy. Candidates for this treatment would include Shaw Creek, lower Corner Creek, and Fish Creek in the Lawrence Creek sub basin, and Cuddeback Creek, Fiedler Creek, Cummings Creek, Fox Creek, Flanigan Creek Hely Creek, Root Creek, and Stevens Creek in the remainder of the Lower Van Duzen River Basin. Reintroduction of large wood into stream systems would not only help scour pools and trap and sort spawning gravels, it would also likely force local downwelling and hyporheic zone connections that would increase local thermal refugia and cool tributary temperatures (NPPC 2000).

Agricultural and Industrial Activities in the Lower Floodplain

The USEPA (2003) stressed the importance of restoring stream reaches flowing through alluvial floodplains, which historically had a high level of groundwater exchange that created cold water refugia suitable for salmonid rearing during the summer. The lower Van Duzen River, lower Yager Creek, and smaller tributaries, such as Barber Creek, are in such alluvial reaches. Restoration efforts should strive to reconnect these streams to their floodplains.

Yager Creek downstream of HRC holdings, just upstream and downstream of Highway 36 has been disconnected from its floodplain by a levee that was constructed for flood control. The lower end of the levee protects the footprint of the old PL Carlotta mill site, which has now been abandoned. Consideration should be given to the removal of this levee and purchase of easements or land adjacent to the stream, so that lower Yager Creek can be reconnected to its floodplain. This would greatly improve fish habitat, increase water storage and likely restore surface water and groundwater connections that would create refugia at this location.

Just downstream of the mouth of Yager Creek, the coho salmon intrinsic potential map (Chapter 2, Figure 2-13) shows that Barber Creek and its tributary Wolverton Gulch fall within optimal ranges. Over 100 years of agricultural use has removed the riparian zone of Barber Creek and converted the stream channel into a ditch to expand grazing and farming lands. Purchase of easements from private land owners should be considered to re-establish channel meanders and a riparian gallery forest.

Gravel Mining

Although it is beyond the scope of this project, we strongly recommend more strict review of gravel mining operations along the lower Van Duzen River. As abundant anecdotal observations testify (C. Quilez on Gravel Mining, Chapter 2), gravel mining in the lower channel is having a negative impact on the integrity of the river. These operations work on the basis of skimming gravel from across the entire channel migration zone, which, in the lower Van Duzen is extremely wide and getting wider. Methods to restore the river should focus on effort to deepen the channel and bring back coho salmon habitat (i.e., deep pools). Gravel mining has the opposite effect. By grading and shoveling the gravel and other course sediment from the sides of the stream, that being the highly aggraded channel in the channel migration zone, these activities actually serve to lower the sides of the river and further interfere with the integrity of the channel, which at this point in the lower alluvial plain, is literally nearly impossible to discern. While our expertise does not extend to gravel mining, we strongly recommend much greater oversight by California agencies that are equipped with the knowledge and expertise to understand the impact of these activities.

Van Duzen Restoration and the Eel River Basin

Brown and Moyle (1991) recognized the dire need to restore cold water habitats in the Eel River basin as soon as possible to prevent loss of Pacific salmon species and the continuing proliferation of the introduced Sacramento pike minnow. Smaller Van Duzen River and Yager Creek tributaries are already cold and, as they recover from logging, their temperatures will drop further. This in turn should promote cooling of larger tributaries such as Lawrence Creek. This geographic area is relatively near the ocean and has cooling marine climatic influence. Consequently, the lower Van Duzen River and Yager and Lawrence Creek sub basins represent some of the best short term opportunities for fully recovering coldwater habitat and re-establishing refugia in the entire Eel River Basin.

Making this area a high priority for restoration also makes sense when considering Chinook salmon conservation. Lawrence Creek has some of the most consistent and highest returns of adult Chinook salmon in the Eel River Basin, which is important considering the very real risk of losing Chinook salmon throughout the entire Eel River basin. Chances for maintaining Chinook salmon and rebuilding the population in this geographic area are favored because of the relatively short distance migrants would have to pass through waters inhabited by predaceous pike minnow in order to reach the mainstem Van Duzen River and Eel River channels, and the short distance from there to the estuary. When the importance of the Chinook salmon stocks in the lower Van Duzen River are considered in an Eel River basinwide context, the importance of prompt action becomes clear. The targets of action, as discussed above, should be the tributaries to Lawrence Creek and particularly those accessible to Chinook salmon, which include Corner Creek, Fish Creek, and Shaw Creek.

Monitoring Watershed and Channel Recovery

Collison et al. (2003) described the challenges of gauging watershed and channel recovery.

> Without a clear quantitative definition of what constitutes recovery, coupled with a clear definition of what constitutes background conditions against which to measure recovery, and adequate quantitative effectiveness monitoring data, it is not possible to determine if these

> disturbed watersheds are moving toward a more impaired condition, or moving toward recovery.

The Van Duzen TMDL provides the following statement on implementation and restoration:

> The overriding implementation need throughout the basin is for resource managers and agencies to conduct assessments to identify and prioritize controllable sediment sources, particularly road networks, and to implement appropriate prevention and control measures in a timely manner. Ideally, implementation of prevention and restoration activities will be prioritized by sub watersheds containing the greatest biological (fisheries) benefit, in accordance with strategies described by Bradbury (1995) and others.

The Van Duzen TMDL fails to capture needed actions for implementation that would achieve sediment pollution abatement because it ignores cumulative watershed effects. Sediment cannot be abated nor can water quality and fisheries be recovered unless anthropogenic sources of stress on habitat are lessened or abated (Kauffmann et al. 1997, Rieman et al. 1993), yet logging (especially clear cutting and tractor yarding) and road building has continued since completion of the Van Duzen TMDL. Despite recommendations by Bradbury et al. (1995), the TMDL does not specify the need to protect less impacted existing watersheds. Bradbury et al. (1995) recommended that the best intact habitats or refugia be protected as a priority, and then watersheds adjacent are next in line for restoration investment.

Prudent Risk Limits to Land Management

TMDL implementation needs to set prudent risk limits for watershed disturbance, which include watershed rest as well as extensive decommissioning of roads to allow sediment reduction and restoration of a normal hydrologic function. These limits should include reduction of road density, road-stream crossings, and near stream roads. Timber harvest rates should never exceed 25% of a watershed in any 30 year period (1% POI). No timber harvest should be allowed within a radius of a stream similar to that recommended by FEMAT (1993) and Spence et al. (1996), which is a minimum of two site potential tree heights or 400 feet in redwood forests. Similarly, no timber harvest should be allowed or roads constructed within inner gorges, headwater swales or zones at high risk of landslide (Montgomery and Dietrich 1994, Dietrich et al. 1998).

In order to gauge watershed and stream recovery, there must be some agreement on standard scientific techniques that will be used for monitoring, and an understanding of which values of these parameters represent undisturbed or recovered conditions. Kier Associates and NMFS (2008) provided a broad base of support from scientific literature for upland disturbance thresholds and aquatic habitat reference values. Representative values have been recommended for tracking the success of watershed (Table 6-2) and stream restoration (Table 6-3).

Table 6-2. Recommended targets for watershed conditions.

Parameter	Upland Target Conditions	References
Road Densities	< 2.5 mi./sq. mi.	USFS (1996), NMFS (1995), Armentrout et al. (1998)
Road-Stream Crossings	< 1.5 road crossings per mile of stream	Armentrout et al. (1998)
Streamside Roads	De-construct streamside roads and relocate haul roads to ridge tops	Bradbury et al. (1995)
Timber Harvest	< 25% of a watershed in 30 years (1% POI)	Reeves et al. (1993)
Unstable areas	No disturbance in SHALSTAB high risk zones or inner gorges	Dietrich et al. (1998), FEMAT (1993)

PL (1998) and HRC (2009) have used many standard aquatic monitoring techniques, and many of the sampling locations throughout the lower Van Duzen River Basin have remained the same over time, which facilitates trend monitoring. HRC should continue to monitor water temperature (MWAT), residual pool depth, median particle size (D50), large y debris and fine sediment (<0.85 mm and <6.4 mm). The V* method (Hilton and Lisle 1993), which measures the volume of sediment in pools, takes only one day per stream per year for sampling and HRC should consider adding it as a trend monitoring tool.

HRC should either go back to wet sieve sampling when measuring fine sediment in stream gravels so that comparison with TMDL references can be gauged, or engage in more studies to understand how to compare dry and wet sieve samples. The low values for sediment less than 0.85 mm (5-10%) are inconsistent with other sediment signals, including sediment less 6.4 mm and with D50 levels in the impaired range.

In addition to monitoring HRC lands, there needs to be expanded flow and water quality monitoring to discern whether flow depletion and nutrient pollution related to rural residential development are a problem. Target streams for this type of monitoring include Wolverton Gulch, Wilson Creek, Fiedler Creek, Cummings Creek, Fox Creek, and Hely Creek. Potential for expanding the volunteer network in the Van Duzen and establishing photo points with a seasonal time series could reveal flow levels. Measuring flow requires considerable expense, but water temperature can also be used as a surrogate for flow because temperatures increase as water volume drops. Therefore, placement of automated temperature sensing devices throughout the watershed should also be considered. Mainstem monitoring could help detect signs of nutrient pollution in the lower basin as a whole.

Aquatic habitat and fish population trends are not showing substantial recovery in the Van Duzen River watershed, including Yager and Lawrence creeks. coho salmon and cutthroat trout have been lost and summer steelhead and fall Chinook salmon are at high risk of extinction. Because of the widespread holdings of HRC in the lower Van Duzen River, Yager Creek, and Lawrence Creek watersheds, the subsequent timber management practices of this company will have a dramatic impact on the survival and recovery of native cold water species in this region.

It is recommended that refugia for fall Chinook salmon be established in Lawrence Creek (Figure 6-1) to help prevent extinction both locally and in the Eel River Basin as a whole. Restoration in the Upper Van Duzen River Basin would help restore steelhead and incrementally improve water quality in downstream areas, but will not substantially benefit salmon species because steep stream gradients makes the area inaccessible. Restoration of alluvial valley reaches of both small and large tributaries should also be a priority because these are the most highly productive locations, and therefore, also likely have the greatest carrying capacity for salmonids in a restored condition. The Van Duzen Watershed Project should continue to build partnerships to assist with monitoring, and to engage all land owners and residents in watershed, water quality, and fisheries restoration.

