Appendix I

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Re: Comments on *Draft Policy for Maintaining Instream Flows in Northern California Coastal Streams*

Dear Ms. Niiya,

I have reviewed the *Draft Policy for Maintaining Instream Flows in Northern California Coastal Streams* on behalf of the Redwood Chapter of the Sierra Club and provide comments on their behalf below. In addition to commenting specifically on the proposed *Policy*, I provide information on the status of Pacific salmon species in northern California, climatic cycles that affect salmon abundance, and on the interplay of cumulative watershed effects caused by land use management and those caused by diversion. I also provide case studies of several northern California watersheds where water diversion is limiting Pacific salmon, including ones outside the area defined by the *Policy*.

I have read the *Draft Policy* and read peer review comments from Dr. Lawrence Band (2008), Dr. Margaret Lang (2008), Dr. Robert Gearheart (2008), Dr. Charles Burt (2008), and Dr. Thomas McMahon (2008). In addition I read or reviewed McBain and Trush and Trout Unlimited (MTTU, 2000), California Department of Fish and Game and National Marine Fisheries Service (2002) guidelines for central California coastal streams and Appendices to the *Policy* (Stetson Engineering, 2007a; 2007b; R2 Consulting, 2007a; 2007b; 2007c). Although I find the *Draft Policy for Maintaining Instream Flows in Northern California Coastal Streams* to have substantial technical merit, much more action is needed on regulation of water use to prevent the further decline of Pacific salmon stocks and the likelihood of stock extinctions.

Qualifications

With regard to my qualifications, I have been a consulting fisheries biologist with an office in Arcata, California since 1989 and my specialty is salmon and steelhead restoration. I authored fisheries elements for several large northern California fisheries and watershed restoration plans (Kier Associates, 1991; Pacific Watershed Associates, 1994; Mendocino Resource Conservation District, 1992) and co-authored the northwestern California status review of Pacific salmon species on behalf of the American Fisheries Society (Higgins et al., 1992). Although I am not a hydrologist, I have considerable expertise in the area of water use and its effect on Pacific salmon.

Since 1994 I have been the project manager for a regional fisheries, water quality and watershed information database system, known as the Klamath Resource Information System or KRIS (www.krisweb.com). This custom program was originally devised to track restoration success in the Klamath and Trinity River basins, but has been applied to another dozen watersheds in northwestern California, including a number that fall within the targeted area of the *Policy*.

The California Department of Forestry (CDF) funded KRIS projects in the Mattole, Ten Mile, Noyo, Big and Gualala rivers as part of the North Coast Watershed Assessment Planning effort. The Sonoma County Water Agency (SCWA) also funded regional KRIS projects (IFR, 2003), including ones for the Garcia, Russian and Navarro rivers and tributaries of the Pacific Ocean and San Francisco Bay in Marin and Sonoma Counties. I am submitting a DVD including all KRIS projects for the geographic area covered by the *Policy*.

Since January 2004, I have been working under contract with the Klamath Basin Tribal Water Quality Work Group, a consortium of environmental departments of Lower Klamath River Basin Indian Tribes, to improve enforcement of the Clean Water Act. Through work on review of Total Maximum Daily Load (TMDL) reports, I have become further acquainted with factors limiting Pacific salmon, including those related to flow depletion.

I also have extensive field experience as a field biologist in the South Fork Trinity, Klamath, Eel, Navarro, Mattole and Garcia rivers as well as smaller coastal streams from Humboldt Bay to San Diego County.

Overview

The *Policy for Maintaining Instream Flows in Northern California Coastal Streams* (*Policy*) (SWRCB WRD, In Review) was created in response to California Assembly Bill 2121, which requires the State Water Resources Control Board (SWRCB) Water Rights Division (WRD) to adopt principles and guidelines for maintaining instream flows in coastal streams from the Mattole River to Marin County and in coastal streams entering northern San Pablo Bay (Figure 1). Much of the *Policy* is derived from a California Department of Fish and Game (CDFG) and National Marine Fisheries Service (NMFS) central California coast water supply paper (CDFG and NMFS, 2002). The *Policy* proposes to:

1) Restrict new appropriative rights for diversion of surface water to October 1 to March 15,
2) Establish minimum bypass flows,
3) Set cumulative diversion limits, and
4) Discontinue permitting dams on Class I and II streams.

The *Policy* also calls for universal screening of new diversions, construction of fish passage facilities, non-native species control and riparian restoration. Appropriate monitoring parameters are identified in the Policy and the adaptive management strategy is theoretically sound (Band, 2008; McMahon, 2008).

Unfortunately, the *Policy* will only be narrowly applied to new appropriative water right applications in a restricted geographic area and does not deal with other aspects of long recognized water supply problems. Shortcomings of the approach include:

- No action to assess summer and fall flows, when the most critical flow shortages for juvenile salmonid rearing are known to occur,
- No recognition of changes in stream channels and watershed hydrology due to land use nor the implications for salmonid suitability or surface water supply,
- Applies only to new diversions seeking appropriative water rights and does not discuss potential problems due unlimited riparian water rights that could be exercised at any time,

Figure 1. North Coast area defined by the *Policy* to which the statutes defined therein will be applied. It does not cover the Klamath or Eel River basins that have greater need of water rights reform and greater potential for salmon and steelhead recovery.

- Insufficient consideration of ground water extraction despite known linkage to diminished surface flow and carrying for Pacific salmon species regionally,
- Enforcement discussion shows the WRD refuses to enforce water law and to provide a disincentive for unpermitted water use, creating an epidemic problem of illegal diversions, and
- The *Policy* recommends recognizing Watershed Groups that are comprised of diverters and envisions transfer of many SWRCB WRD responsibilities to such local extraction interests.

Although AB 2121 has forced publication of this *Policy*, there seems to be a great deal of reluctance on behalf of the SWRCB WRD to fully engage in this effort as indicated by the tone of the report, a lack of willingness to set limits on diversion and to enforce CA Water Code § 1052, 1055, 1243, and 1375. Also the geographic area of the *Policy* does not cover some northern California watersheds with greater need for water rights reform for Pacific salmon species protection, such as the Scott, Shasta and Eel Rivers. Consequently, the *Policy* is not likely to recover coho salmon, Chinook salmon and steelhead in northern California.

Policy Framework

The SWRCB WRD has been working on this *Policy* for more than a decade (R2 Consultants, 2007a) and there is a great deal of merit in the theoretical basis for its minimum base flow and maximum cumulative diversion calculation. Dr. Lawrence Band (2008) summed limitations and benefits of the *Policy*:

> “The documents provided for review contain a set of references to the limited time and budget available for data collection and analysis, and present very limited field sampling at one specific time, with flow records drawn from different periods of time. Given these limitations, the approach adopted in the proposed policy, to provide more conservative restrictions on in-stream water use at the regional level, is a sound strategy.”

There are, however, some instances where the *Policy* strays from a sound scientific basis and potential major data gaps will likely confound the application of the system. The five elements of the *Policy* framework are listed below with observations of peer reviewers and my own comments.

1. *“Water diversions shall be seasonally limited to periods in which instream flows are naturally high to prevent adverse effects to fish and fish habitat.”*

In fact, the only limitation on water diversions would be on new appropriative water rights applicants and no study or action is envisioned for extraction from April through October, when flows are severely limiting for juvenile salmonid rearing. Dr. Thomas McMahon (2008) cautions that the entire exercise will be confounded due to this deficiency:

> "Implementation of a diversion season along with the proposed minimum base flow (MBF) and maximum cumulative diversion (MCD) standards to maintain the fall-winter hydrograph could offer a false sense of protection to the listed species if flow levels during other seasons are insufficient to support the completion of rest of the freshwater life cycle."

The Policy gives little or no scientific defense of its choice of October 1 versus December 15 as the start up of the winter water diversion:

> "Although the DFG-NMFS Draft Guidelines recommended a season of diversion from December 15 through March 31, an earlier diversion season start date is still protective of fishery resources when minimum instream flows and natural flow variability are maintained. This policy limits new water diversions in the policy area to a diversion season beginning on October 1 and ending on March 31 of the succeeding year."

Band (2008) points out that "the recommended limits of October 1 to March 31 is a compromise between the two other options (all year diversions and December 15-March 31), but places the beginning of the diversion season at the beginning of flow increases and Chinook migration in most years." Dr. Margaret Lang concurred and recommended the later start date: "The December 15 start date is much more likely to prevent water diversion during the extreme low flows present before the onset of consistent rainfall." She notes that numerous years there is little runoff on the first major storms of the season, as soil pores and the groundwater matrix soak up most early rainfall.

2. *"Water shall be diverted only when stream flows are higher than the minimum instream flows needed for fish spawning and passage."*

Peer reviewers (Lang, 2008; McMahon, 2008) suggest that impacts on rearing salmonids need equal consideration with those on migrating and spawning adults. Steelhead juveniles typically spend two years in freshwater (Barnhart, 1989) and coho salmon spend a full year feeding before migrating to the ocean (Groot and Margolis, 1991). Dr. Lang (2008) points out that factors such as "food availability, food delivery from upstream, and hiding cover, that are also important and not well characterized" by modeling exercises and cites Harvey et al. (2006) as demonstrating differences in growth rates of juvenile salmonids between diverted and undiverted streams.

Again there is no mention of limiting diversion from April through October, no limit proposed for riparian diversions that do not require off-stream storage, nor restrictions on ground water extraction to actually maintain and restore flows for salmon and steelhead, even if the *Policy* were enacted (Band, 2008; Gearheart, 2008).

3. *The maximum rate at which water is diverted in a watershed shall not adversely affect the natural flow variability needed for maintaining adequate channel structure and habitat for fish.*

This policy requires calculation of minimum base flow (MBF) and maximum cumulative diversion (MCD), but lack of recent or historic flow data and problems with application of models confound accurate estimates (Lang, 2008). Even if the MBF and MCD were accurately calculated, they do not properly account for interactions between diversions. Synergy between diversions in multiple tributaries will cause unintended consequences on flows, fish passage and alteration of substrate quality in downstream reaches that need to be more fully considered (Band, 2008; Gearheart, 2008).

4. *Construction or permitting of new on-stream dams shall be restricted. When allowed, on-stream dams shall be constructed and permitted in a manner that does not adversely affect fish and their habitat.*

Although future permit activities may restrict the construction of new dams, there are 1771 illegal dams already constructed within the geographic area covered by the *Policy* (Stetson Engineers, 2007a) (Figure 3) for which permits are being considered. Avoiding cumulative effects from thousands of impoundments, many of which are on Class I streams that contain salmonids, will not be possible without widespread enforcement action to remove a significant number of these illegal dams.

Several peer reviewers express reservations about damming and diversion of small headwater tributaries (Band, 2008; McMahon, 2008). Band (2008) notes a high risk of cumulative effects despite mitigations proposed for such projects in the *Policy*. According to McMahon (2008) "dams on ephemeral streams have the potential to greatly dampen the early fall/winter freshets important for access to the upper reaches of small spawning tributaries by their capture of the entire flow within the stream until the reservoir is filled, potentially resulting in significant dewatering downstream."

5. *The cumulative effects of water diversions on instream flows needed for the protection of fish and their habitat shall be considered and minimized.*

The *Policy* does not properly deal with cumulative effects of diversions (Gearheart, 2008; Band, 2008) nor those associated with long term changes to streams and watershed hydrology due to land use that effect surface and ground water availability (see Cumulative Effects). Gearheart expressed the following concern:

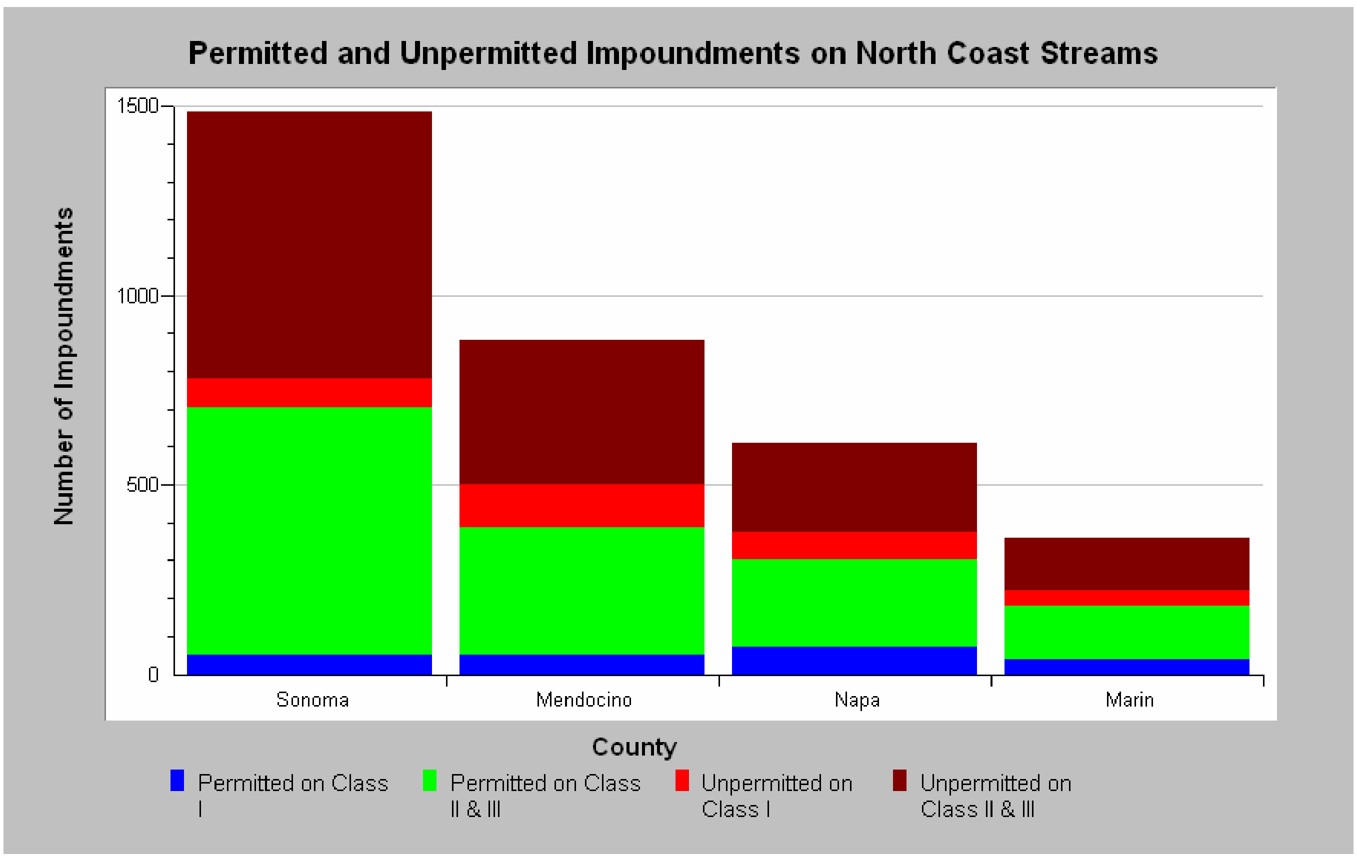

Figure 2. The number of permitted and unpermitted impoundments within the geographic area covered by the *Policy* is displayed above with illegal diversion impoundments outnumbering legal ones. Data from Stetson Engineers (2007a).

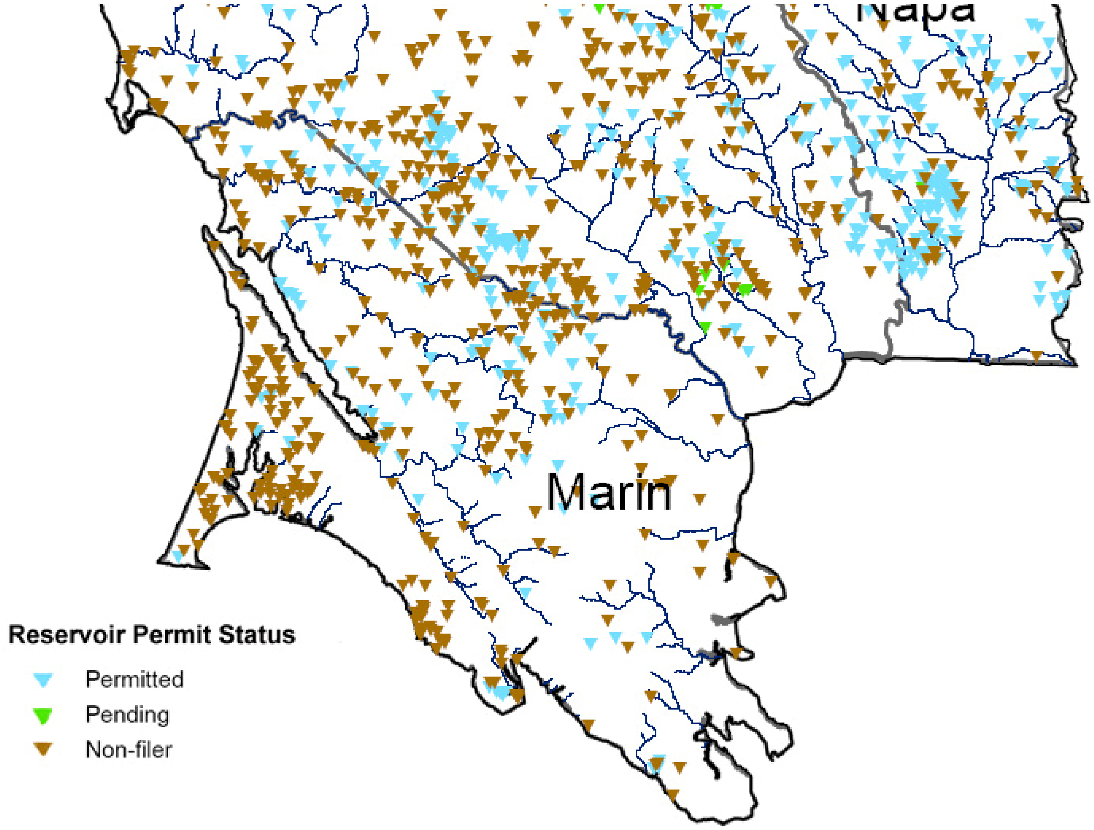

Figure 3. The number of Marin County, southern Sonoma and Napa County diversion impoundments displayed above demonstrate the challenge that an appropriative right water applicant faces in inventorying quantities diverted. Stetson Engineers (2007a) Figure A-3.

> "It appears to me as one evaluates the cumulative effect of scalping 5% of the peak as the storm hydrograph precedes down stream the reduction in the total flow reduces and the delay time (1/2 day recession -flow restricted) increases."

Band (2008) suggests that flow depletion below stream convergence points will magnify fluctuations. This in turn will cause depositions of fine sediment and other undesirable channel changes that could affect spawning salmon and steelhead downstream (see Cumulative Effects).

Minimum Base Flow (MBF) and Maximum Cumulative Diversion (MCD): The Policy hinges on relatively accurate estimate of MBF and MCD. Although the scientific basis for calculation of these statistics is theoretically sound, accurate calculation is confounded by lack of historic records and problems with model simulations.

The *Policy* defines the MBF as "the minimum instantaneous flow rate of water that must be moving past the point of diversion (POD) before water may be diverted" and recommends 60% of the mean annual unimpaired flow (0.60 Q_m) as needed for flows and fish passage in watersheds greater than 290 square miles either at the point of diversion, or at the upper limit of anadromy. Lang (2007) states that 68% (0.68 Q_m) is actually needed for protection of fisheries resources and also points out that there may be substantial error in calculation of mean annual unimpaired flow because there are very sparse gauge data, often with periods of record of less than 10 years. Lang (2008) cautions additionally that model generated mean flow estimates may have significant error:

> "Scaling by watershed area and mean annual precipitation works reasonably well for peak and major storm flows dominated by the rainfall generated runoff (assuming the storm influences at nearby gauged sites are consistently similar to the watershed of interest) but at lower flows, more subtle factors such as watershed geology, slopes, ground cover, soil thickness, etc. influence the stream flow. The mean annual flow is as much a function of storm flows as low flows that do not generally correlate as well to drainage area."

The maximum cumulative diversion (MCD) is defined in the policy as "the largest value that the sum of the rates of diversion of all diversions upstream of a specific location in the watershed can be in order to maintain adequate peak stream flows. The maximum cumulative diversion criterion is equal to five percent of the 1.5-year instantaneous peak flow."

Lang (2008) recommended against the use of MCD in the Policy:

> "The analysis by R2 Resources (2007) and Stetson Engineers, Inc (2007) clearly shows that maximum cumulative diversion limits set as volumes failed to meet the stated criteria of providing for channel maintenance flows. Stating the criteria as a volume would not meet objectives of the policy."

Lang (2008) is joined by most other peer reviewers (Band, 2008; Gearheart, 2008; McMahon, 2008) in calling for additional data collection to better establish flow regime targets.

<u>Water Availability Analysis</u>: Before the SWRCB WRD can issue a permit for an appropriative water right, it must demonstrate that there is "unappropriated water available to supply the applicant" (CA Water Code § 1375) and that sufficient water for remains for "recreation and the preservation and enhancement of fish and wildlife resources" (CA Water Code § 1243). A multi-party regional assessment is laid out as part of the *Policy* plan, but it also envisions a great deal of information being contributed by permit applicants and permit holders (see Watershed Groups).

The *Policy* section entitled Data Submissions (4.1.1.1) repeatedly refers to public domain spreadsheets and programs. The issue is not whether data analysis and models are done using public or private software, but whether the raw data are made available and the computer codes for models are made available so that results can be fully audited. Any revision of the *Policy* should have clear language that specifies full raw data availability and model transparency.

<u>Water Supply Reports and Instream Flow Analysis Required of Applicants</u>: The *Policy* provides the following description of study requirements facing new applicants:

> "This policy requires a water right applicant to conduct a water availability analysis that includes (1) a Water Supply Report that quantifies the amount of water remaining instream after senior rights are accounted for, and (2) an Instream Flow Analysis that evaluates the effects of the proposed project, in combination with existing diversions, on instream flows needed for fishery resources protection."

The water supply report is *not* required to describe flow conditions in the stream or determine surplus availability for April through November. Applicants are asked, however, to hire consultants to make a case that there is surplus water available in winter. This will not only be expensive, the consultants may actually be unable to determine the amount of cumulative diversion without an extensive survey because of unregistered riparian rights, pre-1914 water rights and those that have been established illegally (Figure 3). They will also be forced to use models and simulated data that produce considerable error (Lang, 2008) as discussed above.

Effectiveness Monitoring: Most peer reviewers stress that extensive field data needed on an on-going basis to support adaptive management, or the implementation of the *Policy* will be seriously flawed (Lang, 2008; Band, 2008, Gearheart, 2008; McMahon, 2008). The tone of the *Policy* on this topic, however, is very disappointing and shows little commitment on behalf of the WRD with every passage in this section using *may* not will: "The State Water Board *may* develop and implement a policy effectiveness monitoring program."

Enforcement: The SWRCB WRD has clear authority to regulate water extraction and to penalize those who appropriate water without a permit:

> "Pursuant to Water Code section 1052, an unauthorized diversion or use of water is a trespass against the State subject to a maximum civil liability of $500 per each day of unauthorized diversion or use of water. Water Code section 1055, subdivision (a), provides that the Executive Director of the State Water Board may issue an Administrative Civil Liability (ACL) complaint."

The problem is the WRD's near absolute refusal to enforce the law. Stetson Engineering (2007a) lists 1771 unpermitted diversions in the North Coast region as defined by this project (Figure 2). They note the potential need to remove 1569 structures, but also note that 519 unpermitted structures now have pending permit applications. The pattern of non-enforcement is clear in a number of basins (Figure 3) and I have documented similar problems in northern California case studies below both inside and outside the *Policy* area (i.e. Napa, Navarro, Russian, Gualala, Scott, and Shasta).

The WRD has also been derelict in its duty with regard to CA Water Code § 1243 and 1375, which require that they protect recreation, fish and wildlife and that they establish a surplus before issuing permits, respectively. The WRD has failed to comply with these laws by simply not supplying permits other than after ponds and diversions have been illegally constructed. This has caused not only a loss of fish habitat but also treasured recreational opportunities enjoyed by past generations, such as swimming at the Scout Camp on the Wheatfield Fork of the Gualala or at Hendy Woods on the lower mainstem Navarro River.

Instead of active enforcement, the WRD relies on mechanisms like self-enforcement, whereby permit holders self-report violations, and on complaints from citizens. I know several individuals who have filed hundreds of complaints over several decades with the WRD and have had few resolved as a result (Bob Baiocchi; Stan Griffin, personal communication).

The reluctance to enforce the law is evident in the following passage from the Policy:

> "Every violation deserves an appropriate enforcement response. Because resources may be limited, however, the State Water Board will balance the need to complete its non-enforcement tasks with the need to address violations. It must also balance the importance or impact of each potential enforcement action with the cost of that action. Informal enforcement actions, described below, have been the most frequently used enforcement response. *Such informal actions will continue to be part of this policy for low priority violations*."

Figure 4. Navarro River at Hendy Woods State Redwood Park is so flow depleted that only a stagnant pool not suitable for human contact remains. The mainstem Navarro was formerly rearing habitat for juvenile steelhead (Kimsey, 1952) and a major recreational draw during the hot days of summer and fall. CA Water Code § 1243 is clearly not being upheld in this basin. Photo by Pat Higgins from KRIS Navarro. September 21, 2001.

Some of the WRD criteria for prioritization include any violations:

- On Class I or Class II streams,
- That threaten or cause a take of endangered species,
- That constitute waste, unreasonable use, or unreasonable method of use,
- That illegally take water in a fully appropriated stream system, or
- That injure a prior right holder.

Despite pages of text on enforcement, there is no specific plan mentioned for decommissioning dams that are high priority. Almost all dams in the region effect at-risk salmonids and 308 illegal impoundments are on Class I streams (Figure 2) (Stetson Engineering, 2007 a). The Sierra Club (Pennington et al., 2008) points out that allowing diverters to avoid permit fees and costs of compliance offers them an unfair business advantage as well.

Informal Enforcement: "The purpose of an informal enforcement action is to quickly bring a violation to the water diverter's attention and to give the diverter an opportunity to voluntarily correct the violation and return to compliance as soon as possible." While quickly and voluntarily correcting violations is desirable, as one reads further into the *Policy*, deficiencies become apparent. Informal enforcement may only mean that WRD staff calls or emails the violator and then creates a file as a record of contact.

Penalties: The lack of willingness to enforce extends into the realm of use of fines as a disincentive:

> "The ability to pay administrative civil liability is limited by diverter's revenues and assets. In some cases, it is in the public interest for the diverter to continue in business and bring operations into compliance. If there is strong evidence that administrative civil liability would result in widespread hardship to the *service population* or undue hardship to the diverter, it may be reduced on the grounds of ability to pay."

I have added emphasis to the term "service population" above because it shows the inherent bias of the WRD for diverters (their clients) as opposed to protection of public trust. They also express a willingness to skip the enforcement phase, if the diverters just agree to pay for cooperative management:

> "Accordingly, flexibility should be provided to groups of diverters who endeavor to work together to allow for cost sharing, real-time operation of water diversions, and implementation of mitigation measures."

Watershed Groups: The *Policy* proposes to use watershed groups to fund studies, assess flow availability, and mitigate all problems related to diversions. A watershed group is defined as follows:

> "A watershed group is a group of diverters in a watershed who enter into a formal agreement to effectively manage the water resources of a watershed by maximizing the beneficial use of water while protecting the environment and public trust resources."

Any watershed group formed by special interests that does not include public participation is unacceptable. Consultants working for water diverters would protect vested interests and the quality of science would not likely be as unbiased or equal to that collected by government scientists who have public trust responsibility.

The *Policy* defines further the role these watershed groups would play:

> "The watershed group shall provide the technical information necessary for the State Water Board to determine water availability, satisfy the requirements of CEQA (if applicable), evaluate the potential impacts of water appropriation on public trust resources, make decisions on whether and how to approve pending water right applications for diverters in the watershed group, and make decisions on whether to approve the watershed group's proposed watershed management plan."

In other words, they want to turn their job and that of other State agencies over to local diverters. There are numerous streams in northwestern California that are already so over-subscribed they are dry in summer and fall. Many of the diversions may be unpermitted or constructed illegally and have permit applications pending. This strategy is not going to do anything for public trust and fish and it is likely illegal.

Cumulative Watershed Effects

The California Environmental Policy Act (CEQA) requires that cumulative effects be considered and defines them as "indirect or secondary effects that are reasonably foreseeable and caused by a project, but occur at a different time or place." The *Policy* is subject to CEQA yet fails to meet its requirements in considering cumulative watershed effects. Discussions of this topic are parsed below into 1) discussion of cumulative effects from networks of diversion on downstream reaches, and 2) on how all the watersheds under consideration are cumulatively effected by land use. The emphasis in the latter discussion is on changes in stream channel form and watershed hydrology that effect surface water availability.

Water Use Related Cumulative Effects: Band (2008) described numerous cumulative watershed effects likely from the interaction of diversions, even if all were operating in accordance with minimum base flows (MBF).

> "The cumulative impacts of water diversions from all areas of the drainage network requires consideration of the network as an entity, and not just the sum of all individual reaches."

While each diversion might only capture less than 5% of the 1.5 recurrence interval flow at one location, Band (2008) calculated the interaction between diversions in the stream system could increase to 28% downstream. He sees the necessity of increasing model parameters "to analyze the impacts of sequential dependencies of reach conditions as they will not be randomly distributed."

If interactions of multiple diversions are not factored into consideration, Band (2008) predicts "perturbations to the downstream hydraulic geometry, as well as bed sediment grain size, and seasonal variations in bed composition." Of specific concern to Band (2008) is fine sediment delivery from early storms in streams where flow is depleted: "the first few increased flows of the year may flush fine grained sediment, perhaps without mobilizing coarser grain sizes, which may accumulate in reaches where discharge is drawn down." These reaches might be ones used for spawning.

Band (2008) and Gearheart (2008) expressed concern about cumulative effects potential associated with dams on ephemeral streams (Class III). These headwater swales may constitute 50% of a watershed's area and "the vast majority of coarse grained material delivered to larger streams with salmonid habitat are generated from small, headwater catchments" (Band, 2008). Figure 2 above shows permitted and unpermitted impoundments and there are 1357 permitted impoundments in the Policy's area of interest and another 1771 unpermitted ones (Stetson Engineering, 2007a). Therefore, there is significant likelihood of advanced cumulative effects from interactions of releases from diversions.

Stetson Engineering (2007a) estimates that the capacity of illegal impoundments in the North Coast watershed region, as defined by the Policy, is 48,515 acre feet and that 3,234 surface acres of reservoirs now submerge former stream reaches or headwaters. These impoundments in turn are ideal habitat for bull frogs, which decimate native amphibian populations. They are often stocked with warmwater game fish that escape into water bodies below and may predate upon salmonids or displace them through competition (Higgins et al., 1992).

Ground water is not considered in the *Policy*, yet over-extraction is known to contribute to diminished water quality and greatly reduced fish habitat in many streams within the region (see Case Studies). Peer reviewers (Band, 2008; Gearheart, 2008; McMahon, 2008) point out that no real water budget can be calculated without knowing the influence of ground water withdrawals. The Department of Water Resources, a separate State agency, has oversight over ground water withdrawal, but all well logs are treated as proprietary and restriction of ground water use is uncommon.

Potential additional water withdrawal under riparian water rights is another flow-related cumulative effect. Riparian rights are those where water is extracted for use on lands that directly boarder the stream and any owner of a parcel immediately adjacent to a water course has the right to take water for domestic and agricultural use at any time unless specific deed restrictions are stated in the title to the land. Riparian rights do not require a permit from the WRD. Although the WRD requests that riparian water users file a statement of diversion and use, there is no penalty for not complying and few are filed.

Band (2008) mentions tailwater as a major issue needing consideration by the WRD as a potential effect. Agricultural waste water may have elevated temperature and nutrients and its impact is recognized as substantial on the Shasta River (NCRWQCB, 2006a).

Upland Cumulative Effects and Surface Water Supply: Cumulative effects in northern California watersheds related to logging and associated road networks are well studied (Ligon et al., 1999; Dunne et al., 2001; Collison et al., 2003). Although much of the geographic area defined by the *Policy* is now in agricultural production, virtually all the watersheds have been logged at least historically. All of those logged after WW II have extensive road networks that alter watershed hydrology (Jones and Grant, 1996). High road densities act to extend stream networks and intercept ground water flows (Jones and Grant, 1996), resulting in increased peak flows and decreased base flows (Montgomery and Buffington, 1993).

Most of the streams within the *Policy* area are listed for sediment impairment on the SWRCB 303d list and targeted for remediation under the Clean Water Act TMDL program. A huge amount of sediment recognized as polluting north coast rivers is moving downstream in waves. The level of aggradation can be up to 25 feet (i.e. South Fork Trinity) (PWA, 1994) and high sediment yield has caused dozens of regional streams, such as those of the Lower Klamath (Voight and Gale, 1998), to lose surface flow even when there is no diversion (Figure 5).

The *Policy* needs to consider the question of water supply in a stream environment that is profoundly changed by cumulative effects. Increased flood peaks and excess sediment transport in North Coast rivers have caused a loss of pool habitat, an increased width to depth ratio, reduced large wood, and overall diminishment of salmon and steelhead habitat. Because the streams have become wider and shallower, they are more subject to warming (Poole and Berman, 2000). (The *Policy* skips the discussion of cumulative effects due to April-October flow depletion on stream temperatures by concerning itself only with the October-March time period.) The North Coast Regional Water Quality Control Board (NCRWQCB, 2006a) found that flow depletion in the Shasta River was contributing to temperature pollution and NRC (2004) found the same relationship on the Scott River (see Case Studies).

Anderson Creek in the Navarro River basin might serve as an example. When an early water right was granted for 2 cubic feet per second (cfs), pools were likely frequent with some 6-8 feet deep (CDFG, 1969), and the effect of the withdrawal was likely minimal. The stream has experienced substantial cumulative effects and pools are now infrequent and maximum pool depth is often 4 feet or less; *the effects on fish of the historically permitted quantity of water may now be significant*. Add to the equation decreased baseflows due to high road densities, recent logging and development and one can understand why streams are running dry and fish are going without water. All of these are factors that the *Policy* needs to consider in order to meet CEQA requirements and to determine water availability that truly reflects the needs of fish.

Cumulative effects should also be recognized as compromising recreational opportunities. Not only do north coast rivers lack sufficient flow for recreation, flow depletion and aggradation now cause stagnation that fosters toxic algae. Although the South Fork Eel River is not in the *Policy* area, it none the less serves as a regional example. Generations of Californians have vacationed on the South Fork Eel at Richardson's Grove Redwood State Park or at Benbow Lake, but toxic blue-green algae species now make surface water contact during low flows ill-advised. There have been several accounts in the local press of dogs dying after ingesting SF Eel River water. Rural development in the Eel River watershed has fostered a similar pattern of unpermitted water use as in *Policy* area basins, that when combined with aggradation, leads to major loss of recreational opportunities.

Figure 5. Lower Terwer Creek running underground in late fall 1990. High sediment yield related to watershed disturbance has caused massive aggradation. The stream loses surface flow in late summer and fall yet there is no diversion upstream. Photo by Paat Higgins from KRIS Klamath-Trinity Version 3.0. September 1991.

Case Studies

There are a number of watersheds in northwestern California that have flow levels that limit salmonid production and case studies are provided below for areas both inside and outside the geographic area covered by the *Policy*. Many of my reports are provided on the DVD that is being filed with these comments so that WRD can get more detailed information from them.

Napa River: I am intimately familiar with the Napa River watershed from having commented (Higgins, 2006a) on the *Napa River Sediment TMDL* (SFBWQCB, 2006) and on several proposed vineyard conversions (Higgins, 2006b; 2007). The diminishment of flow from historic levels is most clearly seen through examining what would have been coho salmon habitat. USFWS (1968) estimated the historic coho population in the Napa River at 2000-4000 fish. Coho prefer reaches with a gradient of less than <2% and suitable water temperature, with juveniles spending one year in freshwater. Figure 6 illustrates where coho are likely to have ranged in the middle Napa River watershed. The majority of low gradient mainstem and tributary reaches were found to be dry (Figure 7) or stagnant in 2001 by Stillwater and Dietrich (2002). Figure 8 is taken from Stetson Engineers (2007a) and shows the number of permitted and unpermitted diversions in the lower Napa River, including Carneros Creek. Stetson Engineers (2007a) noted that 43% of winter flow in Carneros Creek is likely diverted.

While Napa River coho are extinct, steelhead are still present, although there is a homogeneous disturbance in the watershed because of urbanization, timber harvest, vineyard development, dams for municipal water supply and changes in the stream channel. Steelhead are blocked from 30% of the Eastside of the watershed by large municipal water supply dams, the mainstem Napa River is now either dry or unsuitable for steelhead rearing, and Westside tributaries sustain steelhead in isolated pools. Stillwater and Dietrich (2002) noted that steelhead juveniles stranded in isolated pools lost weight during summer due to lack of insect drift delivered not being delivered by flows. Given the precipitous decline in steelhead habitat, it is my professional opinion that their population is likely dropping significantly. Chinook salmon still return to the Napa River, but their population is small and also at risk of loss.