Table 6-3. Recommended TMDL Implementation Trend Monitoring Methods and Locations.

Method	Reference	Target	Location
Benthic Macroinvertebrates	Kier Associates and NMFS (2007)	EPT > 25 species Richness > 40 species Percent Dominance < 20%	Repeat at previously monitored locations every five years or after major storm event
Large Woody Debris	Schuett-Hames et al. (1999)	Key Pieces > 3 per mile	Coho salmon tributaries lower than fourth order
Embeddedness	CDFG (2004)	< 25%	All stream sizes. Not necessary if more quantitative fine sediment data are collected.
Pool Distribution and Depth	US EPA (1998b)	> 3 ft.	Use habitat typing data or directly measure pool depths to gauge trends in all sizes of streams
Percent fines (<0.85 mm, 6.4 mm)	Van Duzen TMDL	Less than 14% < 0.85 mm fines Less than 30% < 6.4 mm sand-sized	Same locations as PL study but add tributary locations where fine sediments are a problem (e.g., Wolverton Gulch) or to gauge trends after restoration
Cross Sections	Kelsey (1977)	Recovery Trends (degradation)	Wherever there are previously monumented cross sections
Volume of Sediment in Pools (V*)	Hilton and Lisle (1993) and Knopp (1993)	< 0.21 V* or roughly 21% of pools filled with sediment	Begin monitoring in as many creeks with low gradient reaches as possible.
Median Particle Size (D50)	Knopp (1993), Gallo (2002)	> 42 mm < 85 mm	PL monitoring locations and add stations since cost is low.
Turbidity	Klein (2003)	< 25 ntu	Continue trend monitoring
Water Temperature	Welsh et al. (2001)	< 16.8 degrees C MWAT for tributaries	Continue monitoring at previously sampled locations and add.

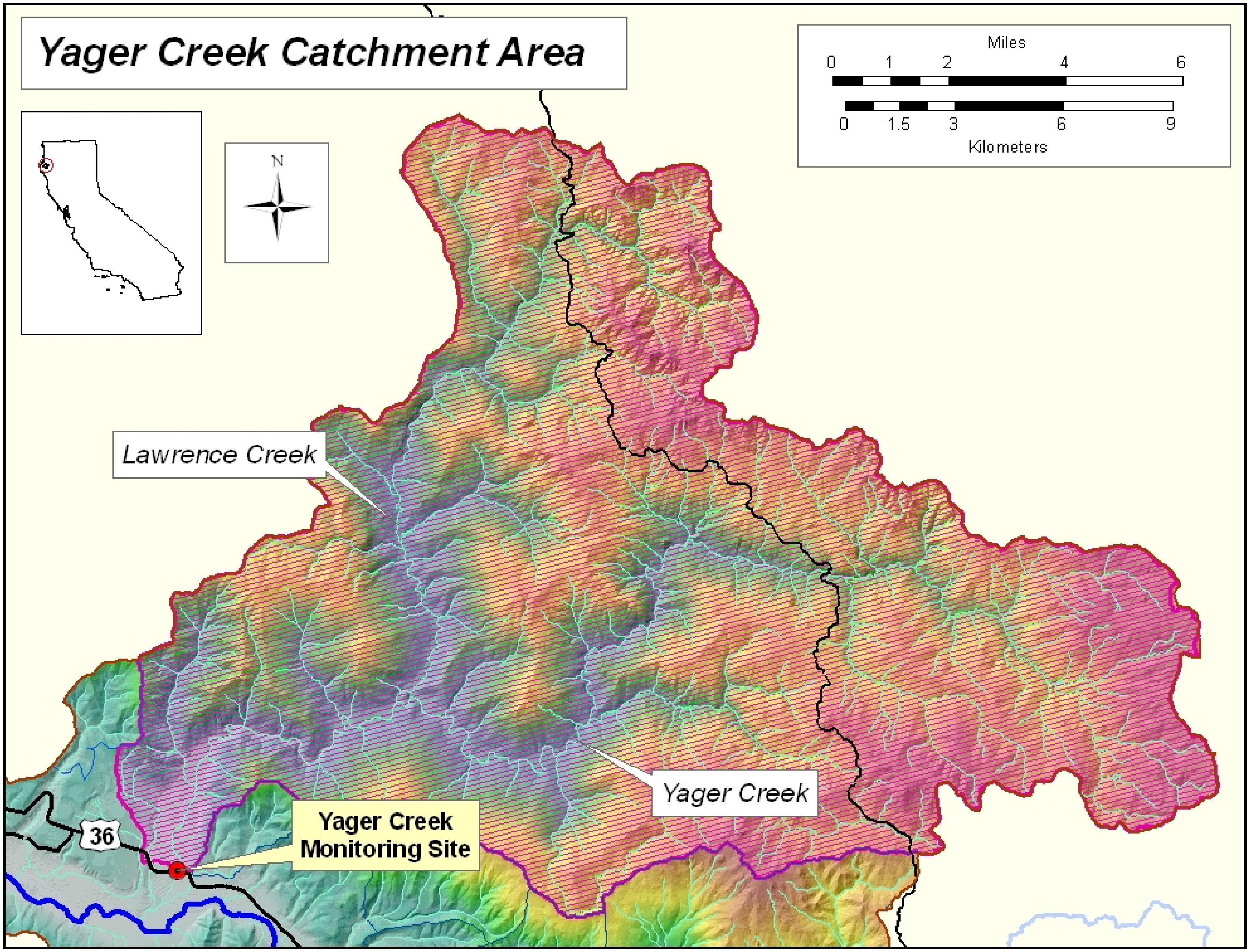

Figure 6-1. Yager Creek sub basin, showing the convergence of Yager Creek and Lawrence Creek.

Van Duzen Firesafe Council Strategies

Over a great number of years now, The Van Duzen Firesafe Council has been very successful in obtaining funding and support for their programs to remove understory and excessive fuels along roads within the Van Duzen River Basin. We view the objectives and priorites of the council as sound and of high priority, and very much in line with the goals and objectives of the Van Duzen Watershed Project. The Van Duzen Firesafe Council has traditionally focused on areas deemed most susceptible to fire and vigorously work to minimize the likelihood of fire, especially in those areas populated by local residents.

The mission of the Van Duzen Firesafe Council is: "To preserve California's natural and man-made resources by mobilizing all Californians to make their homes, neighborhoods, and communities fire safe." In addition the council is committed to formulating a working fire plan, educating and motivating residents to be fire safe, coordinating action plans with government agencies, detailed mapping and risk assessment, actively performing fuel reduction work on property-by-property basis, and creating an emergency response system for the local communities.

Firesafe Council Objectives include the following.

- To educate the community, making their property fire safe, and to describe actions to be carried out in the case of a fire emergency.
- To map homes, roads, and resources, to access and prioritize needs, and to provide maps to emergency services with GPS links.
- To establish a Volunteer Fire Company
- To actively apply for funding to do fuels reduction work in areas of need.
- To coordinate cooperation with government, private, and non-profit organizations involved in similar interests.
- To train and employ a local crew of workers for the tasks of fuel reduction within the Van Duzen River Basin.

Besides reducing the amount of understory and other material that provides fuels for wildfires Certainly fires of any kind, especially forest fires, constitute serious damage to wildlife and property, and our organization fully supports the work of the Van Duzen Firesafe Council in their efforts to bring about a safer environment. We recommend that future efforts to restore the streams and the lands within the basin incorporate the efforts of the Firesafe Council to promote healthy and safe watersheds, which includes minimizing the chances of wildfires within this region and documenting areas where roads and watercourses show incipient and potentially serious problems with regard to failing culverts and impending erosion.

Opportunities for Restoration

Species Distribution and the Role of Refugia

The CA Department of Fish & Game and NOAA Fisheries provide digital data on the distribution of cold water salmonid species in streams of Northern California. These data, in digital format, were clipped to the spatial extent of the VDWP study area to represent the distribution of coho and Chinook salmon (Figure 6-2) in the Lower Van Duzen River Basin. Distribution of coho salmon is most critical, as this species has experienced the most dramatic declines in numbers throughout Coastal Northern California, and has been placed on the endangered species list. Chinook salmon are not as limited in their range as coho, but based on potential and available habitat, have nonetheless experienced dramatic declines in the lower basin. One of the major limiting factors in the ranges of these species is stream gradient. Unlike Steelhead that can negotiate fairly steep gradients when migrating upstream, coho salmon generally do not migrate beyond about 3-4% stream gradient, preferring 2% or less (Burnett et al 2007, Williams et al. 2006), and Chinook salmon also seem to prefer lower gradient habitats.

Based on road and road-stream crossing densities, vegetation, timber harvest including silviculture and yarding methods, and geology, as well as turbidity and suspended sediment levels, project results indicated that while variation exists, most of the planning watersheds within the lower basin are in poor health. Planning watersheds that are particularly impaired would need to be considered as to their potential for restoration and rehabilitation, but it would be futile to attempt restoration of salmon stocks in areas that are inaccessible to these species. Therefore it is advantageous to rate the watersheds as to their potential for returning to an ecologically stable status or successful restoration, and to focus on areas where coho and Chinook salmon populations (as well as cutthroat trout) exist, or have been known to exist. Using s stream network overlaid on 10-m digital elevation model grid data, it is possible to employ algorithms to delineate percent stream gradient for a given area. Percent gradient was thus calculated for all of the 1:24,000-scale streams in the lower basin study area (Figure 6-2).