My *Napa River TMDL* comments (Higgins, 2006a) conclude that sediment and flow problems cannot be remedied without limiting watershed disturbance and that temperature and fish problems cannot be remedied without additional flows:

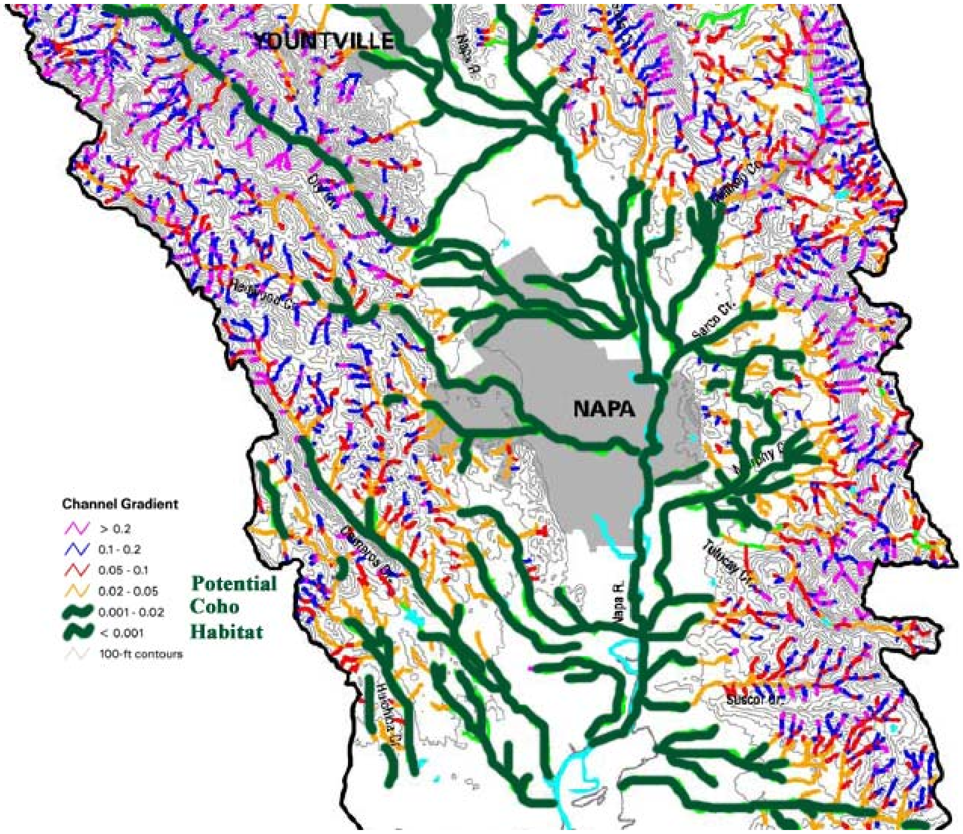

Figure 6. Stream gradient map of the Napa River is overlain with dark green on reaches with gradient less than 2% (0.02) to show likely range of coho salmon prior to human disturbance. Map 6 from Stillwater and Dietrich (2002).

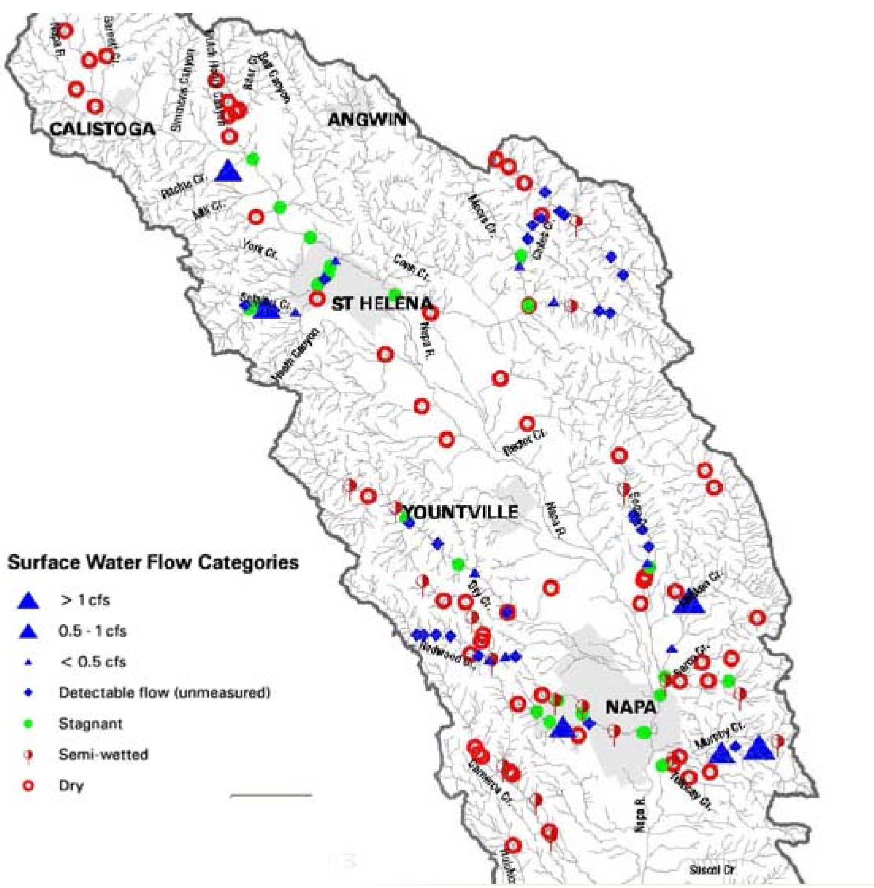

Figure 7. Symbols on this Napa River map indicate that reaches likely formerly inhabited by coho now lack surface flow or are stagnant. Taken from Stillwater and Dietrich (2002) where it appears as Map 13.

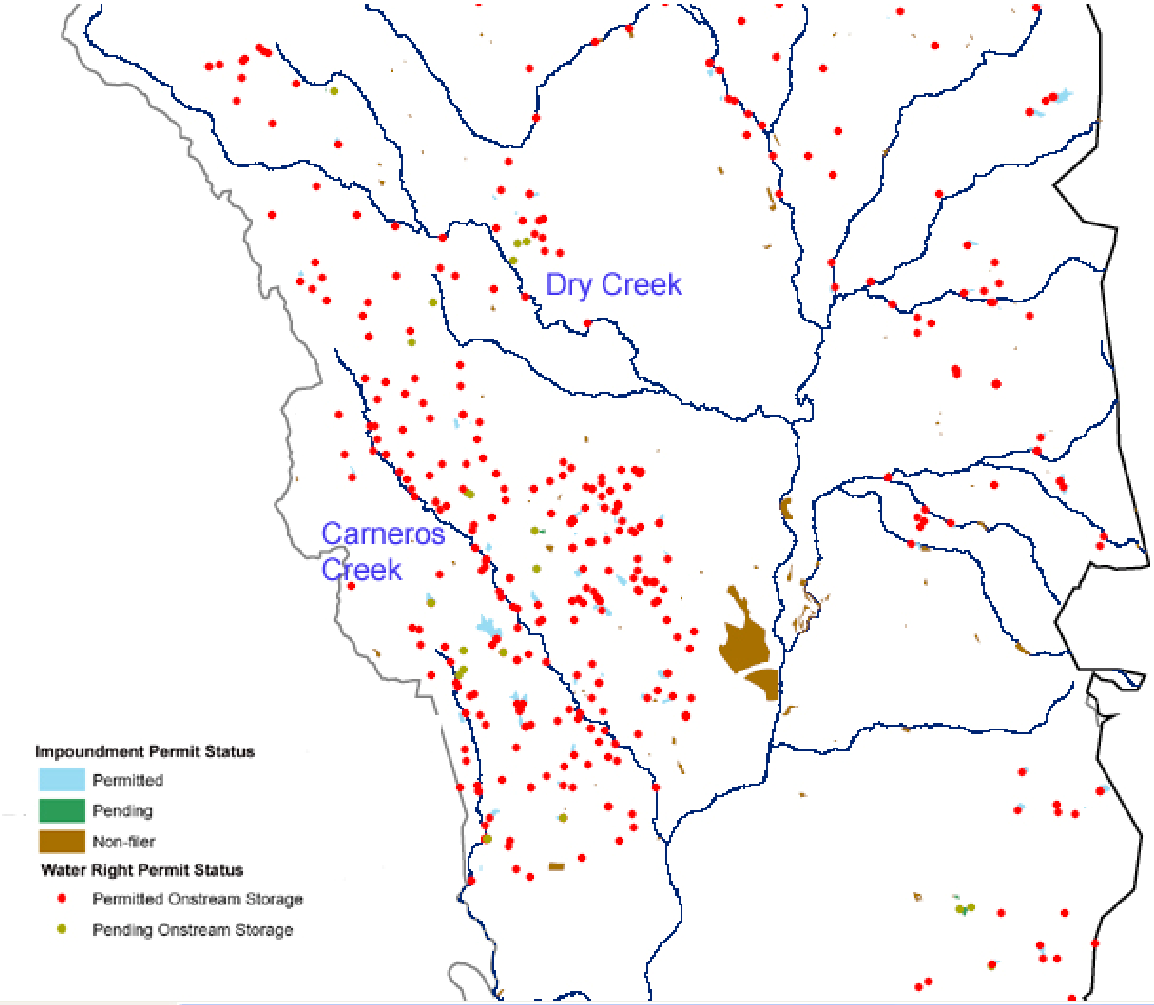

Figure 8. Diversions and impoundments in the lower Napa River basin in Huachuca, Carneros and Dry creeks at left. Impoundments include both those permitted and unpermitted. Stetson Engineers (2007a).

> "The State Water Resources Control Board Water Rights Division has the authority to install stream gages where ever necessary to insure protection of public trust, water quality and water rights. The TMDL should make explicit reference to reaches affected by low flows and call on the SWRCB WRD to take appropriate monitoring and enforcement actions."

Navarro River: I am familiar with the Navarro River having worked in the basin as a CDFG seasonal aid in 1972, commented on proposed timber harvests in Rancheria Creek and Indian Creek in 1993-1994, and more recently helped complete the KRIS Navarro project (IFR, 2003a). The WRD is intimately familiar with the Navarro River as documented in previous comments on regional flow policy by Friends of the Navarro River Watershed (Hall, 2006) and the Sierra Club (2006).

In 1994 the Sierra Club Legal Defense Fund (Volcker, 1994) filed a water rights complaint with the SWRCB WRD for failing to adequately address instream flow needs under the Public Trust Doctrine in the Navarro River basin. In the complaint, Volker (1994) stated that:

> "Illegal and unreasonable water diversions from the Navarro River and its tributaries, primarily for agricultural purposes, have significantly impaired instream fish and wildlife beneficial uses, to the point where the river was literally pumped dry during August and September of 1992. Such illegal and unreasonable diversions threaten again this fall to eliminate the natural flow of

> the river and its tributaries necessary to sustain constitutionally and statutorily protected instream fish and wildlife beneficial uses."

Volcker's (1994) assertion that the Navarro loses surface flow was correct at the time and the condition is still chronic in summer (Figure 9). In processing the complaint, the WRD (SWRCB, 1998) found 121 illegal impoundments (Figure 10), none of which were removed and many of which have now applied for permits (Pennington et al., 2008). The SWRCB (1998) declined to take public trust protection action:

> "The SWRCB could initiate a public trust action in the watershed. However, the cause of the anadromous fish decline may be principally due to factors other than flow, and there is not adequate information available regarding the flow needs of the fishery in the summer. Consequently, the Division recommends that a public trust action should not be initiated at this time. If the complainants, DFG, or some other entity develops adequate information regarding the summer flow needs of the anadromous fishery, this recommendation can be reevaluated."

Illegal diversions of two types for Mendocino County watersheds are shown in Figure 11, which is taken from Stetson Engineers (2007a). The Navarro River appears at left with a combination of regulatory dams, diversions that do not impound water, and illegal impoundments.

<u>Russian River:</u> I am familiar with the Russian River due to work on a KRIS Russian database (IFR, 2003a) and from having provided comments on the Bohemian Grove NTMP (Higgins, 2007b).

As one of the centers of the booming wine industry, the Russian River is one of the most heavily diverted streams in northwestern California, as indicated by the prevalence of unpermitted diversions (Figure 11). Major tributaries lose surface flow during summer and early fall (Figure 12) and significant numbers of large pumps have been installed to tap ground water, some immediately adjacent to the river (Figure 13). The Sierra Club (2006) documented problems with over-diversion and widespread illegal water use in Maacama Creek causing severe damage to public trust.

Coho salmon are increasingly rare in the Russian River, but still known to occur in some tributary sub-basins. Figure 14 shows the existing appropriative rights and those proposed for all tributaries known to have harbored coho salmon in the past. Coho were present in Green Valley Creek all three years of CDFG surveys from 2000-2002, but present in Dutch Bill Creek only one year in that period. While there is only one permit on Green Valley Creek, there were 17 applications as of 2001 and Dutch Bill had 7 water rights permitted, but an additional 10 in the application process. Figure 15 shows identified illegal water withdrawal specifically on these streams (Stetson Engineers, 2007a). Legal and illegal diversions pose significant risk to the last streams where coho still persist in the Russian River.

California Department of Fish and Game habitat typing surveys of Green Valley Creek and Dutch Bill Creek show that both streams lose surface flow in some reaches (Figure 15). Pool frequency is also low relative to the CDFG (2004) target of 40% as optimal for salmonids and coho juveniles are known to require pools for freshwater rearing (Reeves et al., 1988). Additional permitted extraction of surface water is likely to both raise water temperatures and decrease depth and cover for juvenile coho salmon. The extent of dry habitats suggests that both streams are fully or possibly over-allocated and that coho habitat is already significantly diminished.

Figure 9. The lower mainstem Navarro River near Flume Gulch is shown at left during low flow conditions on September 21, 2001. The USGS flow gauge indicated that the average flow on this day was 1.1 cubic feet per second. The algae on the margins of the stream indicate stagnation and no fish were present at the time of observation. Photo from KRIS Navarro by Pat Higgins.

Kimsey (1952) sampled this exact location in August 12, 1962 and found steelhead trout of two age classes (young-of-year, 1+) and a flow of 15 cfs during what was an average water year.

U.C. Davis (Johnson et al., 2002) found only seven suckers in many miles of Navarro stream surveys indicating that even this hardy species is disappearing.

Figure 10. Aerial photo of agricultural development in the Navarro River basin circa 1998 shows ten ponds of different types typical of water storage. Vineyard development and aggradation has almost completely eliminated salmonid summer rearing habitat. Photo from KRIS Navarro.

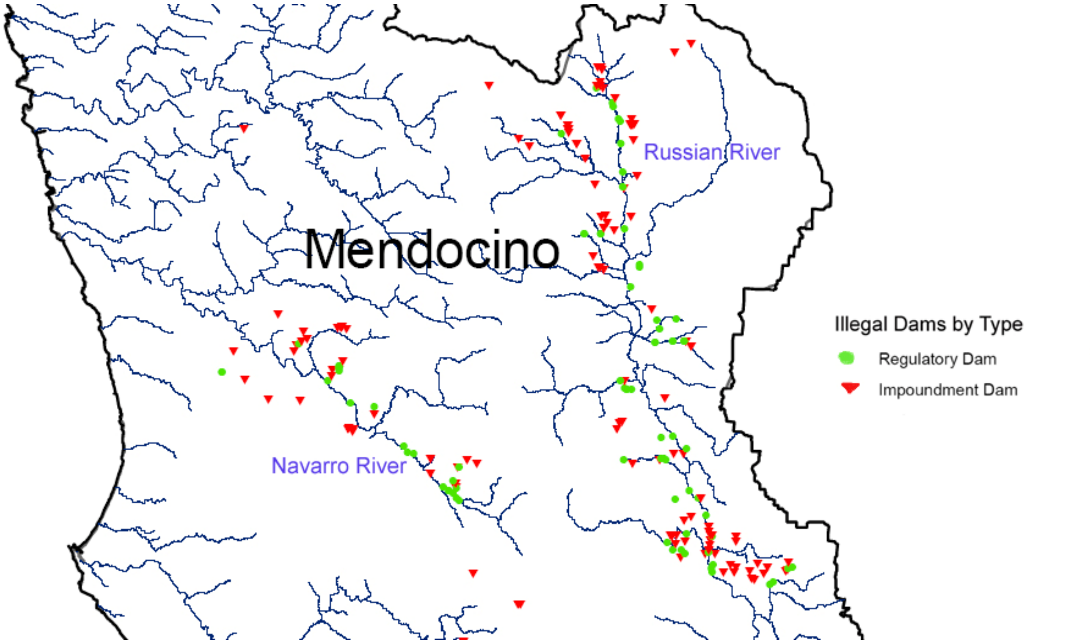

Figure 11. Locations of unpermitted diversion dams of two types in central Mendocino County with the Navarro at left and upper Russian River at right. Regulatory dams are diversions with no impoundments. From Stetson Engineering (2007a).

Figure 12. Looking downstream at the dry stream bed of the West Fork Russian River off the Eastside Road Bridge. The riparian vegetation lining both banks and extending back on the terrace at right is a result of a bioengineering project by Evan Engber. While trees have been successfully re-established to protect adjacent property and to stabilize channel conditions, over-diversion causes loss of flows. Photo by Patrick Higgins from KRIS Russian. July 13, 2003.

Figure 13. Large ground water pump appears right of center in the riparian zone of the Russian River looking west off East Side Road north of Hopland. KRIS Russian. Photo by Patrick Higgins. July 15, 2003.