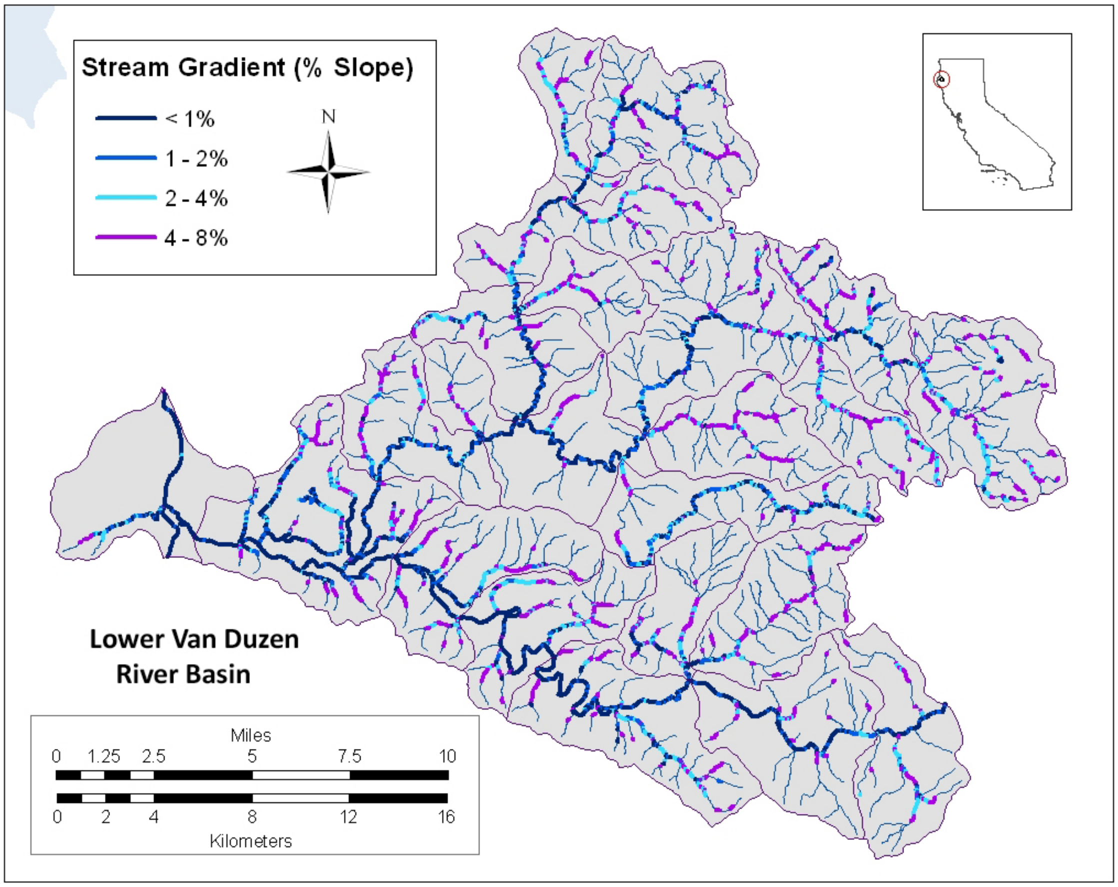

Figure 6-2. Percentage gradient through 8% for all 1:24,000 scale streams within the Lower Van Duzen River Basin. Thin blue lines represent reaches with gradients over 8%.

These data can be compared with CA Department of Fish & Game data on distributions of salmonids in this same region (Figure 6-3). A comparison of the two figures shows good agreement between the distribution of coho in 2005 and stream gradient. Projects to restore stream habitat for coho would be most successful if limited to the areas downstream of their original range, such as Shaw Creek as an upper limit on Lawrence, and the lower reaches of Woverton Gulch and Grizzly Creek (Chapter 3, Figure 3-1). However, restoration of steelhead habitat could be more extensive, and would be advisable as far up as the headwaters of Lawrence Creek, Upper, Middle, and Lower Forks of Yager Creek, Cummings Creek, Hely Creek, Root Creek, Stevens Creek, and a large portion of Grizzly Creek (Chapter 3, Figure 3-1).

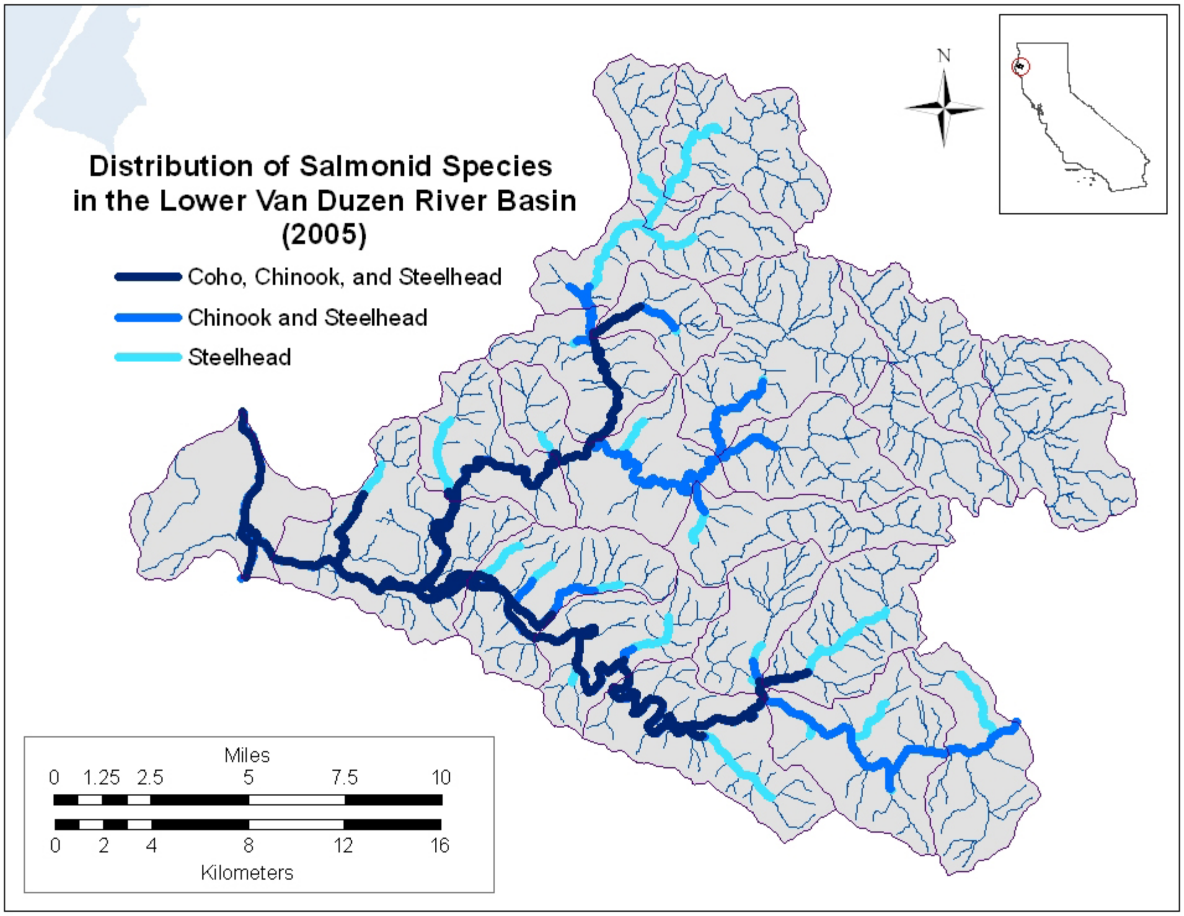

Figure 6-3. Distribution of salmonid species within the Lower Van Duzen River Basin. Data from CDFG, provided by CalFish.

Using stream gradients, salmonid distributions, and data collected on the conditions of the streams and watersheds, a listing of priorities for streams within the lower basin can be developed (Table 6-4). Planning watersheds can also be prioritized based on their relative potential as to the severity of sediment yield, opportunities for sediment reductions, and the presence of streams with the potential for salmonid recruitment (Table 6-4).

Table 6-4. Streams within the Van Duzen Watershed Project area of highest priority for Action Plans, based on potential for reduction of sediment delivery.

Sub Basin	Planning Watershed	Stream
Lawrence Creek	Bell Creek	Bell Creek
	Lawrence Creek	Lawrence Creek
	Booths Run	Booths Run
	Shaw Creek	Shaw Creek
	Corner Creek	Corner Creek Lawrence Creek
Yager Creek	Blanton Creek	Yager Creek Blanton Creek
	Copper Mill Creek	Cooper Mill Creek
	Wolverton Gulch	Wolverton Gulch Yager Creek Wilson Creek
	NF Yager Creek	NF Yager Creek
	MF Yager Creek	MF Yager Creek
	SF Yager Creek	SF Yager Creek
Lower Van Duzen River	Cummings Creek	Cummings Creek
	Hely Creek	Hely Creek Flanigan Creek Fox Creek
	Root Creek	Root Creek
	Stevens Creek	Stevens Creek
	Grizzly Creek	Grizzly Creek
	Swans Flat	Van Duzen River

Objectives for Action Plans within the Lower Basin

Action 1: Sustainable Forest Management and Policy

Implementation of modifications to forest management practices will occur in collaboration and cooperation with Humboldt Redwood Company and appropriate state agencies (e.g., State Water Quality Control Board, CA Department of Fish & Game, and CA Department of Forestry).

Naturally, recommendations directed at modifying logging practices and the management of timber harvest would primarily involve changes in policy at both the industry and state agency (CDF) levels. Modifications and improvements in Best Management Practices need to be adopted by the timber industry as a whole, but regulations and incentives through the State of California need to be in place for these improvements to be adopted. Some of the recommendations listed below have already been adopted by the Humboldt Redwood Company, bringing it more in line with the practices that were in place in the original company (Pacific

Lumber Company) before the Maxaam/Hurwitz take over in 1985. However, these and the other recommendations listed below need to become state policy and adopted by the industry, if clean water and watersheds are to return to healthy conditions in the lower basin.

1) **Eliminate the cutting of old growth forest –** this will promote greater overall forest and watershed health, greater forest complexity and stability, reduced sediment yields and delivery to streams, and more sustainable and economically rewarding timber harvest management practices than exist currently.

2) **Eliminate clear cutting** from all timber harvest practices, and transition (strongly favor) multi-aged harvest plans.

    - Encourage timber companies and operators to discontinue clear cutting by enacting state policies that would reward operations (possibly with tax incentives) that shift from clear cutting to multi-aged harvest plans.

3) **Restrict and eventually phase out tractor yarding** methods of timber harvest throughout Northern California, especially the Lower Van Duzen and Yager-Lawrence sub basins.

    - As with clear cutting, phasing out tractor yarding in favor of aerial yarding (e.g., helicopter, balloon, or cable) could be encouraged with tax-based incentives coupled with gradually greater regulatory safeguards.

4) **Restrict timber harvest (especially of redwood) on steep slopes and/or unstable geology**, such as Wildcat formations.

    - More thorough regulations would require greater levels of vigilance, more on-the-ground observations, and a stronger commitment by both industry and state agencies to improve best management practices.

5) **Establish at least 300 foot buffers** around fish-bearing (Class I) streams, and 150 foot buffers around Class II streams.

    - Buffers will represent a healthy riparian zone that will be comprised of both hardwoods (initial colonizers) and conifers that will come in after hardwoods have become established.

    - A healthy riparian zone with adequate shade from both hardwoods and conifers will create an appropriate microclimate, and maintain cool water temperatures in the streams – highly beneficial for cold water species like salmon, steelhead, and trout.

6) **Extend re-entry time into the forest system** (especially redwood) by timber harvest operations to at least 40, and more appropriately, 60-year intervals.

    - Repeated entry into forest habitats **compacts the soil, interferes with water absorption, damages tree roots and growth processes**, and interferes with the ability of forests to return to a more ecologically balanced and sustainable condition.

- **Watersheds need to rest** and require time to return to a more stable condition, so that they are better equipped to absorb water during heavy storm events and release water to streams during the dry months.

7) **Use objectives** from **the Garcia Forest Management Plan** (The Conservation Fund 2006) as a guide for BMP recommendations, as follows.

   a) Under proper intensive management, **a long-term growth rate of at least three percent** is realistic and attainable when carrying appropriate inventories.

      - For the first eight decades, beginning in 2006, harvest less than the periodic growth increment, allowing surplus volume and in growth to accumulate and add to the growing stock (until the inventory goals are attained)
      - During initial entry, thin forest stands from below to adjust spacing, maximizing light and space to allow crop trees to attain "target" size.
      - At each entry, remove selected low quality and slower-grow trees, consistent with aesthetic and wildlife goals.
      - Reduce hardwood component on sites where conifer was historically dominant.

   b) **Silviculture** will be primarily **uneven-aged (multi-aged), to develop and maintain a range of tree sizes and ages within a stand**, with the goal of producing valuable timber and utilizing natural regeneration.

   c) **Harvest levels will be significantly less than growth rates** over the next few decades so as to increase the timber inventory (growth rates expected to double in 25 years).

   d) Provide for **increased riparian buffers** on Class I streams so as to improve riparian habitat conditions and provide late-seral connectivity across the landscape.

   e) Special attention will be given to critical wildlife habitat features, such as snags, down wood, and trees of significant size.

   While our specific recommendations will vary from the above plan for forestry management (#7) as put forth by the Garcia River Conservation Fund (2006), the Garcia plan is **an example of how to structure an economically viable forest plan that is also ecologically sound** with the strong likelihood of sustainability, and many of its features are reproducible.

8) The California Department of Fish and Game's Recovery Strategy for coho salmon specifically recommends that **continued economically sustainable management of forest and agricultural lands** be encouraged in the range of coho salmon to reduce the potential for conversion to residential or commercial development.

   - In other words, **timberlands are important**, and should be reserved for the harvesting of timber, but in an ecologically sound and sustainable manner, similar to the recommendations described above.

Action 2: Upland Management

Virtually all actions to remediate and improve forest practices directly relate to an upland management plan, as forests within the Van Duzen River Basin are uphill from the river and streams. As with the instream and riparian restoration effort, much of the upland effort and management project would be accomplished in cooperation and jointly with ERWIG, as this organization has developed considerable skill and experience in the restoration of hillslopes including the decommissioning of roads and culverts. As most of the logging roads are on HRC lands, road and culvert decommissions will also involve working cooperatively with this company and reaching agreements on all decommissioning projects. A good guide for construction, reconstruction, maintaining, and closing wildland roads is included in the handbook on forest and ranch roads published by Mendocino Resource Conservation District (MRCD 1994).

Additional efforts to improve uplsope conditions with respect to roads in the lower basin would thus include the following.

1) **Decommission all inactive and failed roads**, wherever possible, especially adjacent streams (e.g., within 30 meters of a stream, and 90 meters of any fish-bearing stream).

2) **Redesign and modify problematic roads** to eliminate the channeling of water and sediment into streams, and promote ground water infiltration.

3) **Repair, replace or decommission failed or problematic culverts**, and where possible replace with concrete and/or steel bridgework.

Action 3: In-Stream and Riparian Habitat

Riparian habitats are generally rich in biological diversity. Regeneration of early successional vegetation communities is an important process in maintaining the habitat heterogeneity required for healthy riparian systems (Naiman, et al. 1993). Fully functioning riparian ecosystems have been shown to improve groundwater and stream quality by removing undesirable constituents such as nutrients and pesticides (Lowrance et al.1985). Results from other studies suggest that horticultural approaches (e.g., planting native species) to restoration are advancing conservation goals, but that considerable additional benefit may be gained from implementing strategies that area compatible with natural processes (Golet et al. 2003).

On several occasions members of the Van Duzen Watershed Project have met with the Eel River Watershed Improvement Group (ERWIG), which over the years, has gained a great deal of experience in upslope and instream rehabilitation projects. This group has been successful in receiving funding for restoration projects, and works diligently in the area stream and hillslope restoration. ERWIG would be a major participant in the implementation efforts. Much of these efforts towards stream restoration would be done in cooperation with ERWIG. Currently, the California Department of Fish & Game does not allow any concerted instream effort to control pikeminnow populations in the Van Duzen River or Eel River Basins. However, should the recommended actions become implemented and stream conditions become more suitable for salmonids (i.e., colder stream temperatures and deeper channels), these habitats will become increasingly less suitable for invasive species such as the pikeminnow. Some instream recommendations are as follows:

1) **Implement an instream monitoring program** where turbidity threshold sampling (TTS) stations can be established to collect data on turbidity and suspended sediment on an annual basis (see Action 10 for listing of candidate streams).

2) **Engage in the planting of hardwoods and conifers** within stream riparian zones to increase the shading and microclimate moderating capacity, as well as enhancement and deepening of the channel over time.

3) **Inventory and map sources of stream bank erosion** (e.g., landslides) and prioritize according to present and potential sediment yield, to identify sites that should be treated to reduce the amount of fine sediment entering streams.

4) Establish a program for **placement of large wood** into streams with historic or present occurrence of salmonids, especially coho salmon, to promote development of deep pools in streams slated for temperature monitoring (see Action 2, Water Quality).

5) Where appropriate, **provide support for stream banks with bouldering, cabling, and wing diverters** to prevent loss of soil and encourage stream meandering.

6) **Eliminate or strictly regulate gravel mining** in the lower river alluvial plain, especially near and adjacent the river channel, in order to foster the return of a healthy riparian zone, deepening of the channel, and cooler stream temperatures.

7) **Locate and remove instream barriers** to fish passage.

    - All impacted and problematic **culverts should be modified or replaced** with improved mechanisms such as concrete bridges, or in appropriate situations (e.g., where roads are being decommsioned), removed entirely.

    - **Collect comprehensive information** on blockages to fish passage, **with on-the-ground reconnaissance**, some of which could be accomplished through cooperation with the Van Duzen Firesafe Council.

    - Where blockage is severe (i.e., steep drop offs on downstream side of culverts that completely block fish passage), **rehabilitation of stream segments** would be required.

      \- For example, blockages of fish passage have been reported on Wolverton Gulch and Fox Creek at the overpass of Highway 36. These **culvert systems should be replaced with boulder stepping in the stream and concrete bridgework** over the stream at the highway locations. All culverts associated with Highway 36 should be replaced with concrete bridges.

- Other barriers, including those that are natural in origin such as log jams, could be remediated with less cost by their **physical removal or modification in situ**.

Action 4: Water Quality

1) **Water temperatures**, especially in July and August, suggest that maximum temperatures in the main stem Van Duzen River and Yager Creek, as well as some of its tributaries are above the acceptable range for juvenile salmonids. Therefore maintain and expand instream continuous monitoring of stream temperatures throughout the summer months using HOBO temp data loggers.

   - **Expand the number of temperature recording sites** from seven to a total of at least 29 sites.

   Stream sites will include the original seven monitored during our project, which include Wolverton Gulch, Lower Yager Creek (downstream from the Lawrence Creek convergence), Cummings Creek, Hely Creek, Grizzly Creek, and two sites on the main stem Van Duzen River.

   - **Additional stream sites will include** Lawrence Creek, Yager Creek (above the Lawrence Creek Confluence), Bell Creek, Fish Creek, Alan Creek, Booths Run, Shaw Creek, Cooper Mill Creek, Blanton Creek, Corner Creek, North Fork, Middle Fork, and South Fork Yager Creek, Barber Creek, Wilson Creek, Cuddeback Creek, Fiedler Creek, Fox Creek, Flanigan Creek, Stevens Creek, Grizzly Creek (above the confluence with Stevens Creek), and Root Creek.

2) **For streams listed above (#1), sample for V* and D50 (sediment and particle size**, respectively).

   - All streams will be **monitored a minimum of three to five consecutive years** during summer months

3) **Streams will also be monitored year-round for** dissolved oxygen, pH, and conductivity for each of three consecutive years. The number of streams that are sampled will be doubled over those that were sampled in the current project, which will include Lawrence Creek, Booths Run, Shaw Creek, Corner Creek, Cooper Mill Creek, Blanton Creek, Upper Yager Creek, Cuddeback Creek, Fiedler Creek, Fox Creek, Flanigan Creek, Hely Creek, Stevens Creek and Grizzly Creek.

4) **The amount of water in the streams is a limiting factor** for cold water species.

   - More effort will be made to **monitor and record flow rates**, or discharge, on an annual basis, in order to show the relationships between flow rates in the wet season versus the dry season, and the influence of intact forest vegetation on seasonal flow rates.