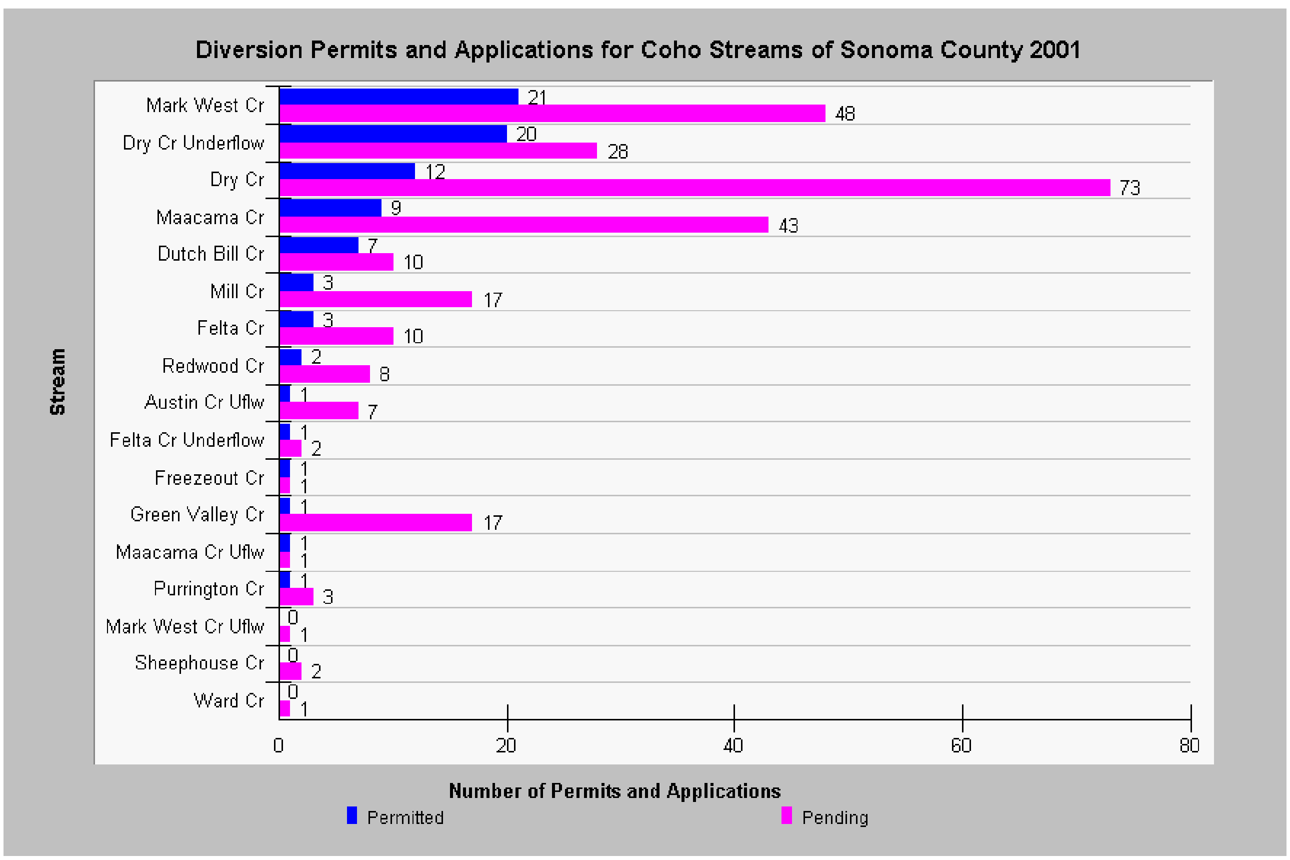

Figure 14. This chart displays the number of approved permits for appropriative water rights and those submitted for approval in Russian River tributaries known to have harbored coho salmon, including Green Valley Creek and Dutch Bill Creek. Data from the SWRCB WRD. March 2001. Chart from KRIS Russian.

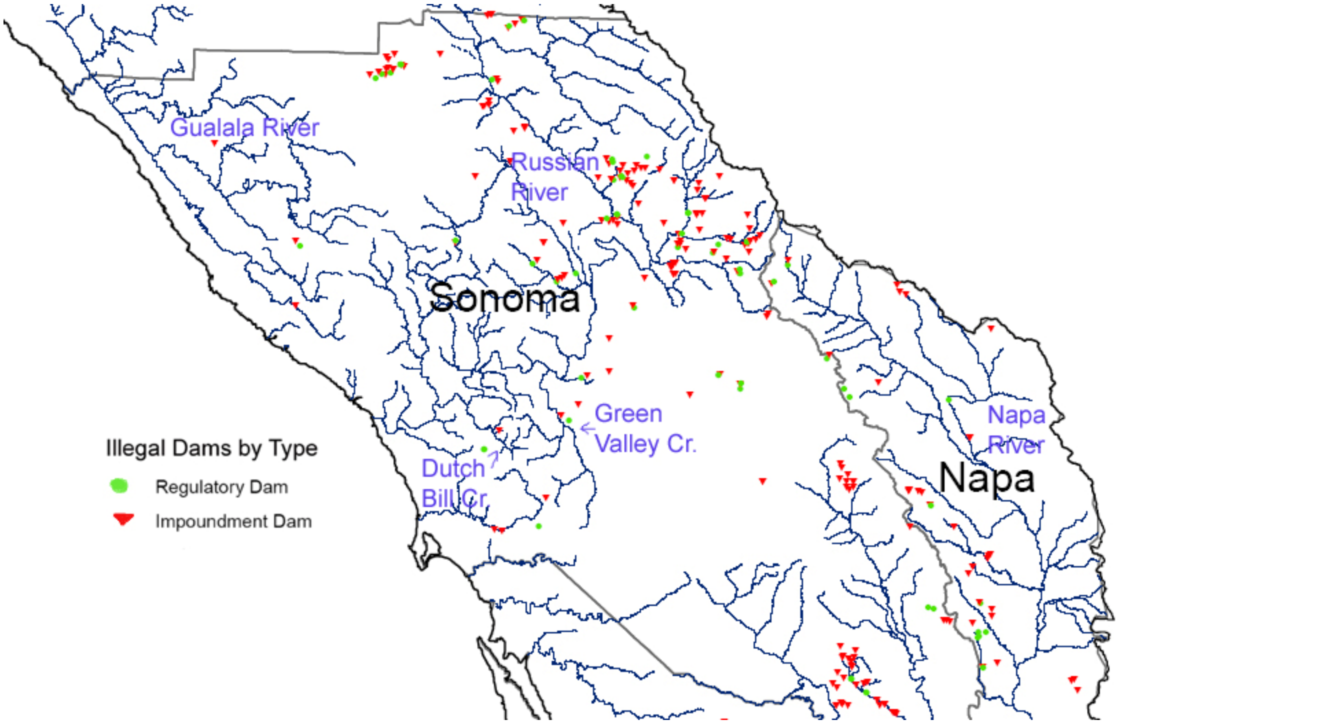

Figure 15. This map shows the locations of unpermitted diversion dams of two types in southern Sonoma and Napa counties, including lower Russian River tributaries Green Valley and Dutch Bill Creeks, which have recently harbored coho. Regulatory dams are diversions with no impoundments. From Stetson Engineering (2007a).

Sonoma Creek: My familiarity with Sonoma Creek is primarily due to my participation in the KRIS East Marin-Sonoma database project. Similar types of evidence are available to those used to demonstrate problems on the Russian River above. Habitat typing data (Figure 16) from upper Sonoma Creek indicates that reaches downstream of the headwaters go dry in summer. The cause of this loss of surface flow might be partially related to aggradation, but is still a sign that surface water availability has been diminished and that fish habitat is currently compromised. Figure 17 shows the dry bed of Carriger Creek, a tributary of Sonoma Creek, with what appears to be a large diversion pipe upstream. While Sonoma Creek itself has some problems with unpermitted diversion (Figure 18), diversion in the Tolay Creek basin indicates major illegal over-appropriation. It is likely that steelhead in Tolay Creek are at a very low level, if they persist at all.

Gualala River: I am familiar with the Gualala River from having worked on the KRIS Gualala database (IFR, 2003), completed a literature search and data assessment (Higgins, 1997), and commented on several proposed vineyard conversions (Higgins, 2003; 2004a, 2004b).

The Gualala River lies within southern Mendocino and northwestern Sonoma counties. It is recognized as impaired with regard to sediment (NCRWQCB, 2004) and has major problems with loss of surface flow and high water temperature (IFR, 2003b). CDFG (2001) characterized coho salmon in the Gualala River as “extirpated or nearly so.”

The following passage from KRIS Gualala (IFR, 2003b) characterizes SWRCB WRD prior actions in the North Fork:

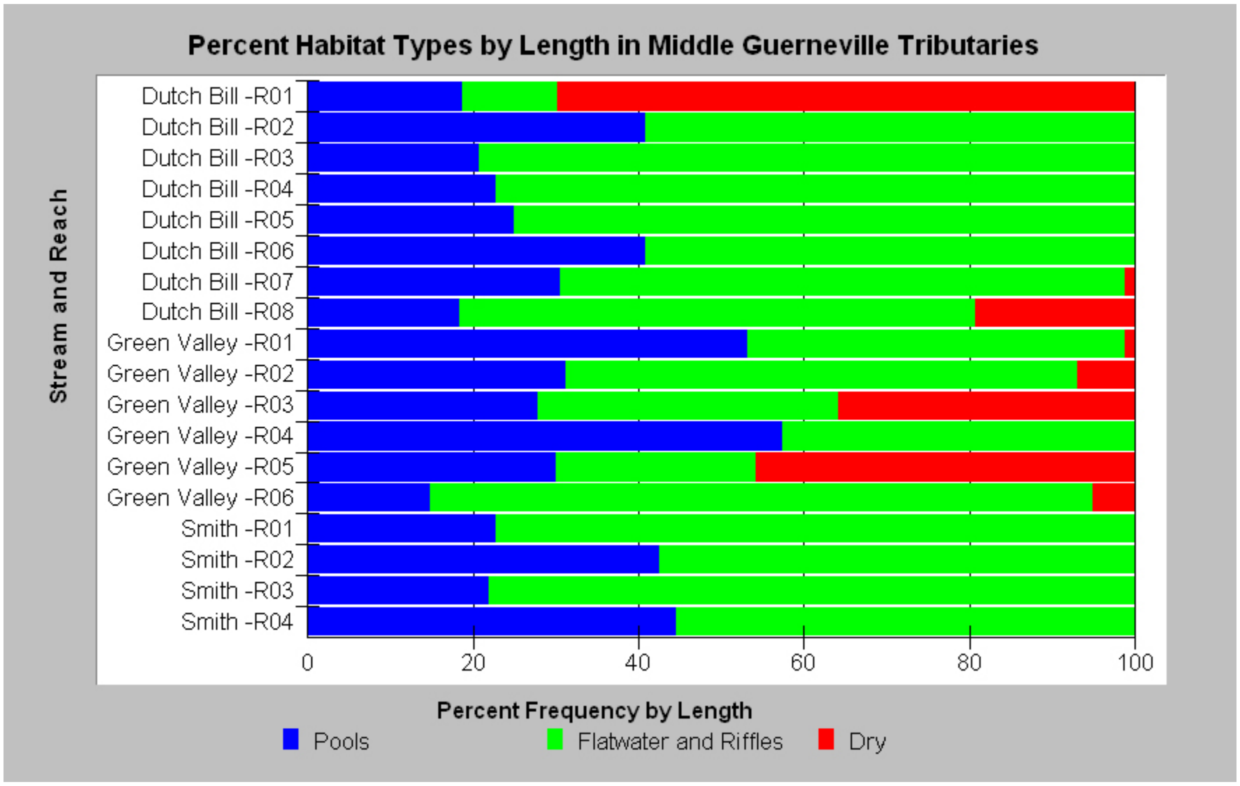

Figure 15. This chart shows CDFG habitat typing data for three lower Russian River tributaries. Notice that Dutch Bill and Green Valley Creek have significant dry reaches. Data from CDFG chart from KRIS Russian.

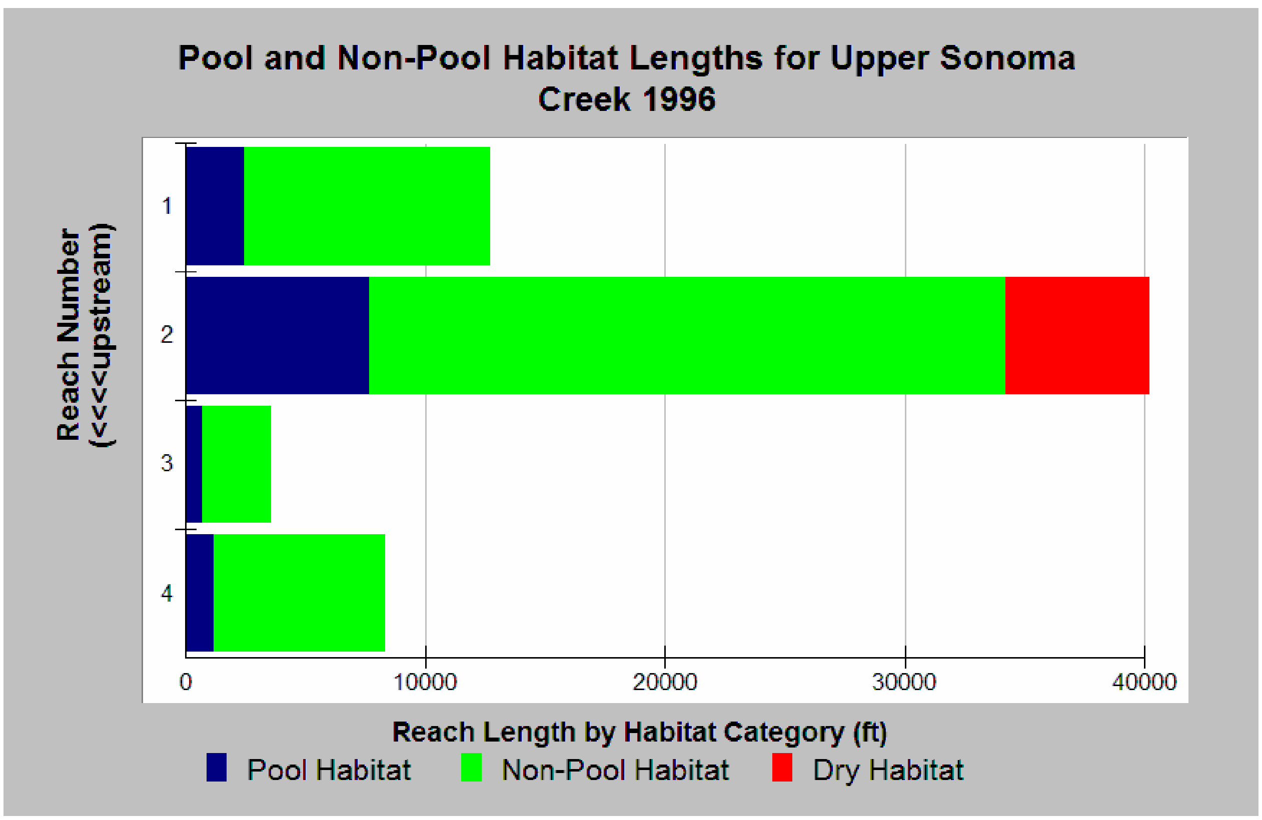

Figure 16. This chart shows Sonoma Creek Ecology Center habitat typing data for upper Sonoma Creek. The pool frequency is lower than optimal for salmonids (CDFG, 2004) and there are significant dry reaches. From KRIS East-Marin Sonoma.

Figure 17. This photo shows Carriger Creek, a tributary of Sonoma Creek, with a dry stream bed and what appears to be a large diversion pipe along cutbank upstream. From KRIS East-Marin Sonoma.

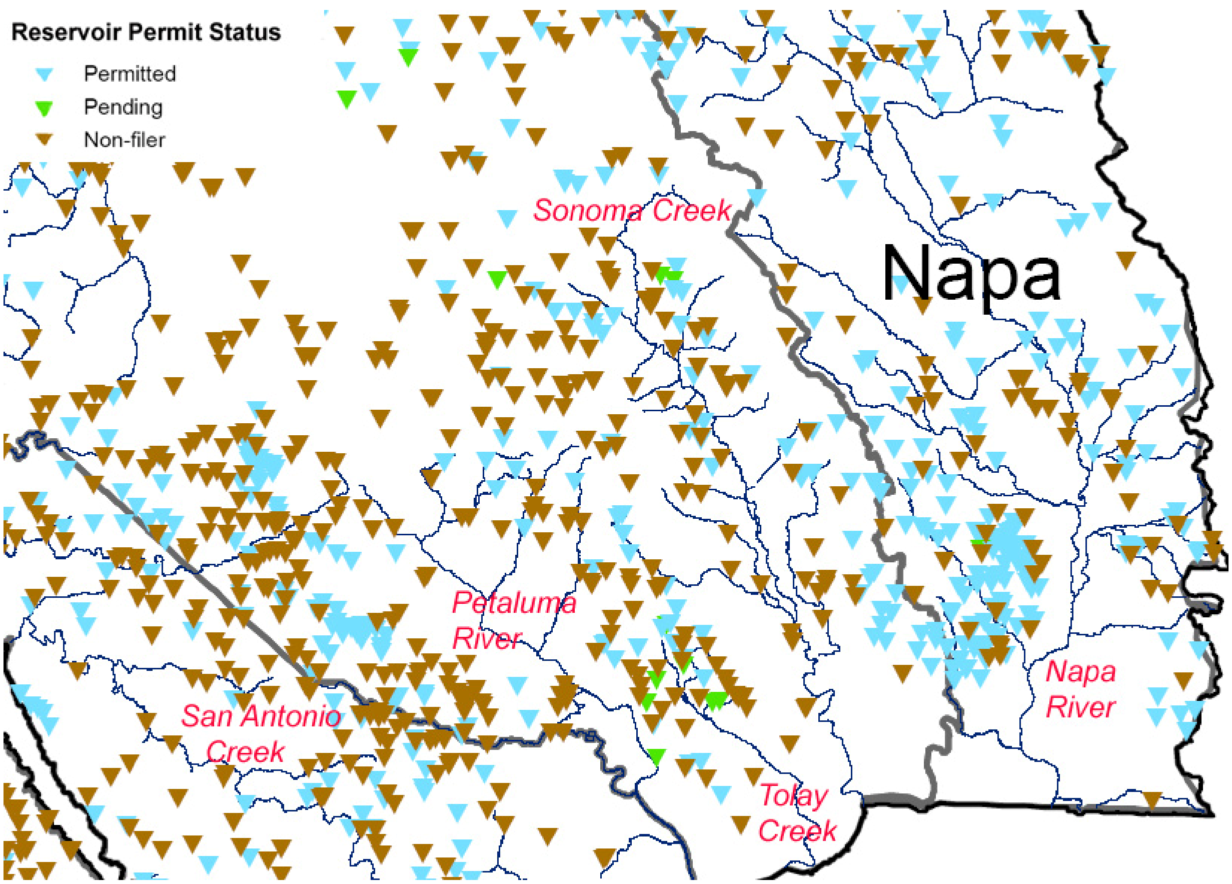

Figure 18. Locations of unpermitted diversion dams of two types, non-filers (brown) and pending (green). While there are many legal and illegal diversions on Sonoma Creek, cumulative effects risk is much greater in Tolay Creek, a much smaller basin, where there are 29 unpermitted diversions. From Stetson Engineering (2007a).

> "The California Department of Fish and Game (Hunter, 1996) expressed concern about the diversion of the North Fork Gualala by the North Gualala Water Company, citing reduction in fish habitat if minimum stream flows were not retained. The State Water Resources Control Board (1999) prohibited diversion of surface water when the North Fork dropped below four cubic feet per second (cfs), then in August 2000, ruled that this order applied to two NGWC groundwater wells (SWRCB, 2000). This decision recognizes the importance of North Fork flows to the lower mainstem Gualala as well."

The Gualala River combination of aggradation and increased water use due to vineyard expansion has created an expanding problem with stream reaches in this basin losing surface flow (Figure 19), including the lower mainstem, Wheatfield Fork, South Fork, Buckeye Creek and Rockpile Creek (Higgins, 2003; 2004). Habitat typing surveys by CDFG (2001), as part of the North Coast Watershed Assessment Program, found mainstem reaches going dry (Figure 20) where they maintained surface flow during the 1976-77 drought (Boccione and Rowser, 1977). Although rainfall in 1976-77 was only 16.0 inches, total rainfall in 2001 was 24.6 inches, yet flows in 1976-77 were 12.5 cfs and all major tributaries contributed surface flow. This indicates a major decrease in water yield and water supply.