- Intact, healthy watersheds with **forests of increasing age structure and complexity will have a greater water holding capacity** than impaired watersheds, where forests are of a single dimension and lack complexity. Greater water holding capacity will reflect intact forests that facilitate sustainability in timber harvest management.
- In those streams where TTS stations are installed (8 sites), **stream discharge should be monitored continuously**, and therefore should be part of the cumulative data base.
- Flow rates will also be **monitored in at least 10 other streams** throughout the year. These streams will include: Bell Creek, Fish Creek, Alan Creek, Booths Run, Shaw Creek, Cooper Mill Creek, Blanton Creek, Corner Creek, Cuddeback Creek, Fiedler Creek.

Action 5: Cost Effectiveness (Budget and Sources)

The funding of our project by the CA Water Quality Control Board marked the first milestone in our ability to recognize the impaired conditions that exist in the Van Duzen River Basin. Funding through the State of California represents a great opportunity for non-profit organizations, as well as municipalities, to obtain support for much needed monitoring, research, analysis, and restoration of local streams and watersheds throughout the Pacific Northwest. While extremely involved, this process serves to assure state officials and their constituents that projects approved for funding will provide the greatest opportunities for successful improvement in water quality throughout the state.

Attempting to determine the cost of implementing the entire series of recommendations throughout the Lower Van Duzen River Basin is a daunting task and one that, by necessity, inevitably involves best estimates. Based on estimated stream miles, sediment reduction targets proposed in the TMDL (USEPA 1999), and the area of the planning watersheds deemed to have potential for salmonid returns and in need of restoration, a general budget of costs for the most reasonable implementation plan within a duration of ten years was developed (Table 6-5).

Streams with the very highest priority (Table 6-4) would be those deemed to be good candidates for placement of TTS stations throughout the lower basin (see Action 10: Monitoring Efficacy). Planning watersheds considered good candidates based on earlier descriptions of priorities are recommended for upslope rehabilitation, including decommissioning of roads and culverts and instream habitat improvement.

Table 6-5. Draft Budget for Implementation of Recommended Actions over a ten-year period.[1]

Project	Units	Approximate No. of Units	Average Unit Cost	Cost per Year	Total Expenses for 10 Years
Water Quality	Instrumentation	29	500	15,000	150,000
Instream Habitat	Stream Miles	30	6,100	183,000	1,830,000
TTS Monitoring	Stations	8	14,000	112,000	1,120,000
Load Reductions	yds^3/mi^2	12,000	12	144,000	1,440,000
Total				**454,000**	**4,540,000**

1 Some average unit costs are based on estimates as listed in the Mattole Integrated Coastal Watershed Plan (2009). Load reductions are based on 50% improvement, which results in a reduced load of 630 yds^3/mi^2, times 190 mi^2 of critical watersheds, which roughly equals 120,000 units for a ten-year period, or 12,000 units per year. TTS monitoring includes initial costs of construction plus annual data collection, processing, and analysis, spread across ten years.

Technical and Financial Assistance (Element 4)

The above plan is ambitious and probably represents the largest budget in terms of funding and time commitment ever recommended for a restoration project in the Van Duzen River Basin. However, our preliminary evaluations of the lower basin suggest that the timing of such a project may be nearly ideal, as we are seeing greater innovation both in recent timber harvest management, and in agency (state and federal) support of these types of projects. We envision a project of this magnitude to be funded through many different sources, including private industry, and state and federal sources of support.

Knowledge of funding sources will be fundamental to establishing a viable implementation program in the future. Sources of funding exist at a variety of levels, and are often suitable and geared for non-profit organizations. Many of these sources are described in Table 6-6, originally listed in the draft Salmon Creek Integrated Coastal Watershed Management Plan (Gold Ridge RCD 2010).

Table 6-6. List of Funding Sources for Watershed and Water Quality Programs throughout California and the U.S. (Gold Ridge RCD 2010).

Funding Entity	Funding Program
State Agencies	
State Regional Water Board	319(h) Nonpoint Source. Funding is through the USEPA and is intended to result in improved water quality through projects that address TMDL implementation or problems in streams, bays, rivers, and lakes that have been listed as impaired.
	Small Community Wastewater Grant Program. The program provides assistance for planning, design, and construction of publicly owned wastewater treatment and collection systems.
	Clean Water Revolving Loan Fund. Provides low-interest loans for stormwater and wastewater treatment, and implementation of projects to reduce nonpoint source pollution.
	Integrated Regional Water Management Grant Program. The intention is to integrate sustainable and reliable water supply, better water quality, stormwater management, environmental stewardship, and a strong economy.
CDFG	Fisheries Restoration Grant Program. This is a long-standing competitive grant program funded by both state and federal sources. Funding can be used for planning, barrier removal, habitat restoration, monitoring public involvement, maintenance, and education for projects consistent with current CDFG priorities.
State Coastal Conservancy	Funding is primarily through voter-approved bond funds. Provides funding for projects to purchase, protect, restore, and enhance coastal resources.
Department of Water Resources (DWR)	Groundwater program. Includes a range of grants for groundwater monitoring and management.
	Integrated Regional Water Management Grant Program. DWR administers IRWM grants through Proposition 84. DWR also manages many other grant and loan programs.
Cal Fire	Fire Prevention Program. Fire-safe landscaping for homeowners and communities.
	California Forest Improvement Program (CFIP). Provides cost-share assistance to private landowners, RCDs, and non-profit groups for planning, planting, fish and wildlife habitat improvement, and land conservation practices.
Department of Public Health	Safe Drinking Water State Revolving Fund. Provides funding to correct public water system deficiencies. Selection is based upon a prioritized funding approach that addresses public health risks, compliance with requirements of the Safe Drinking Water Act, and need on a per household affordability basis.

Funding Entity	Funding Program
Federal Agencies	
USEPA	The USEPA website features an extensive catalog, sorted by keyword (e.g., invasive species, monitoring, land acquisition, watershed management), of federal funding sources for watershed protection (http://cfpub.epa.gov/fedfund/keyword_list.cfm).
U.S. Fish and Wildlife Service	Cooperative Conservation Initiative. Provides cost-share assistance to private landowners to restore natural resources and establish or expand wildlife habitat.
	Open Rivers Initiative provides funding and technical expertise for community-driven, small dam and river barrier removals.
NOAA Fisheries	Multi-year regional habitat restoration partnerships including watershed-scale projects that yield significant ecological and socioeconomic benefits. National Association of Counties and NOAA are partners in the Coastal Counties Restoration Initiative (CCRI). CCRI encourages innovative, county led or supported projects that restore important marine and coastal habitats and living resources. These projects also develop the capacity of county governments, citizens groups and other organizations to conduct community-based restoration that will enhance local watershed-based resource management and promote stewardship.
Natural Resources Conservation Service (NRCS)	NRCS manages a suite of programs (shown below) that provide technical and cost-sharing assistance to implement conservation practices, primarily for owners of land in agricultural production. http://www.ca.nrcs.usda.gov/programs/
	A single, voluntary conservation program for farmers and ranchers to address significant natural resource concerns. Nationally, it provides technical and financial assistance to address natural resource concerns. Reauthorized in the 2008 Farm Bill and awards cost share assistance to projects which provide significant environmental benefit. Eligible farmers and ranchers may apply for EQIP program benefits at any time.
	The Healthy Forest Reserve Program is a voluntary program established for the purpose of restoring and enhancing forest ecosystems. It can provide cost-share for conservation practices, a conservation easement in exchange for market value, and Safe Harbor from future regulatory restrictions under the Endangered Species Act.

Funding Entity	Funding Program
Natural Resources Conservation Service (NRCS)	The Agricultural Water Enhancement Program (AWEP) is a voluntary conservation initiative that provides financial and technical assistance to agricultural producers to implement agricultural water enhancement on agricultural land for the purposes of conserving surface and ground water and improving water quality. As part of the Environmental Quality Incentives Program (EQIP), AWEP operates through program contracts with producers to plan and implement conservation practices in project areas established through partnership agreements.
	The Conservation Stewardship Program encourages land stewards to improve their conservation performance by installing and adopting additional activities, and improving, maintaining, and managing existing activities on agricultural land and nonindustrial private forest land.
	Through the Conservation Stewardship Program, financial and technical assistance is offered to eligible producers to conserve and enhance soil, water, air, and related natural resources on their land. Eligible lands include cropland, grassland, prairie, improved pastureland, rangeland, nonindustrial private forest, agricultural land under the jurisdiction of an Indian tribe, and other private agricultural land (including cropped woodland, marshes, and land used for the production of livestock) on which resource concerns related to agricultural production could be addressed.
Other Sources	
National Fish & Wildlife Federation (NFWF)	NFWF has a number of programs that could apply including: Native Plant Conservation Initiative supports projects that protect, enhance, and/or restore native plant communities.

As the majority of these projects will be on Humboldt Redwood Company (HRC) lands, there will be a joint and cooperative effort to work with the company at each step of the process, from the initial layout of the individual projects to the actual work and collection of data. As HRC personnel will be contributing time and energy to the restoration effort, it will be considered match funding on the part of the company. We also anticipate as our project and funding are demonstrated, HRC will contribute cost-sharing (either in the form of grants or on-the-ground help) to many of the different aspects of the restoration effort. If the goals of the project are shared by the company, then mutual commitments to the end result will benefit all stakeholders.

It will also be imperative to acquire federal support of these projects, mostly in the form of competitive grants. The Van Duzen Firesafe Council has been very successful in being repeatedly funded by the Bureau of Land Management. Therefore, a consortium of groups (all of which have successfully sought external funding) including the Firesafe Council, Friends of the Eel River, Eel River Improvement Group, and Humboldt Watershed Council, will be brought together to strategize and jointly develop proposals for the funding of such an implementation project. Federal funding agencies would include the Environmental Protection Agency, the Fish & Wildlife Service, and the Bureau of Land Management.

State agencies will also need to be involved in many aspects of a project of this magnitude, both as sources of funding and as advisors on the direction and level of progress made through the course of the project. We are indebted to the Water Quality Control Board for funding this planning grant, and would expect that Water Board would be a major participant and influence in the operation and direction of the continuing project. Other state agencies that would be likely sources of funding for the project would include CA Department of Fish & Game and the CA Fire Safe Council. Other potential sources of funding would include companies in the private sector that are committed to environmental quality and the perpetuation of salmon and steelhead in the Pacific Northwest.

Our planning project was funded for about two years, and was geared to collect water quality samples throughout the lower basin for two years. However, because of the time that these funds were awarded, and the limit set on the duration of our project, monitoring during the first year was unavoidably limited and incomplete. It is recommended that the Water Quality Control Board re-evaluate the time of the year that funding is awarded, and set up the proposal deadlines so that funding could be awarded sufficiently early to allow organizations enough time to acquire the necessary materials and be ready for the onset of the next hydrologic season. In our case, materials could not be purchased until approval of funding (mid November of 2006), thus making it impossible to receive and set up the equipment in time to begin monitoring prior to the first storm event. Our Turbidity Threshold Station was not operational until mid January, and by then fully one-third to one-half of the largest storm events had already taken place.

We are very grateful to the Water Quality Control Board for supporting and funding our project. We strongly recommend however, that the Water Board consider funding projects for longer durations than the typical two year project, or at least provide a streamlined opportunity (possibly a simplified project description and funding request) for project renewals of up to an additional 2 to 3 years. A two-year project is not enough time to adequately acquire the amount of information necessary to formulate a valid watershed plan, or to even begin to understand the behavior of these streams. The literature is full of publications that demonstrate the need to monitor most watersheds over extended periods of time (e.g., decades), in order to characterize the variability and fluctuations that occur from year to year. Although we were unaware of it at the time, our project was initiated at the beginning of a 3-year dry spell, and during each of the two years of sampling for water quality, rainfall was dramatically below normal. As turbidity and suspended sediment yields are proportional to discharge, which is in turn proportional to the severity of storm events (i.e., rainfall), our results do not represent typical levels of impairment for these streams. Had our monitoring program occurred during average or greater than average rainfall, our project would have been a better predictor of the conditions of impairment within these watersheds.

Action 6: Information/Education (Element 5)

Educational and outreach programs initiated with the planning grant would be considered worthwhile endeavors to continue as projects through the implementation phase. Information, and education and outreach programs will fall into four categories: 1) Education of students in the classroom and in the field, and authorized school outings and field trips, 2) Monitoring of water quality and participation in various parts of the project by volunteers (the CMG), 3) Community outreach events, such as stakeholder events, presentations, updates, and public forums (e.g., Salmon Night), and 4) Internet.

Classroom and Field Events

Implementation will continue the Watershed Science in the Schools project, which has been very successful in past years. Recently, in coordination with AmeriCorps, members of the Van Duzen Watershed Project participated in a willow-planting project along the main stem of the Van Duzen River that took place over the course of several days (Figure 6-3).

Figure 6-4. Planting willows to support riparian habitat along the Van Duzen River about a mile downstream from Hely Creek outlet during late summer of 2009. Photo by P. Trichilo.

Projects such as this, serve a two-fold purpose. Riparian habitats are restored and students are exposed to sound environmental practices while gaining experience in the field. Projects such as this, which involve students and members of the community in a cooperative effort to improve conditions in the stream will be continued and promoted during implementation projects. The Van Duzen Watershed Project was also involved in several field trips for student to obtain hands-on experience seeing conditions in the streams and operating instruments for measuring and recording water quality. One of the most rewarding experiences was the AmeriCorps Field Day at Pamplin Grove on the Van Duzen River, during the late spring of 2008. During this outing, many students of varying ages learned about the importance of water quality and were allowed to obtain hands-on experience using authentic water quality measuring and sampling instruments (Figure 6-5).

Figure 6-5. Members of the Van Duzen Watershed Project demonstrate the use of water quality sampling and measuring equipment such as the Hach 2100P Turbidimeter to students at the AmeriCorps Field Day at Pamplin Grove, May 2008. Photo by S. Campbell.

Additional programs that will be supported through implementation will include workshops at local schools regarding salmon migration, place-based learning (a process that uses the local environment as a context for learning) in the Adopt-a-Watershed model, macro invertebrate sampling in the field with students, taking turbidity samples in the field and teaching students to use a turbidimeter, training students in the use of GPS devices, and to use proper protocol in recording data, encouraging science fair projects related to the watershed, implementing the Science in the Schools program, where scientists share information about careers in science, daily life experiences, and education, and Encouraging local schools to adopt a local stream for a series of study projects.

Volunteer Monitoring Program – The Citizens Monitoring Group

Members of the community will be encouraged to participate in the Citizens Monitoring Group that was an important part of the VDWP grab sample monitoring program. Some grab sampling will continue throughout the monitoring part of the implementation project, but as stated earlier, most of the sampling for turbidity and suspended sediment will be accomplished using turbidity threshold sampling (TTS) station. However, as the implementation project is so much more vast and involved than the planning project, there will be exceptional opportunities for public participation, both as staff and volunteers, depending upon individual preferences. As always, project staff will continually interact with the public and welcome new members from the community at large into the program to find useful and rewarding opportunities for anyone wishing to participate. These opportunities will not only benefit the project and the watersheds, but also serve to educate members of the community and they seek ways to become involved in the Community Monitoring Group.

Community Outreach

The implementation project represents a much expanded version of the planning project, and as such, will have a substantial group of stakeholders that will be interested in the program and the outcome of the projects. Landowners and stakeholders, including industrial concerns such as Humboldt Redwood Company, as well as individual members of the community, will be able to contribute opinions and suggestions to the development of ideas for accomplishing goals and objectives. All members of the public will be encouraged to attend semi-annual meetings and workshops. These events will update information on the progress of the project and the various programs underway within the overview of the project. Public participation will be encouraged at these meetings, which will also feature guest speakers with specific expertise on various and pertinent topics relating to the implementation project.

Internet

Friends of the Van Duzen Website has been instrumental in presenting all of the latest information in the form of documents, tables, photos, and maps, relating to the planning project over the last 3 years. This website (www.fovd.org) will also be instrumental in posting all announcements, including dates and times of stakeholder meetings and workshops, and all other information relating to the implementation project. Therefore, the website with in multiple web pages becomes a bulletin board and a source of vital information on the state of the Van Duzen River Basin.

Action 7: Schedule and Implementation Prioritization (Element 6)

As with developing a ten-year budget, attempting to determine the specific timing of projects and how they will play out over a ten-year period throughout the Lower Van Duzen River Basin is also a challenging task and one that, by necessity, inevitably involves some estimates. The following schedules roughly estimate timelines for projects recommended in this plan.

Forest Practices and Policy

Sustainable Forest Management and Policy	Implementation Schedule									
	2012	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**
A. Push for state-wide elimination of the cutting of old growth trees, espcially Redwood.										
1. Work with CDF and industry (including small operators to cease cutting old growth trees, especially Redwood.										
B. Eliminate clear cutting from all timber harvest practices, and transition (strongly favor) multi-aged harvest plans.										
1. Encourage timber companies and operators to discontinue clear cutting by enacting state policies that would reward operations (possibly with tax incentives) that shift from clear cutting to multi-aged harvest plans.										
C. Work with agencies and timber managers to phase out tractor yarding methods of timber harvest throughout Northern California, especially the Lower Van Duzen and Yager sub basins.										
1. As with clear cutting, phasing out tractor yarding in favor of aerial yarding (e.g., helicopter, balloon, or cable) could be encouraged with tax-based incentives coupled with gradually greater regulatory safeguards.										
D. Restrict timber harvest (especially of redwood) on steep slopes and/or unstable geology, such as Wildcat formations.										
1. More thorough regulations would require greater levels of vigilance, more on-the-ground observations, and a stronger commitment by both industry and state agencies to improve best management practices.										

Sustainable Forest Management and Policy	Implementation Schedule									
	2012	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**
E. Establish at least 300 foot buffers around fish-bearing (Class I) streams, and 150 foot buffers around Class II streams.										
1. Work with CDF and industry (including small operators to cease cutting on slopes greater than 40% and slopes on Wildcat geology										
F. Extend re-entry time into the forest system (especially redwood) by timber harvest operations to at least 40-year intervals.										
1. Work with CDF and industry (including small operators to extend times of re-entry into cut areas to at least 40-year intervals										
G. Use objectives from the Garcia Forest Management Plan (The Conservation Fund 2006) as a guide for BMP recommendations										
1. Use a long-term growth rate of at least three percent, which is realistic and attainable when carrying appropriate inventories										
2. For the first six decades, harvest less than the periodic growth increment, allowing surplus volume and in growth to accumulate and add to the growing stock										
3. Use uneven-aged (multi-aged) harvest to develop and maintain a range of tree sizes and ages within a stand, with the goal of producing valuable timber and utilizing natural regeneration										

Upland Management

Upland (and Upslope) Management	Implementation Schedule									
	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
A. Engage in an assessment of road conditions in planning watersheds where road densities are greater than the average density of 6.24 miles per sq. mile.										
1. Work with the Van Duzen Firesafe Council to assess logging roads and other dirt roads in critical planning watersheds where densities exceed the average of 6.24 mi. per sq. mi. (Wolverton Gulch, Booths Run, Chalk Rock, and Bell, Shaw, Corner, Cooper Mill, Blanton, Cummings, Hely, Root, & Stevens Creeks).										
2. Work with Van Duzen Firesafe Council to assess dirt and paved roads for presence of hazardous fuels, and to prioritize road for fuels hazard reduction. Primary candidates are those listed in #1 above.										
B. Decommission all inactive and failed roads, wherever possible, especially adjacent streams (e.g., within30 meters of a stream, and 90 meters of any fish-bearing stream).										
1. Decommission failed roads, especially near fish-bearing streams and in watersheds where densities exceed the average of 6.24 mi. per sq. mi. (Wolverton Gulch, Booths Run, Chalk Rock, and Bell, Shaw, Corner, Cooper Mill, Blanton, Cummings, Hely, Root, & Stevens Creeks).										
2. Decommission logging roads within 30 meters of any perennial stream, including the Main Stem Van Duzen River, Upper Lawrence Creek, and other streams listed in #1 above.										
3. Decommission logging roads within 90 meters of any fish-bearing stream stream, especially Lawrence Creek, Shaw Creek, Corner Creek, Cooper Mill Creek, Root Creek, Stevens Creek, and Grizzly Creek.										
4. Redesign roads to avoid channeling of water, build water diverters to the downslope sides of roads, especially in watersheds with fish-bearing streams, & as listed in #1 above.										
5. Remove/replace failed culverts, especially on fish-bearing streams, & as listed in #1 above.										