The extensive loss of surface flows in the Gualala River represents a major threat to the continuing survival of steelhead, which are still a major part of the local tourist-based economy.

Figure 19. The Wheatfield Fork, just upstream of its convergence with the South Fork, ran underground in 2001. Although the aggradation of the Wheatfield Fork is a factor contributing to lack of surface flows, water diversion for several vineyards and rural residential use exacerbate the problem. Photo by Pat Higgins from KRIS Gualala database.

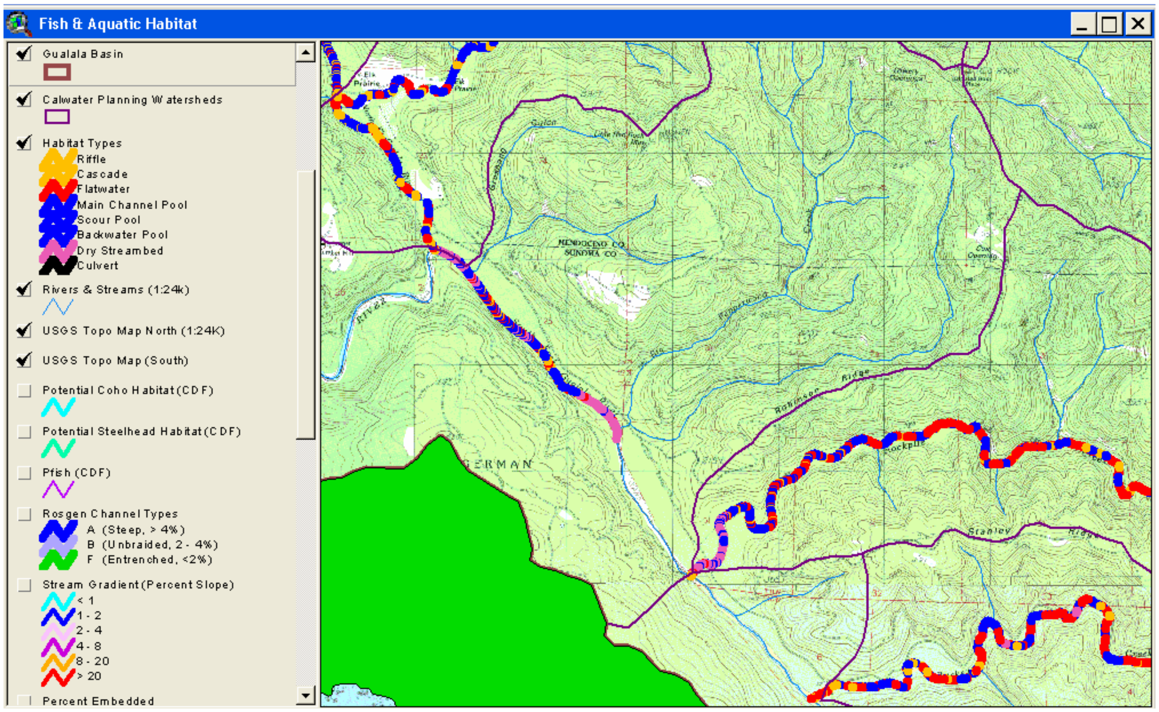

Figure 20. CDFG habitat typing of the Gualala River in 2001 shows the lower mainstem Gualala River below Big Pepperwood Creek ran underground for an extensive reach. Lower Rockpile Creek also lost surface flows in more than a quarter mile. KRIS Gualala and Higgins (2003).

<u>West Marin Tributaries</u>: Salmon, Americano, Stemple and Walker creeks all have agricultural water extraction that both compromises water quality and limits habitat for steelhead and coho salmon. Figure 21 shows a close up of these West Marin tributaries with all impoundments, 1) permitted, 2) those with applications pending, and 3) illegal diversions with no contact from the operator. The epidemic problem of over diversion and potential for cumulative effects is self-evident.

All these West Marin tributaries have extensive agricultural land use, mostly by dairies. Cattle may deposit fecal material directly into streams or it may enter as a result of overland flow. Grazing takes place up to stream banks leaving no riparian buffer capacity (Figure 22). Lack of canopy also promotes stream warming and flow depletion contributes promotion of both increased water temperatures and nutrient pollution.

Charts from KRIS West-Marin Sonoma (IFR, 2003a) show the degree of water quality impairment due to the cumulative effects of agricultural activity and flow depletion. Salmon Creek is the most northerly of tributaries considered, entering the Pacific Ocean north of Bodega Bay. Figure 23 shows dissolved oxygen (DO) values from several stations sampled by CDFG on Salmon Creek that are indicative of nutrient pollution. Super-saturated DO of greater than 10 mg/l at Highway 1 is linked to very high biological activity of algae blooms that thrive in the stagnant, nutrient-rich waters. Minimum DO levels at the Bodega location approached the recognized lethal limit for salmonids of 3.8 mg/l (WDOE, 2002). While D.O. is super-saturated during daylight hours due to photosynthesis, D.O. becomes depressed as algae respire at night or as algae dies off.

Merritt and Smith Consulting (1996) studied Americano Creek for the City of Santa Rosa. Figure 24 shows flow measurements indicating that surface flow near Garicke Road (Station E-6) was not present from April until November 1988 and from May-September 1989. Flow depletion also contributes to major pollution problems similar to those in neighboring creeks. Stemple Creek shows another symptom of nutrient pollution, high pH (Figure 25). A pH value of over 9.5 is directly lethal to rainbow trout (Wilkie and Wood, 1995).

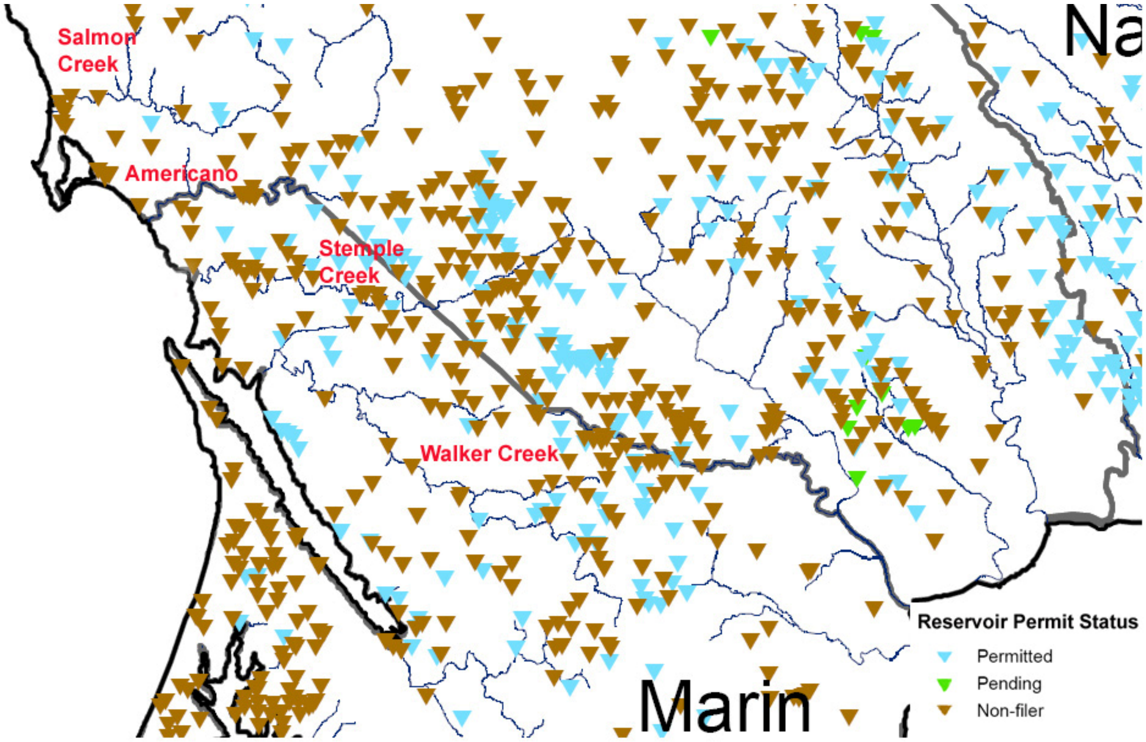

Figure 21. This map shows a zoom of the same type as Figure 2 with close up of West Marin County creek diversion impoundments that are permitted, have permits pending or are unpermitted (Non-filer). There is an obvious huge cumulative effects problem with diversion and water use. From Stetson Engineers (2007a).

Figure 22. The photo at left shows the lower mainstem of Walker Creek with very poor fish habitat as a result of livestock grazing and flow depletion. The shallow, wide stream channel and lack of riparian vegetation makes the stream subject to warming. Photo from KRIS West Marin-Sonoma.

Creel census data from 1949-1974 indicate that hundreds of adult steelhead were harvested in some years and adult coho were present in the catch (Kelley, 1976). Kelley (1976) interviewed long time residents and anglers, who said that the coho salmon run in Walker Creek was much more robust prior to 1950.

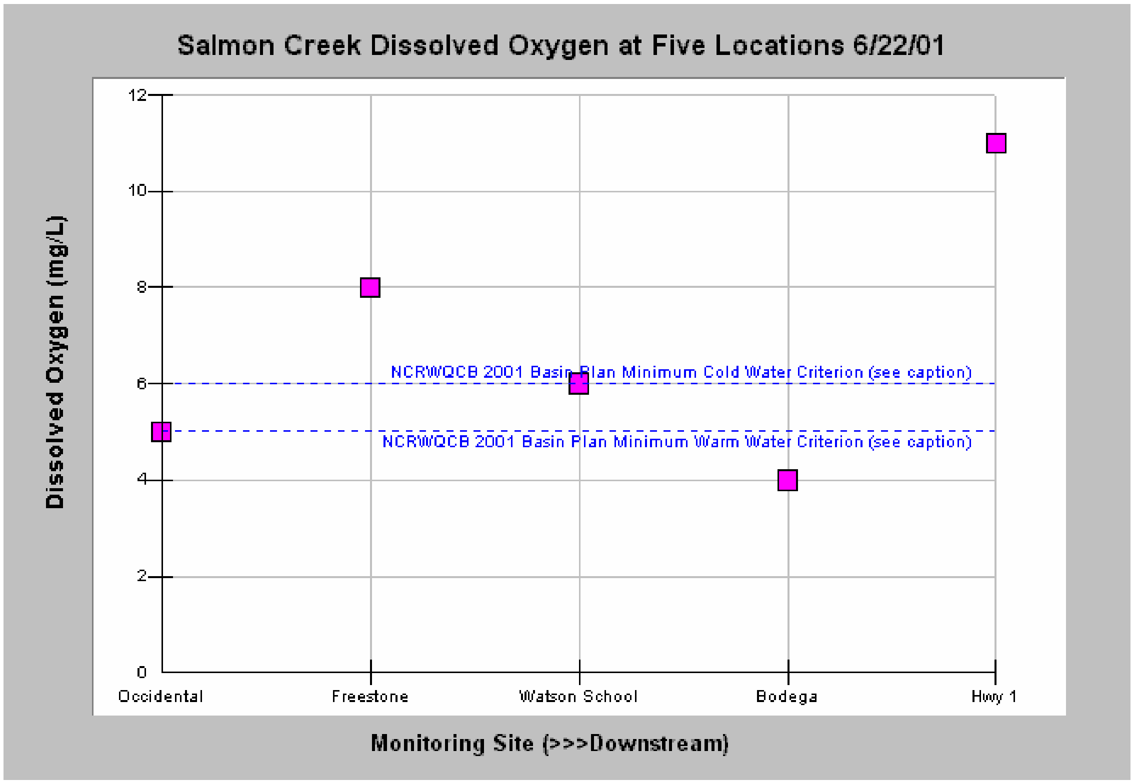

Figure 23. Dissolved oxygen at five stations (going downstream from left to right) in Salmon Creek. The high dissolved oxygen at Highway 1 is consistent with elevated pH values indicating photosynthetic activity characteristic of nutrient pollution. D.O. sags would occur at night. These data were collected by the North Coast Regional Water Quality Control Board as a part of the Surface Water Ambient Monitoring Program (SWAMP). June 22, 2001. From KRIS West Marin-Sonoma.

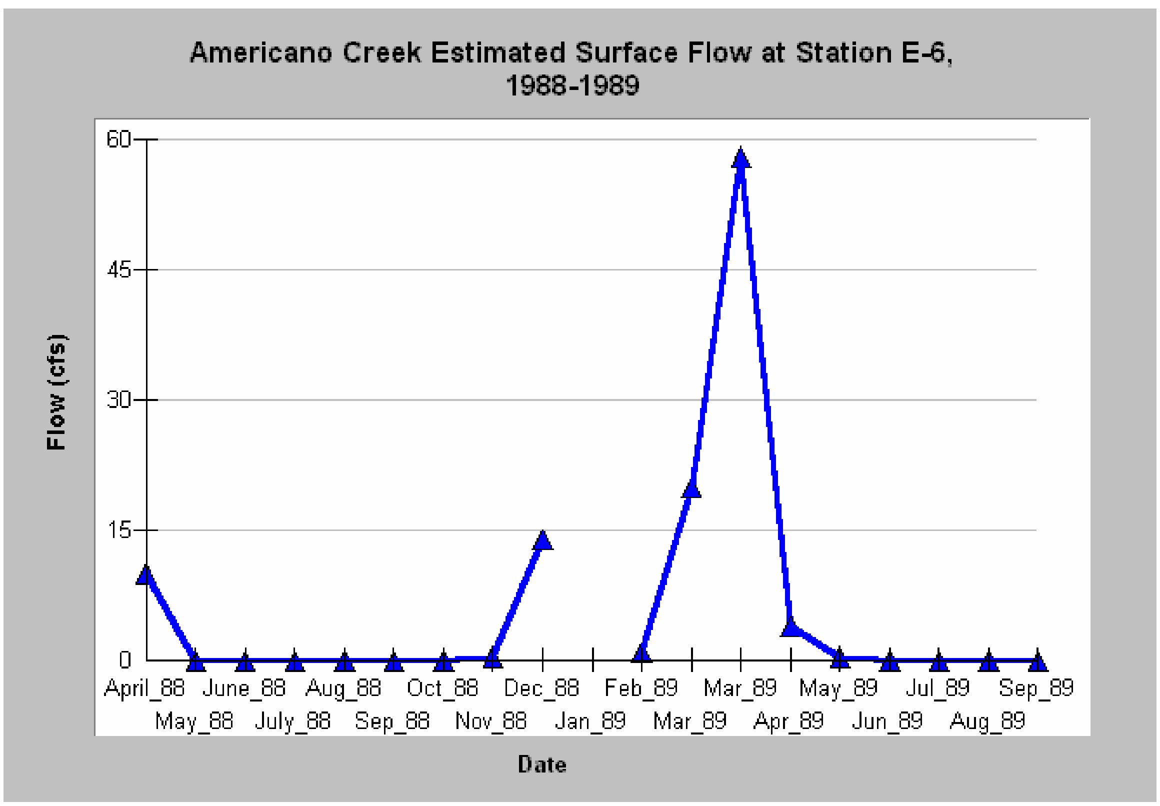

Figure 24. Surface flow was estimated approximately once monthly near Garicke Road (Station E-6) in Americano Creek from 1988-1989. Flow was not present after April in 1988 until November 1988 and from May-September 1989. Data from Merritt Smith Consulting for the City of Santa Rosa and U.S. Army Corps of Engineers. KRIS West Marin-Sonoma.

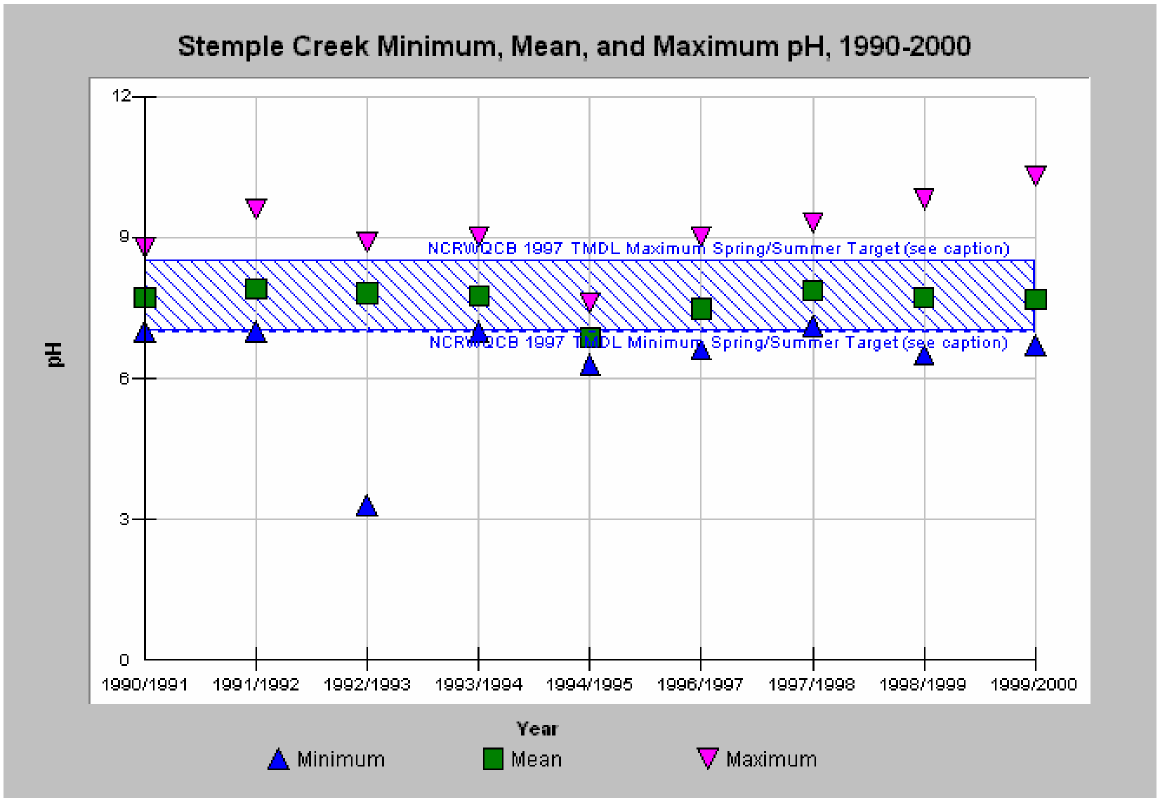

Figure 25. The pH of Stemple Creek exceeded stressful or lethal for salmonids (>9.5) as a result of nutrient enrichment from cattle waste in combination with flow depletion. Data from CDFG and chart from KRIS West Marin-Sonoma.