Upland (and Upslope) Management	Implementation Schedule									
	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
6. Where fall-away has occurred creating barriers to fish migration, construct rockwork step or ladders and replace culverts, especially on Wolverton Gulch, Cummings Creek, and Fox Creek.										
7. Replace culverts under major haul roads and over fish-bearing streams with concrete bridge work, including Wolverton Gulch and Fox Creek.										

Instream and Riparian Habitat

Instream Habitat and Riparian Zone	Implementation Schedule									
	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
A. Engage in the planting of hardwoods and conifers within stream riparian zones to increase the shading and microclimate moderating capacity, as well as enhancement and deepening of the channel over time.										
1. Locations within the Lawrence Creek sub basin include Lawrence Creek, Shaw Creek, Corner Creek, Blanton Creek, Fish Creek, Alan Creek, and Cooper Mill Creek.										
2. Locations within the Yager Creek sub basin include Yager Creek (above the Lawrence Creek Confluence), North Fork, Middle Fork, and South Fork Yager Creek, Barber Creek, and Wilson Creek.										
3. Other sites in the Lower Van Duzen River sub basin will include Cuddeback Creek, Fiedler Creek, Fox Creek, Flanigan Creek, Stevens Creek, Grizzly Creek (above Stevens Creek), and Root Creek.										
B. Inventory and map sources of stream bank erosion (e.g., landslides) and prioritize according to present and potential sediment yield.										
1. Identify sites that could be modified to reduce the amount of erosion near streams.										
C. Establish a program for placement of large wood (LWD) into streams with historic or present occurrence of salmonids, especially coho salmon, to promote development of deep pools in streams slated for temperature monitoring.										
1. Placement of LWD should be based on sections A and B in the above projects.										

Instream Habitat and Riparian Zone	Implementation Schedule									
	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
D. Provide support for stream banks with bouldering, cabling, and wing diverters to prevent loss of soil and encourage stream meandering.										
1. Placement and location of cabled boulders should be based on Section B above.										
E. Locate and remove instream barriers to fish passage.										
1. Modify or replace all impacted and problematic culverts on fish-bearing streams with improved mechanisms such as concrete bridges, or where roads are being decommsioned, removed entirely.										
2. Collect comprehensive information on blockages to fish passage, with on-the-ground reconnaissance, some of which could be accomplished through cooperation with the Van Duzen Firesafe Council.										
3. Where blockage is severe (i.e., steep drop offs on downstream side of culverts that completely block fish passage), rehabilitation of stream segments would be required.										
4. Blockages of fish passage have been reported on Wolverton Gulch and Fox Creek at the overpass of Highway 36. These culvert systems should be replaced with boulder stepping in the stream and concrete bridgework over the stream at the highway locations. All culverts associated with Highway 36 should be replaced with concrete bridges.										
5. Remove other barriers, including those that are natural in origin such as log jams with less cost by physical removal or modification in situ.										

Monitoring Restoration Efficacy

Monitoring Efficacy of Restoration Efforts	Implementation Schedule									
	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
A. Phase out the use of grab sampling to where it will only be necessary where placement of a TTS station is extremely difficult or unfeasible.										
1. Use grab samples initially, but only where data cannot be obtained with TTS stations.										
B. Establish eight turbidity threshold sampling (TTS) stations over a ten-year period on appropriate streams throughout the lower basin										
1. Stations will be located based on sediment yield and the with potential for restoration and reintroduction of salmonid stocks: Lawrence Creek, Yager Creek, Cummings Creek, Flanigan Creek, Hely Creek, Root Creek, Stevens Creek, and Grizzly Creek										
2. Initiate and continue monitoring for flow/discharge, continuous turbidity, and suspended sediment at all operational TTS stations throughout each rainfall season										
C. On-the-ground reconnaissance of sediment information collected during a second TMDL type of study will also be used to mark and record attainment of anticipated milestones.										
1. Engage in a second (and possibly third TMDL study similar to PWA (1999)										
D. Initiate a series of habitat typing studies of the streams of established priority with regard to TTS stations.										
1. Habitat studies should be done in connection with CA Department of Fish & Game.										

Monitoring Water Quality

Water Quality	Implementation Schedule									
	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
A. Maintain and expand instream continuous monitoring of stream temperatures throughout the summer months using HOBO temp data loggers & recruit volunteers.										
1. Expand the number of temperature recording sites from seven to a total of at least 29 sites.										
2. Stream sites will include the original seven monitored during our project, which include Wolverton Gulch, Lower Yager Creek (downstream from the Lawrence Creek convergence), Cummings Creek, Hely Creek, Grizzly Creek (below the confluence with Stevens Creek), and two sites on the main stem Van Duzen River.										
3. Sites within the Lawrence Creek sub basin will include Lawrence Creek, Bell Creek, Fish Creek, Alan Creek, Booths Run, Shaw Creek, Cooper Mill Creek, and Corner Creek.										
4. Sites within the Yager Creek sub basin will include Yager Creek (above the Lawrence Creek Confluence), North Fork, Middle Fork, and South Fork Yager Creek, Barber Creek, and Wilson Creek.										
5. Other sites within the Lower Van Duzen River sub basin will include Cuddeback Creek, Fiedler Creek, Fox Creek, Flanigan Creek, Stevens Creek, Grizzly Creek (above the confluence with Stevens Creek), and Root Creek.										
B. Sample for V* and D50 (sediment and particle size, respectively).										
1. Monitor streams listed in A1 and A2 a minimum of three to five consecutive years during summer months										
C. Monitor streams year-round for dissolved oxygen, pH, and conductivity for each of two consecutive year groupings.										
1. Streams will include Lawrence Creek, Booths Run, Shaw Creek, Corner Creek, Cooper Mill Creek, Blanton Creek, Upper Yager Creek, Cuddeback Creek, Fiedler Creek, Fox Creek, Flanigan Creek, Hely Creek, Stevens Creek and Grizzly Creek										

Water Quality	Implementation Schedule									
	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
D. Place increased emphasis on flow and water availability in streams that contribute to the main stem Van Duzen.										
1. Monitor and record flow rate or discharge - annually in all streams with TTS stations										
2. Flow rates will also be monitored in at least 10 other streams throughout the year. These streams will include: Bell Creek, Fish Creek, Alan Creek, Booths Run, Shaw Creek, Cooper Mill Creek, Blanton Creek, Corner Creek, Cuddeback Creek, Fiedler Creek.										

Public Outreach

Outreach	Implementation Schedule									
	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
A. Recruit volunteers for help with numerous projects that are scheduled for implementation within the lower basin.										
1. Recruit volunteers to help collect samples (bottles) from the TTS stations, download data from station data loggers, transport samples (bottles) to laboratory facilities, and participate in developing protocols for analyzing data.										
2. Recruit volunteers to help collect data on stream habitat and other physical conditions such as pH, dissolved oxygen, conductivity, and temperature										
3. Recruit volunteers to participate in riparian habitat restoration, such as planting of willows, alder, and cottonwood.										
4. Encourage participation and public contribution to special events such as "Salmon Watch" in which members of the community report sighting of spawning salmon.										
5. Recruit volunteers to help remove barriers, such as log jams that involve physical removal or modification in situ.										

Action 8: Measurable Milestones (Element 7)

Milestones for the implementation project can be considered the completion of specific goals designated as achievable accomplishments through the course of the overall project or program. These milestones should be achievable in a progressive manner as the project progresses from initiation to completion. As with goals, these milestones can be thought of as short term and long term events that will be tracked throughout the duration of the project, and summarized and reviewed at the conclusion of the implementation project. Some of the more critical milestones, which can also be thought of as benchmarks throughout the project as listed below.

Short Term Milestones (5 – 20 Years)

1) Elimination of logging old growth Redwood in the Lower Van Duzen River Basin.

2) Elimination of clear cutting as a silvicultural practice in the lower basin.

3) Elimination of tractor yarding methods of timber harvest in the lower basin.

4) Establishment of buffer zones of at least 300 feet around fish bearing streams.

5) Establishment of greater standardization of re-entry times to at least 40-year intervals between harvest activities in a given area, in order to minimize cumulative effects.

6) Adoption of Multi-Aged timber harvest management practices in the lower basin, which would include retention of large trees that confer greater forest complexity and watershed stability.

7) With approximately 1,500 miles of road in the lower basin (see Chapter 3), removal of 2% of those roads (specifically, logging roads) is a conservative target. Therefore a milestone of 30 miles of roads removed within 10 years is reasonable. This level of decommissioning would specifically target roads within 30 meters of streams and roads on slopes greater than 40 percent.

8) Beyond decommissioning, another milestone would be that at least another 10% (150 miles) of roads could be re-engineered to better disperse water away from sources of sediment, and away from streams to avoid debris torrents that typically plague these logging roads.

9) With approximately 848 road-stream crossings occurring within the lower basin and unknown numbers of culverts at risk or near failure, arriving at a reasonable number suitable for decommissioning is difficult. A rough estimate would be that at least 5% could be

decommissioned and/or re-engineered, and at least 10% repaired or replaced. Thus, a milestone for culverts would be the decommissioning of 42 culverts and repair/replacement of 85 additional culverts.

10) All streams listed as having high potential for riparian planting success should have at least 1-2 miles of critical stream reaches planted in hardwoods, including willow, cottonwood, and alder.

11) A significant contribution to the amount of (or number of sites with) LWD in those streams deemed having the highest potential for salmonid recruitment.

12) A significant decrease in average temperatures in streams shown to be higher than acceptable average summer temperatures for salmonid growth and survival.

Long Term Milestones (20 – 50 Years)

1) **Road densities** equal to or less than 4.0 miles of road per square mile of watershed for all planning watersheds within the lower basin.

2) **Road-stream crossing densities** equal to or less than 1.2 miles of road per stream mile for all planning watersheds within the lower basin.

3) **Reduction in sediment yield** and sediment delivery to target levels or below (Table 6-1) will mark a major milestone in the progress of the project and its subsequent impact in the lower basin.