Walker Creek had coho salmon historically (Figure 26) but flow depletion and nutrient pollution have contributed to their disappearance. Kelly (1976) used electrofishing and netting for the Marin Municipal Water District sponsored studies that found coho, abundant Pacific lamprey juveniles and steelhead juveniles of all age classes in Walker Creek. Flows now annually fall to near 5 cfs or less from July through September (Figure 27). Reduced flow and grazing impacts have resulted in water quality problems similar to previously discussed tributaries related to nutrient pollution.

Scott River: Although the Scott River is not within the *Policy* area, it has very well recognized water quality and fisheries problems related to surface and ground water extraction (NRC, 2004). I am intimately familiar with this basin from helping with restoration planning (Kier Associates, 1991), restoration evaluation (Kier Associates, 1999), building three versions of KRIS databases, and four years of work on Scott River issues for the Klamath Basin Tribal Water Quality Work Group. Several papers on the Scott, Shasta and Klamath TMDLs are posted on their website and WRD can easily access documents on the Internet at www.klamathwaterquality.com.

I draw below from previous comments on the *Scott TMDL* (Higgins, 2006c) that are on the DVD with regional KRIS projects filed with these comments. The principal findings were as follows:

1. Flows have been decreased by ground water extraction,
2. Flows have declined to far below those required by the Scott River adjudication and often cause stream reaches and tributaries to go dry,
3. Low flow exacerbates water temperature problems, and
4. Flow and temperature problems combine with sediment to severely limit productivity of salmon and steelhead populations.

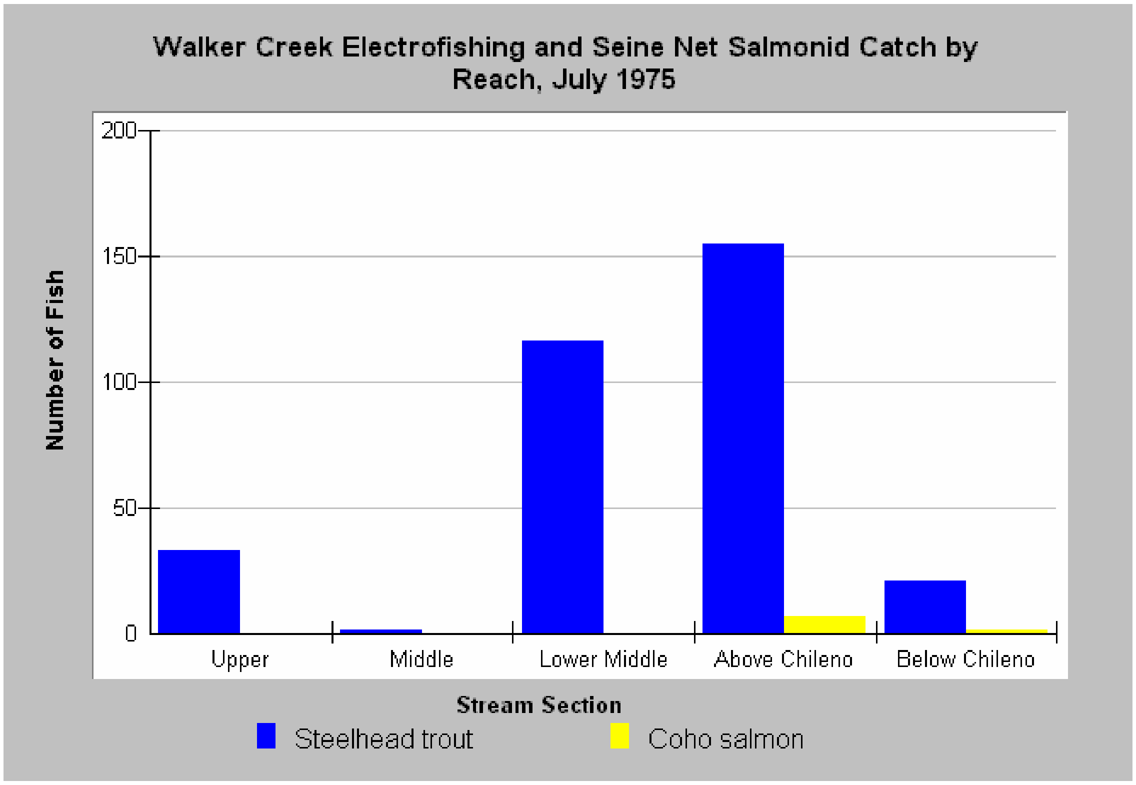

Figure 26. Fish sampling in Walker Creek in 1975 found coho salmon and numerous steelhead. Kelly (1976).

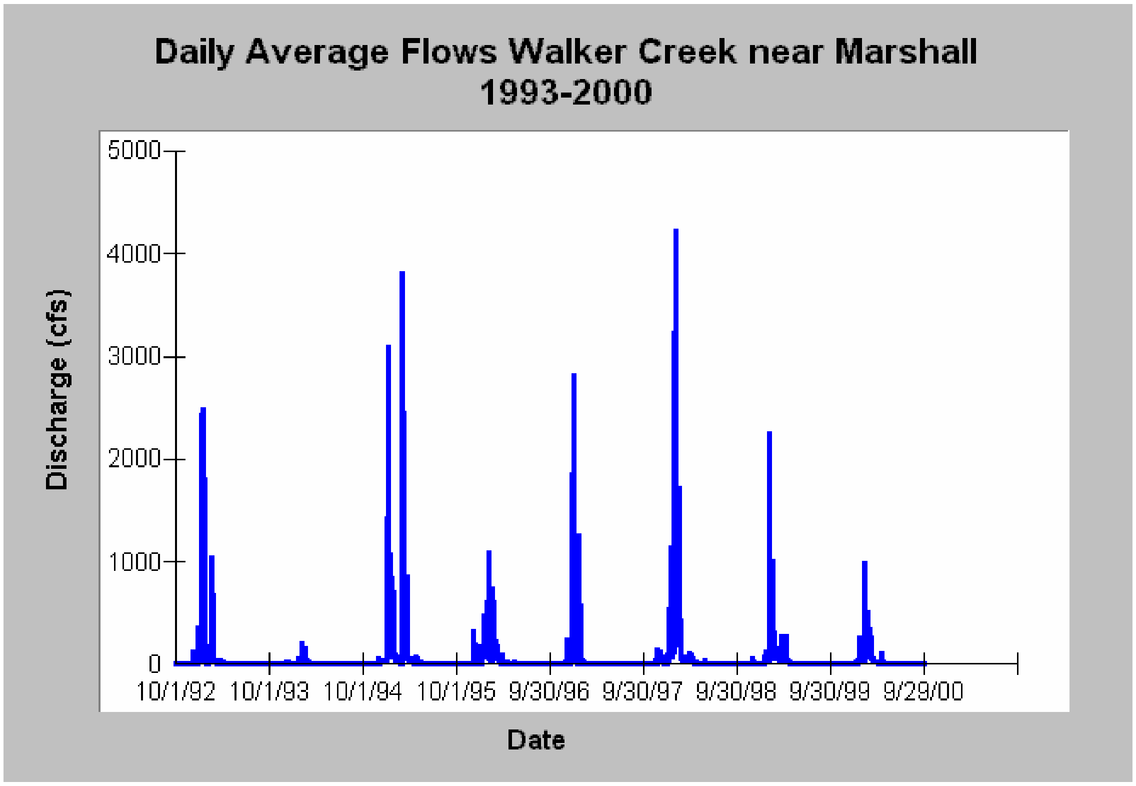

Figure 27. Flows in Walker Creek, tributary of Tomales Bay, dropped to 5 cfs or less on average annually according to USGS flow gauge records. Chart from KRIS West Marin-Sonoma.

The Scott River channel and many of its major tributaries are dried up annually, in violation of CDFG code 5937 (Figure 28 & 29), severely limiting rearing habitat for salmonids. Although the Scott River is adjudicated (SWRCB, 1980), flow levels fall below those required for months of the year (Figure 30). This causes major reductions in habitat quality in the lower Scott River, which formerly served as a summer refugia for juvenile salmonids.

The *Long Range Plan for the Klamath River Basin Conservation Area Fishery Restoration Program* (Kier Assoc., 1991) noted that ground water pumping in the Scott River valley depleted surface flows because of interconnections between surface and ground water. The Scott River has experienced major declines in surface flows coincident with installation of ground water pumps beginning in the 1970's. Pumps continue to be installed through NRCS and EQIP funding (Figure 31) and drops in ground water levels are becoming evident (Figure 32). The chart suggests that while annual maximum levels have remained relatively constant over time, annual minimum levels have declined since 1965, although they fluctuate with precipitation.

The National Research Council (2004) makes a clear case that flow depletion is at the root of temperature problems in the Scott River. As flows drop, transit time for water increases allowing an opportunity for stream warming. A thermal infrared radar (TIR) image of Shackleford Creek (Figure 33) was taken by Watershed Associates (2003) as part of the Scott River TMDL and shows dramatic effects of flow depletion on water temperature. Shackleford Creek is cool enough for juvenile salmonid rearing above points of diversion, then warms rapidly as its flow is depleted. Flow resumes below the major tributary Mill Creek, warms again as flow is reduced by irrigation until surface flows are lost, just upstream of the convergence with the Scott River.

Fall chinook salmon from the Scott River are an important component of the Klamath River run that supports ocean, sport and Native American fishing. Scott River fall chinook returns plummeted in 2004 and 2005 to the lowest level on record for two years in a row (Figure 34). Even after prolonged drought from 1986-1992 Scott River fall chinook returns ranged from 3000-5000 adults annually.

A major potential problem for chinook salmon is that they are stranded in the lowest reaches of the Scott River due to continuing stock water activities and other illegal diversions after October 1 (Figure 30). The fish are forced to spawn in lower reaches of the Scott River (Figure 35) where decomposed granitic sand levels are very high, which threatens egg survival as sand is transported during winter storms.

The SWRCB WRD needs to make the Scott River a priority for enforcement. Fall chinook are collapsing and coho salmon only have one strong year class of three, indicating a high risk of extinction. Immediate action is appropriate given the change in weather and flow patterns expected with a change of the Pacific Decadal Oscillation (PDO) expected sometime from 2015 to 2025 (Collision et al., 2003) and with longer term drought cycles expected with global warming (see Climate Cycles and Change).

<u>Shasta River</u>: My experience on the Shasta River parallels that described for the Scott River and my TMDL comments (Higgins, 2006d) also serve as the source for information below. The Shasta River Adjudication (CDPW, 1932) does not require a minimum flow level similar to the Scott River Adjudication (CSWRCB, 1980) and average daily flows can fall to near 20 cfs (Figure 36), which has major consequences for elevated stream temperatures (NRC, 2004). Lack of coordination of irrigation operations may sometimes cause flows to fall below the listed average and present an even greater challenge for fish survival. Dwinnell Reservoir (Figure 37) blocks the headwaters of the Shasta River and is a major source of pollution itself (NCRWQCB/UCD, 2005). Major tributaries like Parks Creek (Figure 38) and the Little Shasta River lose surface flows for several months a year.

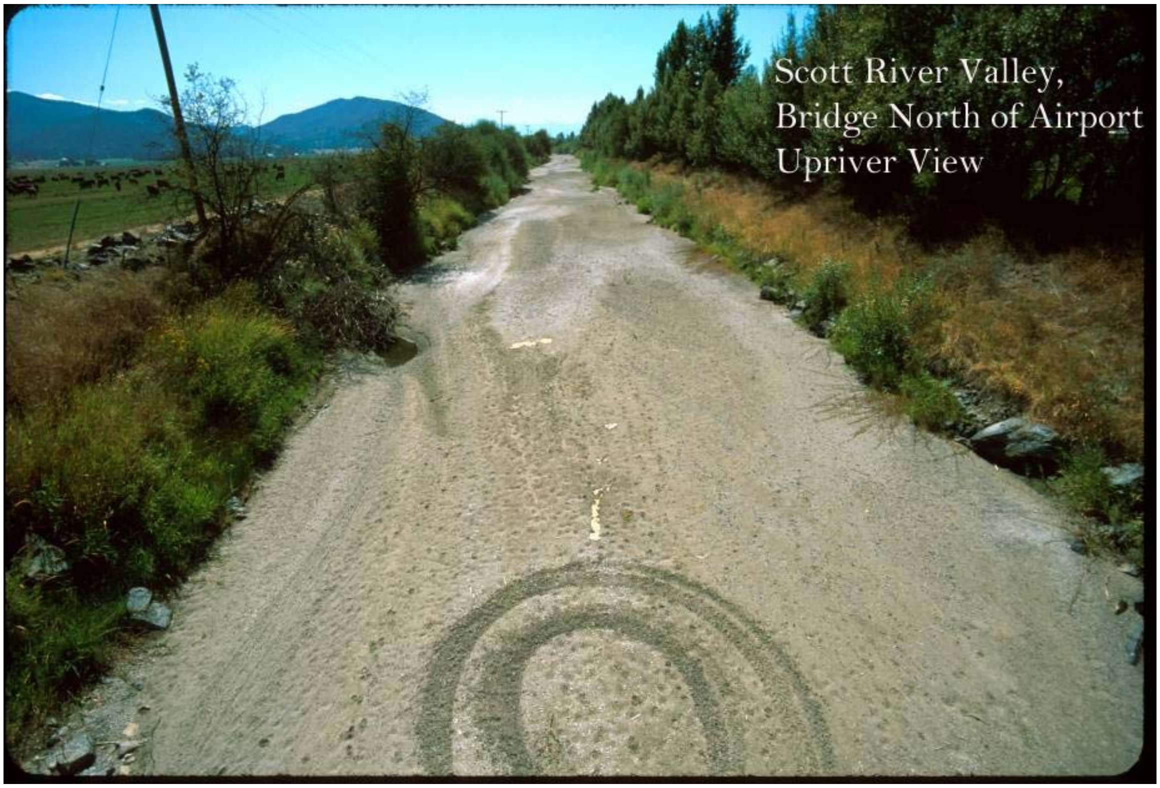

Figure 28. The dry bed of the Scott River in a reach near the airport looking upstream. This is a violation of CDFG Code 5937. Photo from KRIS Klamath-Trinity V 3.0 taken by Michael Hentz. 2002.

Figure 29. Shackleford Creek is shown here running dry at its convergence with Scott River in August 1997. The creek has coho and chinook salmon and steelhead trout, but diversions dry it up annually during summer and fall. This is also in violation of CDFG Code 5937. Photo by Pat Higgins from KRIS V 3.0.

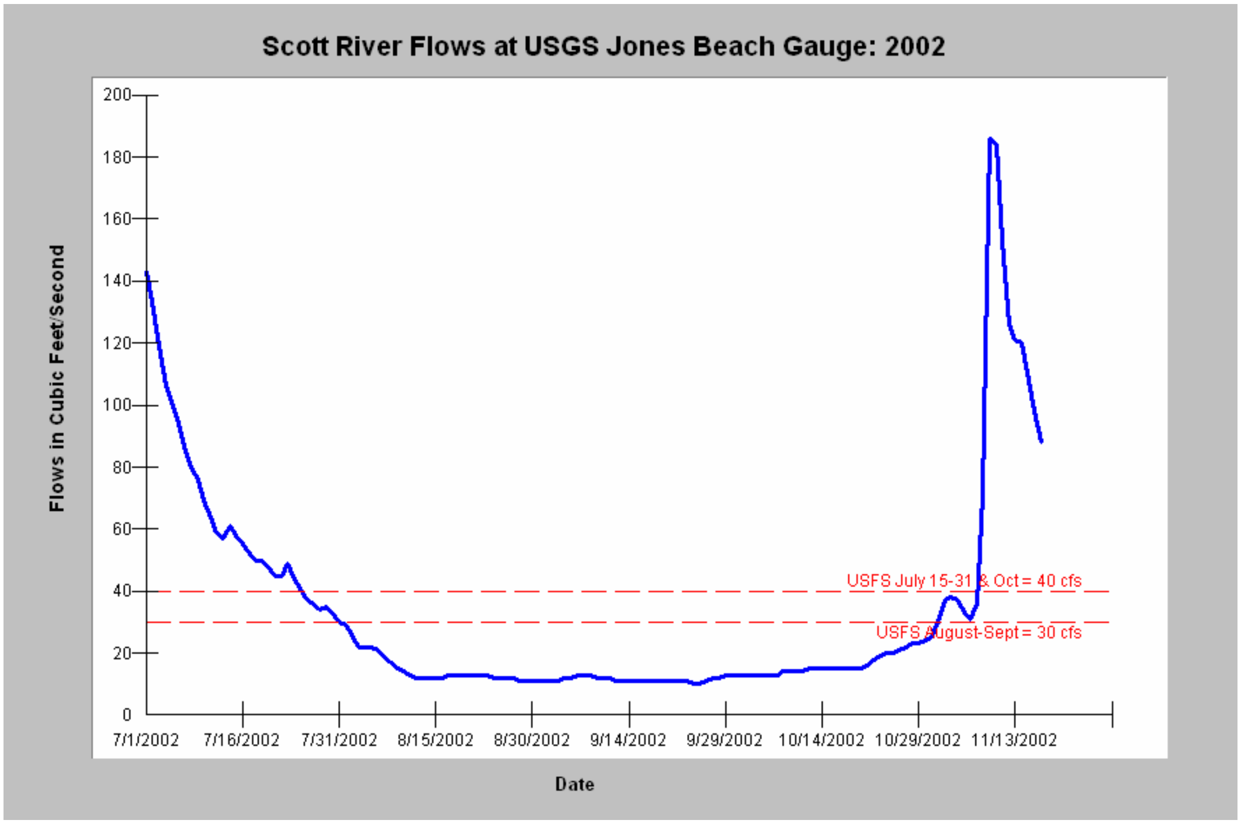

Figure 30. Jones Beach USGS flow gauge data from the irrigation season of 2002 show that flows failed to meet adjudicated levels for the USFS and flows needed for fish migration, spawning and rearing in August, September and October. Reference lines are those from the SWRCB (1980) adjudication.