4) **Reduction in continuous (chronic) turbidity, turbidity exceedence levels, and suspended sediment** to below target levels listed in Table 6-1.

5) **Enhancement of stream habitat and significant increases of salmonid numbers** to earlier levels seen in the mid 1900s.

6) I**ncrease in the frequency of pools by length** to at least 45% in streams within the lower basin, and a significant increase in the average summer depth of pools to 4 feet.

7) **A significant decrease in average winter flow rates** relative to the amount of rainfall, and a significant increase in average summer flow rates in streams within the lower basin.

8) **Significant increase in educational programs** related to the study of watersheds and aquatic ecosystems, which will be affiliated with the implementation program as well as an increased opportunity to coordinate with organizations such as AmeriCorps and their program-sponsored field days.

Action 9: Evaluation of Progress (Element 8)

There are many methods for measuring the progress of an implementation project over the course of short term and long term expectations. The first measure of accomplishment would have to be how well it has achieved it goals and objectives, and the rate and timing at which milestones are reached – in other words, are you on track? This question can best be answered by project personnel as well as peer review panels.

Beyond this type of direct feedback and self-assessment there are other less direct but equally effective ways to evaluate progress. These include 1) feedback from granting agencies, and how well the project meets its deliverables, 2) comments, suggestions, and recommendations from the Technical Advisory Committee, and how well the project meets their expectations, 3) community outreach and public feedback, especially at presentations and workshops, will convey how well community responds to the effort and accomplishments through time, and how well it understands the issues, 4) public feedback through the website will be possible as there will be a webpage devoted to public questions directed to project personnel and an opportunity for public comments on the project, in part or as a whole, and 5) the frequency of educational opportunities for project-sponsored events to increase community involvement in the programs, as well as awareness of the beneficial uses of water and the importance of watershed issues.

Chances for Restoration Success

In a study of Bear Creek, Stitz Creek, Jordan Creek, Freshwater Creek and Elk River watersheds, all of which were in PL ownership, and have similar climate, bedrock geology, ownership, and disturbance regimes Collison et al (2003) stressed the need to recover these systems before ocean and climate cycle shifts occur relative to the Pacific Decadal Oscillation (PDO) cycle (Hare et al. 1999) as follows:

> If current patterns prevail, with shifts in the PDO occurring every 20 to 30 years (Hare et al., 1999), the next negative shift in the PDO for California is likely to occur in the 2015 to 2020 timeframe. The next shift may be critical for ESA-listed stocks in Bear, Jordan, Stitz, Freshwater, and Elk watersheds. If fresh water habitats in the watersheds have not recovered by that time, the fish will simultaneously face both degraded freshwater habitats and an unproductive ocean. The result could shift the stocks to endangered status or result in extinctions.

These findings and recommendations clearly apply to the lower Van Duzen River Basin and streams flowing from HRC lands as well.

As discussed earlier, Lower Van Duzen and Yager Creek basin tributaries are not showing signs of recovery. Freshwater Creek in nearby Humboldt Bay provides a case study that indicates recovery from logging can occur. After railroad logging from the late 1920s through the early 1940s, the watershed had stabilized by the 1980's and aquatic habitat and fish community structure had largely recovered, as summarized by Higgins (2003). This indicates channel recovery took 30 to 50 years with complete watershed rest. A major difference between early logging and more recent timber harvest is the extensive road network that was constructed and remains on the landscape.

Hydrologic and sediment perturbations associated with road networks far outlast those of timber harvest. As a result roads will prolong, if not confound, recovery of aquatic systems unless road-related recommendations described above are deployed. It is unlikely that fully functional conditions can be restored in the time frame recommended by Collison et al. (2003), but positive trends could be established with full cooperation.

Potential for Recovery

The coho salmon (<u>Oncorhynchus kisutch</u>) has been declared a federally endangered species in coastal Northern California. When considering endangered species, the first question is where can these individuals be found now? With regard to endangered and threatened salmonid populations in the Van Duzen, where are coho and Chinook salmon distributed, and most likely to survive and thrive? Where are Steelhead and Cutthroat Trout most likely to be found? It could be argued that all of these species are endangered or threatened in the Lower Van Duzen River Basin, which is a status that did not come about naturally. While these populations experienced dramatic declines after the 1964 flood, they have not rebounded and are now facing near extinction in some cases, and certainly the crashing of these populations was precipitated by conditions resulting from the externalities of the logging industry. Remediation of these species is wholly dependent on recovery of the watersheds that influence their habitats, and watershed recovery will only occur if/when there is recognition that a dramatic change in the timber harvest paradigm is necessary.

Obviously, timber companies and others have and continue to acknowledge errors in past methodologies of management practices (PWA 1999, USEPA 1999, HRC 2009), but whether the proposed modifications to standard operating procedures are enough to bring about observable change is legitimately questionable. As described in earlier chapters, the relationship between management-related effects on upslope conditions (primarily sediment delivery) and water quality is very complex and effects of modifying management protocols cannot be easily predicted or even measured on a short term basis. However, we do know that there are several key characteristics of water quality that can be used to describe the conditions of these streams. All of these characteristics reflect varying degrees of time scales by which they can be used to indicate water quality, and have been discussed in some degree of detail in the preceding chapters. The most important of these characteristics can be listed as follows: turbidity, suspended sediment, temperature (short duration – one to several years), some stream habitat conditions including density or frequency of large woody debris, land and aerial photo-based assessment of sediment yield and delivery (moderate duration – every 10 years), and additional stream habitat conditions, including state of the channel migration zone (CMZ),

Many of the tributaries to the Van Duzen River are ephemeral (e.g., Wilson Creek, Flanigan Creek, Fox Creek), in that they run dry or nearly dry in the summer. These streams were probably perennial at one time but because of habitat loss over the last 50 to 100 years, flows have significantly declined or disappeared in the summer months, or water now goes underground (i.e., the hydraulic systems have disintegrated). Currently Cummings Creek is now becoming ephemeral as well, and runs dry downstream at the Highway 36 overpass. Yager Creek is also verging on running dry near the Highway 36 Bridge. All of these tributaries were at one time vigorous salmon-bearing streams, but loss of flow is jeopardizing the potential for rehabilitation of these populations. Remnant salmonid stocks are still present in some of these streams, and undoubtedly could be restored if restoration were the only priority. However, that scenario becomes less likely with the continued presence of logging in these watersheds at rates observed over the last 20 years (see Chapters 3 & 4), especially those that typify problematic conditions, such as operations on steep slopes and unstable geology.

Action 10: Monitoring Efficacy of Restoration Efforts (Element 9) - Tracking Objectives and Reaching Milestones

Ultimately, the success of an implementation project will be recognized by how well it achieves its goals and objectives. The best way to determine their achievement is to accurately and precisely quantify the environmental conditions that signify the health and well-being of the areas being targeted by the project. Therefore, it is mandatory that a thorough and well-tested system for measuring these environmental conditions be in place for the duration of the project. Below is a list of monitoring projects geared to thoroughly track and measure water quality and how upslope conditions, including road densities, etc., change with time, and how these condition interact and affect conditions in the streams.

1) **Phase out the use of grab sampling** to where it will only be necessary where placement of a TTS station is extremely difficult or unfeasible. Recruit volunteers into the Citizens Monitoring Group to help with placement of HOBO temperature probe data loggers into streams of significance with regard to salmonid presence/absence.
2) **Establish eight turbidity threshold sampling (TTS) stations** over a ten-year period on appropriate streams throughout the lower basin, including HRC lands, to record suspended sediment annually and track the degree to which project short and long term goals (e.g., sediment reduction, habitat rehabilitation) are being achieved. These stations will be located on streams that are deemed to have the highest priority with respect to the level of impairment (anticipated amount of sediment yield in the watershed), but also the greatest

potential for restoration and successful reintroduction of salmonid stocks (Table 6-7). Volunteers will also be recruited to help collect samples (bottles) from the TTS stations, download data from the stations data loggers, transport samples (bottles) to laboratory facilities, and participate in developing protocols for analyzing data.

Table 6-7. Streams within the Van Duzen Watershed Project area of highest priority for Action Plans, based on potential for habitat restoration, water quality, and accessibility.

Sub Basin	Planning Watershed	Stream
Lawrence Creek	Corner Creek	Lawrence Creek (above confluence with Yager)
Yager Creek	Blanton Creek	Yager Creek (above confluence with Lawrence)
Lower Van Duzen River	Cummings Creek	Cummings Creek
	Hely Creek	Flanigan Creek
		Hely Creek
	Root Creek	Root Creek
	Grizzly Creek	Stevens Creek
		Grizzly Creek

3) **Likely candidates** for placement of TTS stations **in the Lawrence - Yager Creek sub basins** (see Chapter 3 for map of planning watersheds, Figure 3-1) include:

- Lawrence Creek and Yager Creek, above (upstream of) their confluence.

4) **Likely candidates** for placement of TTS stations in the **Central Lower Van Duzen River Basin** (see Chapter 3 for map of planning watersheds, Figure 3-1) include:

- Cummings Creek, Flanigan Creek, Hely Creek, Root Creek, Stevens Creek, and Grizzly Creek, all of which represent direct tributaries to the Van Duzen River and historically important streams for salmonid habitat.
- Root Creek is problematic as it is located on the south side of the Van Duzen River and access may be difficult to reach in the winter season during severe storm events. However, this watershed is a critical tributary to the main stem Van Duzen River, and if provided access by Humboldt Redwood Company, information on this stream would be extremely valuable. This is the only north running stream of significance on the south side of the river within the lower basin.

5) **On-the-ground reconnaissance of sediment** information collected during a second TMDL type of study will also be used to mark and record attainment of anticipated milestones.

6) **Initiate a series of habitat typing studies** of the streams of established priority within the study area, and include all streams with established TTS stations, those that are listed as high priority with regard to salmonid habitat potential. Volunteers will also be recruited to help collect data on stream habitat and other physical conditions such as temperature.

7) **Collect, manage, maintain, and update a complete GIS database** on the most current environmental conditions that relate to upslope, instream habitat, and water quality conditions within the Lower Van Duzen River Basin.