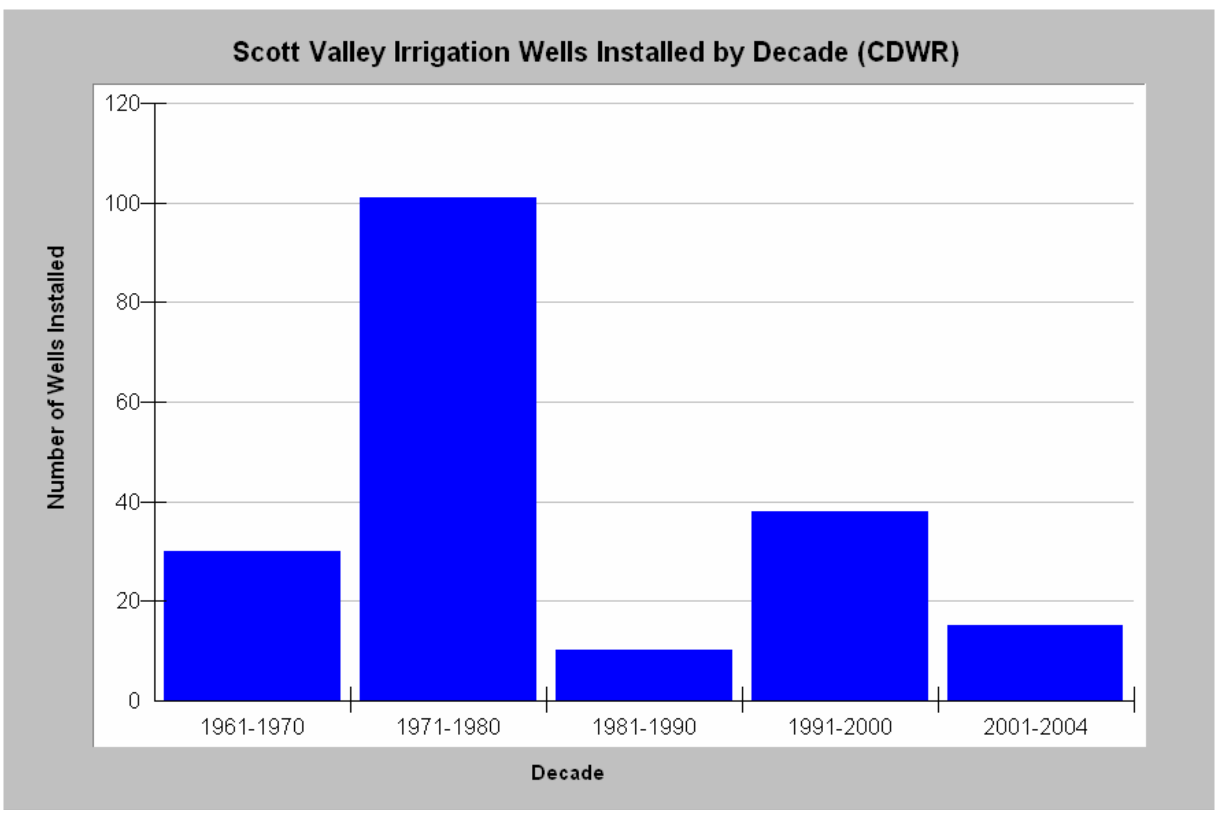

Figure 31. This chart shows the number of irrigation wells recorded by the California Department of Water Resources. Data may be only partial as not all parties installing wells file with DWR.

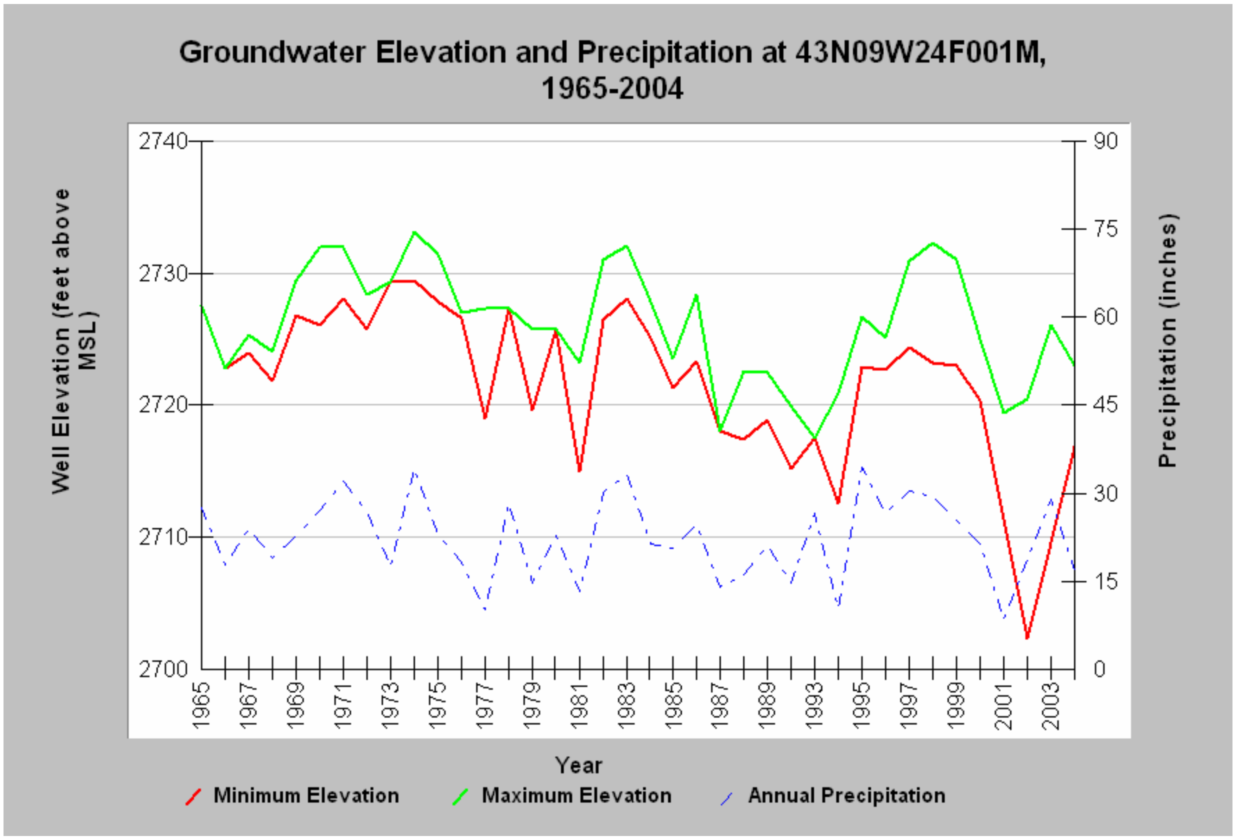

Figure 32. Department of Water Resources well 43N09W24F001M, approximately 5 kilometers south-southeast of Fort Jones, for the years 1965-2004. Minimum elevation declines are likely indicative of ground water depletion. From QVIC (2006).

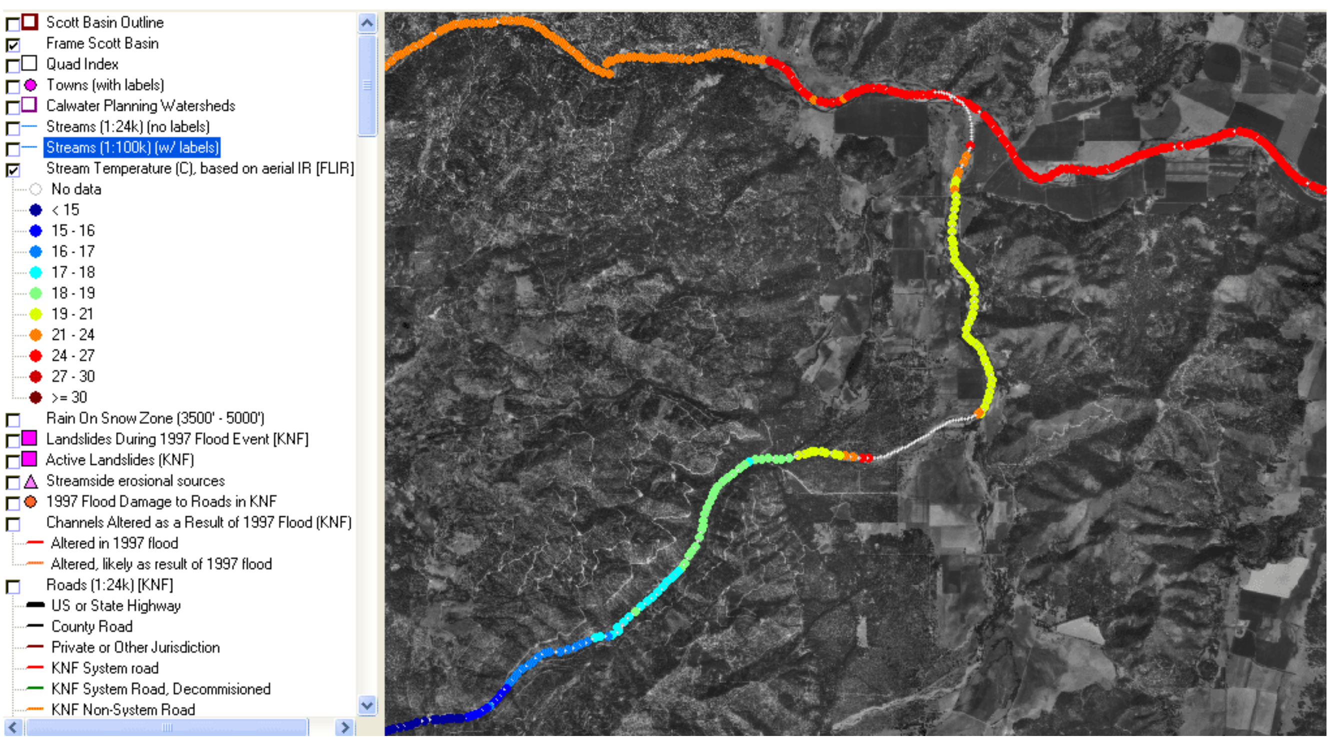

Figure 33. This map shows summary data of Scott River Thermal Infrared Radar (TIR) surveys for Shackleford Creek. Note that water temperature warms in a downstream direction as flow is depleted. Reaches with no temperature coded color are dry, indicating loss of surface flow in violation of CDFG Code 5937 and over-diversion in violation of SWRCB Codes 1243, and 1375. Data from Watershed Sciences (2003).

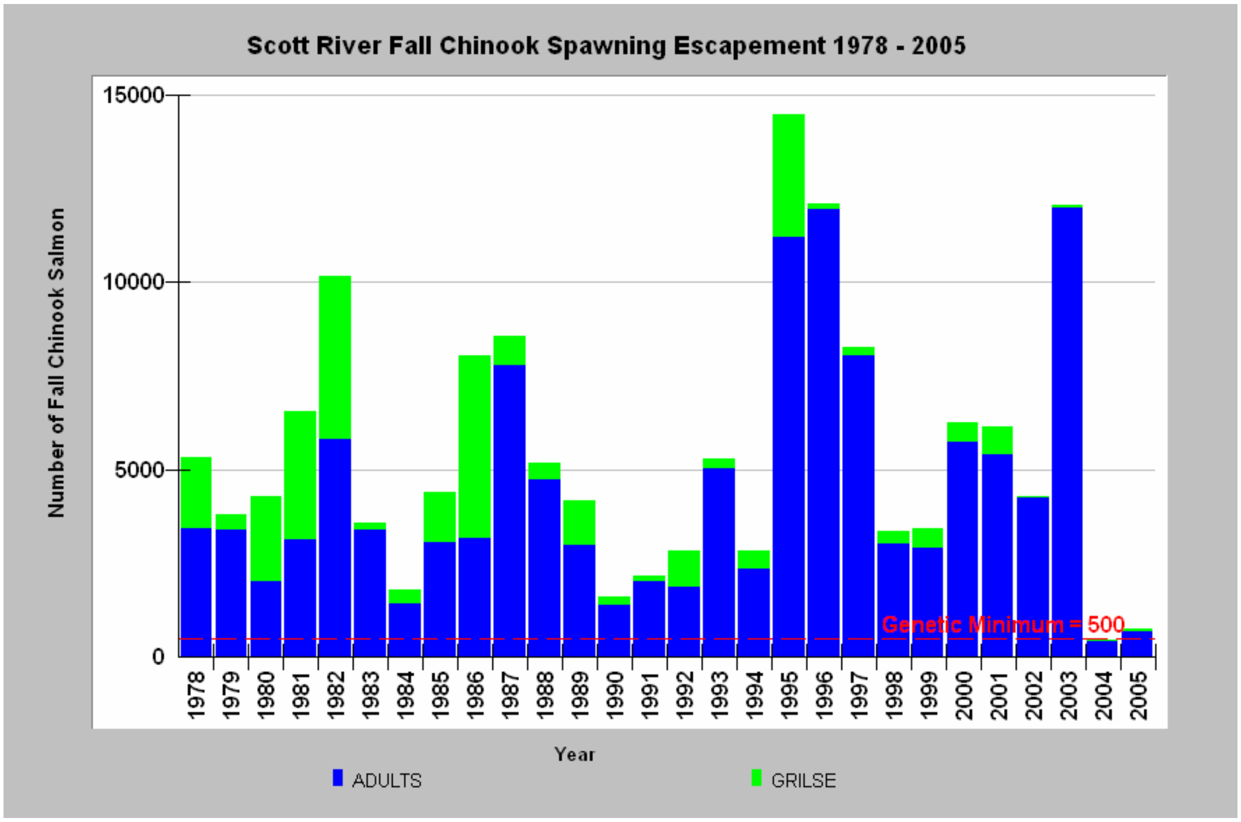

Figure 34. Scott River fall chinook spawning runs from 1978 to 2005 shows both 2004 and 2005 as the lowest years on record. Summer and fall flow conditions were near all time lows for preceding 2004-05 brood years (2001-2002). Data from CDFG.

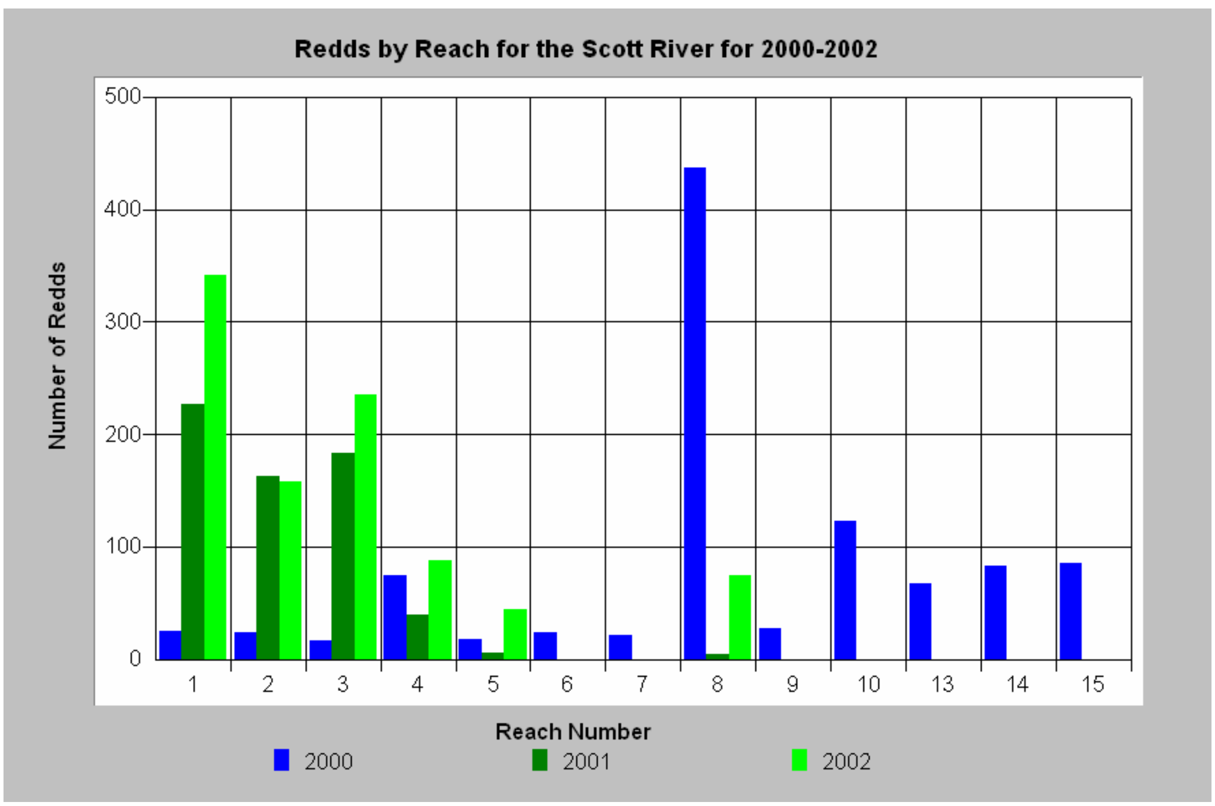

Figure 35. Data from CDFG spawner surveys show that fall chinook salmon spawned mostly in the lowest five reaches of the Scott River in 2001 and 2002, where eggs may be vulnerable due to potential for bed load movement or transport of decomposed granitic sands. Low flows in fall prevent salmon disbursement to upstream reaches where gravel conditions are superior and chances of egg survival greater. KRIS V 3.0.

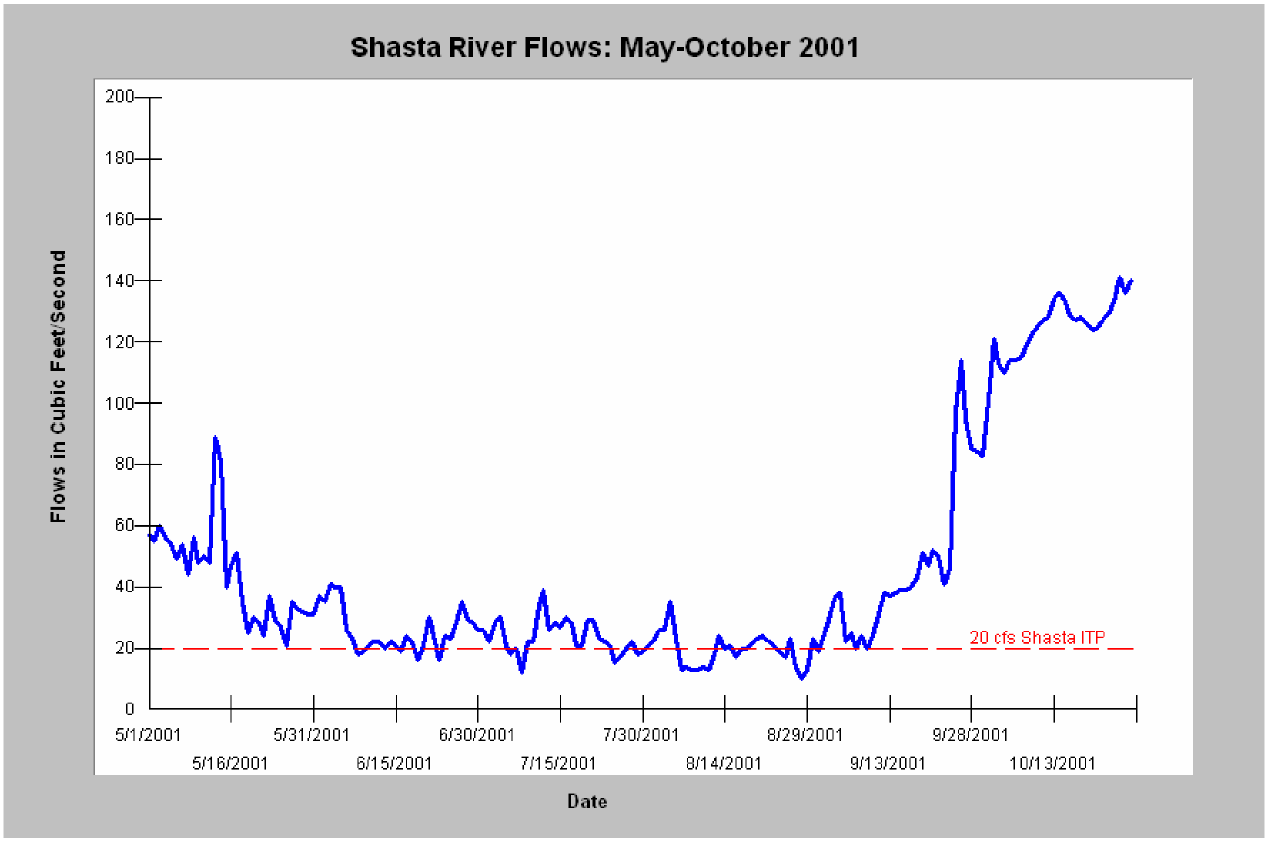

Figure 36. Average daily flow at the USGS Shasta River gauge for May through October 2001 shows a pattern of extremely low flows with many days falling below 20 cubic feet per second. This contributes to temperature problems as less water mass warms easily and agricultural runoff back to the river is hot.

Figure 37. Dwinnell Reservoir looking southeast off the dam with water levels at less than full pool in 2002. Long retention time and exposure to sunlight trigger algae blooms and nutrient pollution. Water releases from this reservoir are restricted to avoid adding to water pollution downstream. It has blocked downstream flow since 1928 in violation of CDFG 5937. Photo from KRIS V 3.0 by Michael Hentz.

Figure 38. Parks Creek is shown here below the diversion to Dwinnell Reservoir with surface flows almost completely depleted. This not only shuts off cool water that could buffer high Shasta River water temperatures. Winter flows are also diverted blocking adult fish passage and blocking spawning gravel recruitment to the mainstem Shasta River. Photo by Michael Hentz.

Mack (1958) measured flow in Big Springs Creek of 103 cfs, which is very similar to the measurements taken by the California Department of Public Works (1925) for the Shasta River Adjudication (CDPW, 1932). This spring source was at optimal temperatures for salmonid rearing and the California Department of Water Resources (1981) found that Big Springs Creek had the highest spawning use of any Shasta River reach or tributary. Kier Associates (1999) noted that the spring feeding Big Springs had been depleted due to ground water pumping to less than 20 cfs.

Major increases in diversion of surface and groundwater have changed the temperature regime of the Shasta River. Thermal infrared radar (TIR) imagery captured by Watershed Sciences (2003) illustrates how flow depletion affects Big Springs Creek and Shasta River water temperature (Figure 39). The image shows water temperatures below 20^{o} C only immediately downstream of Big Springs Lake, but warming to 21.7^{o} C (Watershed Sciences, 2003), which is stressful for salmonids (U.S. EPA, 2003). The NCRWQCB (2006b) recommends that flows increases at Big Springs to at least 50 cfs to restore water quality.

The Shasta River and Scott River will also be where new private Watermaster service will be pioneered. The service has been ineffective in protecting instream flows in these basins (Kier Associates, 1991; 1999). The cost of DWR Watermaster service is born by the water users and it has been rising in recent years. Recent legislation now allows the water users to hire private contractors to render the same service. Questions have been raised as to whether a private contractor working for the water users can be expected to elevate public trust interests over those of his clients.

The NRC (2004) asked for consideration of removal of Dwinnell Dam in order to restore fish passage and increase flows. Models of snow fall changes resulting from global warming indicate that only Mt. Shasta's snow pack will increase, which makes the Shasta River one of the best places to maintain salmonids in the Klamath Basin in the face of climate change.

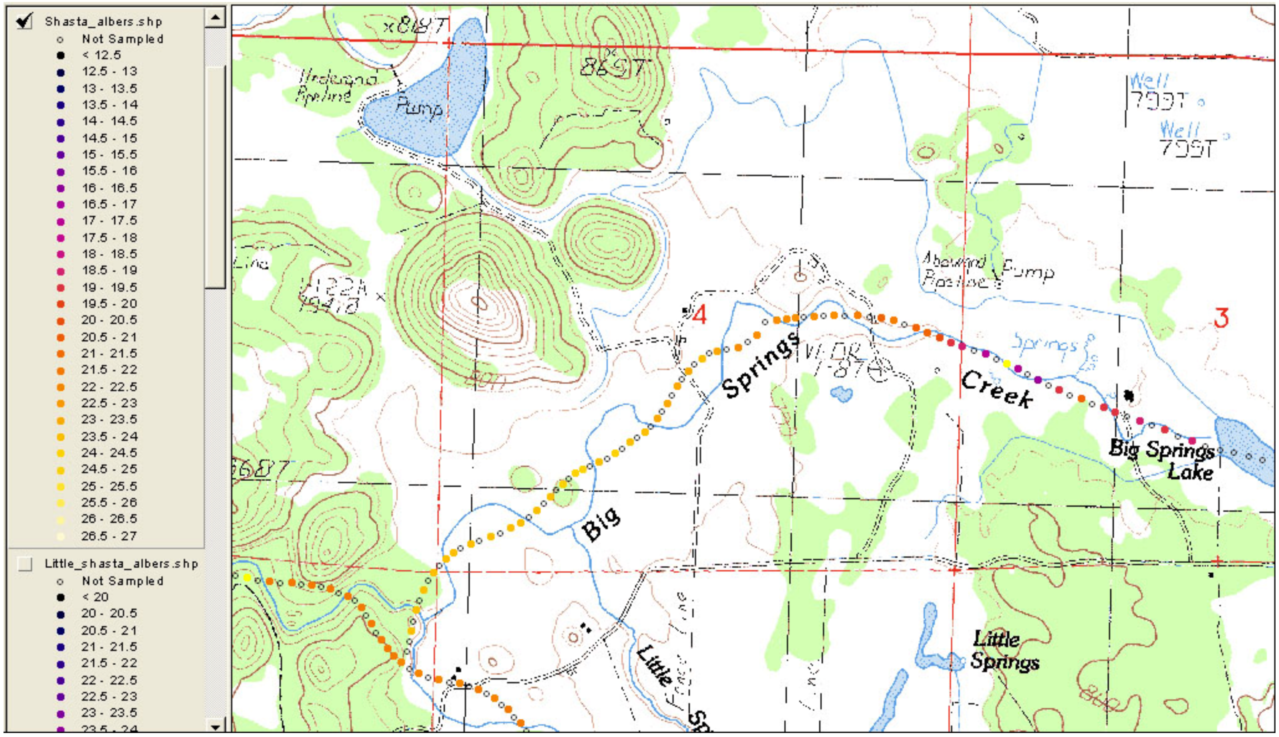

Figure 39. Thermal infrared radar (TIR) map of Big Springs Creek shows that the stream warms rapidly as a result of diversion and now is too warm for optimal salmonid rearing within a distance of less than three miles. Data from Watershed Sciences (2003) provided as GIS by NCRWQCB staff.

Climatic Cycles and Climate Change

The majority of the peer reviewers of the *Policy* (Lang, 2008; Gearheart, 2008; Band, 2008; McMahon; 2008) stated that SWRCB WRD needed to factor climate change into their planning. As mentioned above, NRC (2004) asserts that the Shasta River has the greatest restoration potential in the Klamath Basin in the face of global warming. Oscillations of climatic cycles will likely accentuate drought, which will act in concert with increased water demand from a growing population (Stetson Engineering, 2007b). While study of climate change is still progressing, shorter term cycles of rainfall and ocean productivity are now well recognized (Hare, 1998).

The Pacific Decadal Oscillation (PDO) cycle causes major shifts in ocean productivity from favorable to unfavorable for salmon approximately every 25 years off the coast of California, Oregon and Washington (Hare et al., 1999). Good ocean conditions are linked to wetter weather cycles and prevailed from 1900-1925 and 1950-1975 and returned to favorable again in 1995 (Collison et al., 2003). Poor ocean productivity and dry on-land cycles from 1925-1950 and 1976-1995 created very adverse conditions for salmon, particularly coho. The wet climatic cycle from 1950 to 1975 included the 1955 and 1964 floods. As the PDO cycle shifted, the 1976-1977 drought combined with highly aggraded stream beds to create a freshwater habitat bottleneck. Poor upwelling in the ocean also reduced growth and survival. Coho salmon populations on the California coast from Santa Cruz to Mendocino plummeted and many have never recovered (Figure 40).

The PDO influence is also evident in the Shasta River fall Chinook spawning returns (Figure 41). The highest return of 80,000 adults was just after Dwinnell Reservoir was built, despite being in a less productive ocean and climatic cycle (1925-1950). Even with access to less spawning habitat, runs in the 1960's exceeded 30,000 fall Chinook. The lowest ebb of the Shasta came during an extended drought from 1986-1992, when adult returns dropped to as low as 500 fish. Hopefully the WRD and DWR will get more water back in the Shasta River before the PDO switches in 2015-2025.

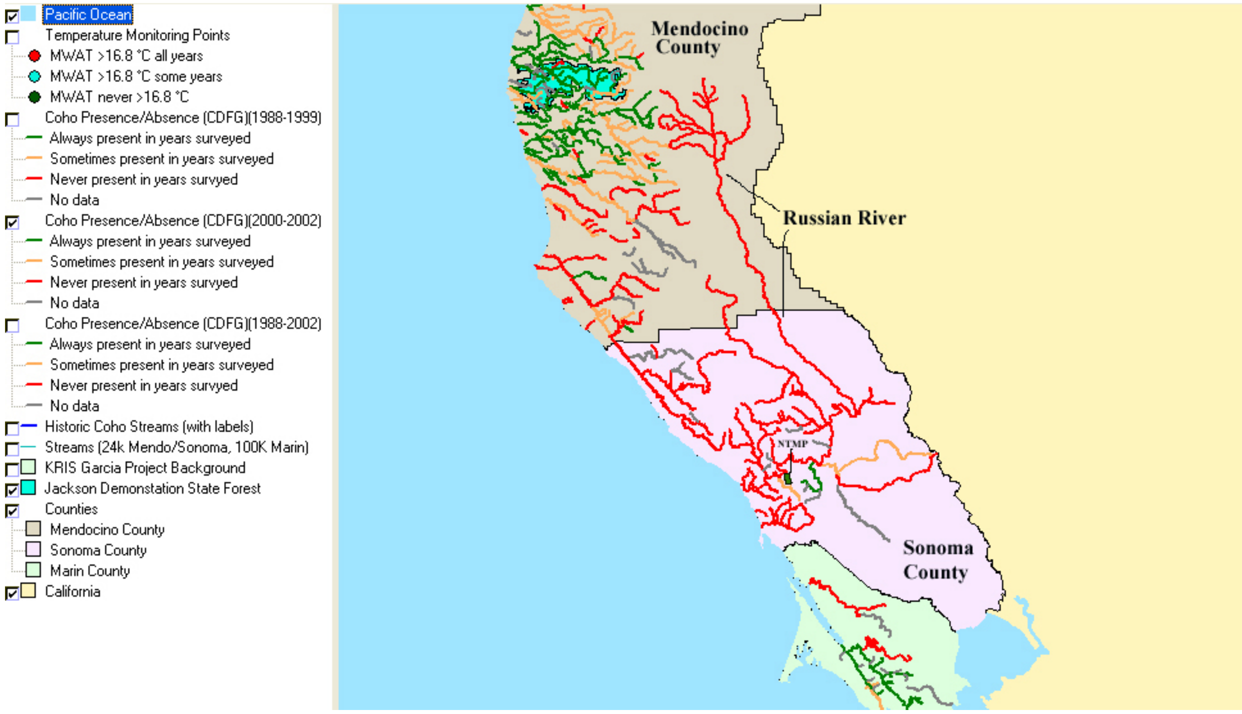

Figure 40. CDFG northern California coho salmon presence and absence maps show streams as green, if coho were always present, yellow if present in at least one year and red if absent in all three years from 2000-2002. Remaining populations are mostly near the coast within the redwood ecosystem and associated with more intact forests patches in coastal Marin County and around Jackson Demonstration State Forest. KRIS Russian.

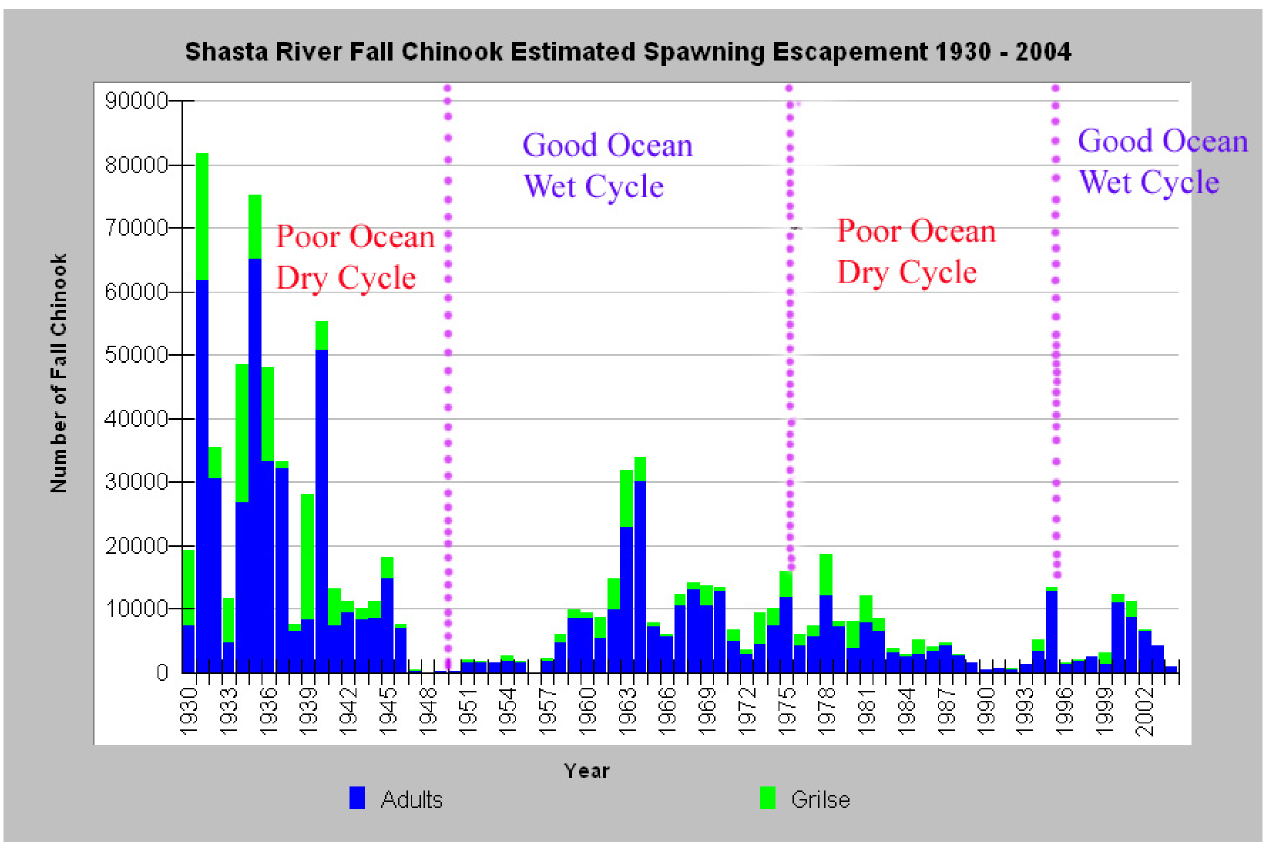

Figure 41. The CDFG Shasta Rack counts show fall Chinook returns from 1930 to 2004 with the PDO cycles overlaid. Returns fluctuate with climate and ocean cycles but the long term trend is down as a result of continuing loss and degradation of freshwater habitat. From Higgins (2006c) and KRIS V 3.0.

Restricted Geographic Scope Misses Basins With Greater Need

The *Policy* implementation is restricted to coastal watershed from the Mattole River south to San Francisco Bay (Figure 1) and does not include either the Klamath or the Eel River basins, which have enormous fisheries potential, more wildlands, and arguably greater need for help resolving flow issues.

The Shasta and Scott river basins are both recognized as water quality impaired to the degree that fisheries resources are compromised. CDFG is currently attempting to issue Incidental Take Permits (ITP) under the California Endangered Species Act for agricultural operations in these watersheds (CDFG, 2006a; 2006b). Lack of flows is confounding coho recovery under both State and federal ESA and, similarly, over-diversion is thwarting attainment of water quality standards under recently completed Scott and Shasta TMDLs (NCRWQCB, 2006a; 2006b). Despite the critical need for resolution of water supply issues, SWRCB WRD involvement is not apparent in either the ITP process or TMDL Implementation. California Department of Water Resources (DWR) staff have taken a similarly passive role in management of groundwater, which is directly linked to surface water supply problems in both basins. DWR has also failed to provide effective Watermaster Service and a new law permits the privatization of the service, which poses a potentially substantial impediment for insuring public trust oversight.

Timely action to restore flow and improve water quality in the Scott and Shasta Rivers could get the best return on investment for the WRD, if fish production is the index. The Shasta River has recently produced more than 10,000 adult Chinook salmon (Figure 41) and still has a run of coho salmon. Similarly, a restored Scott River could produce 10,000 fall chinook and viable populations of coho and steelhead as well. As NRC (2004) points out, increasing flow in the Shasta River would decrease water temperature. Functional Scott and Shasta River canyons would once again revitalize the rearing capacity of the both rivers for steelhead.

The Klamath River is recognized as being in crisis with regard to water quality and fish disease (Nichols and Foott, 2004) and the potential cumulative benefit of restoring flows and cold water from the Scott and Shasta Rivers should not be overlooked. Currently the Shasta and Scott contribute very little flow in summer to the mainstem Klamath River and what water they do contribute is warm and high in nutrients. McIntosh and Li (1998) used forward looking infra-red radar (FLIR) to examine water temperatures of the Klamath River. Figure 42 shows the FLIR image of the convergence with Shasta River water temperatures exceeding 29^{o} C (84^{o} F) and the Klamath River itself above lethal limits for salmonids. This influence is the opposite of the historic role the Shasta River played in moderating Klamath River water temperatures and nutrient loads.

The Eel River once had hundreds of thousands of salmon and steelhead, yet even the mainstem has gone dry in recent years just above Fernbridge in late summer. Flow depletion due to Pillsbury Dam reduces mainstem habitat, but the South Fork Eel is now also flow depleted. The latter has become so stagnant in recent years that blue green algae has proliferated that is toxic to dogs and makes recreational use impossible. Dozens of formerly productive tributaries for fisheries now run dry in summer and early fall. Because the Eel River watershed remains largely unpopulated and wild land, it has a great deal more chance for recovery than urbanizing watersheds or those with extensive agricultural activity.

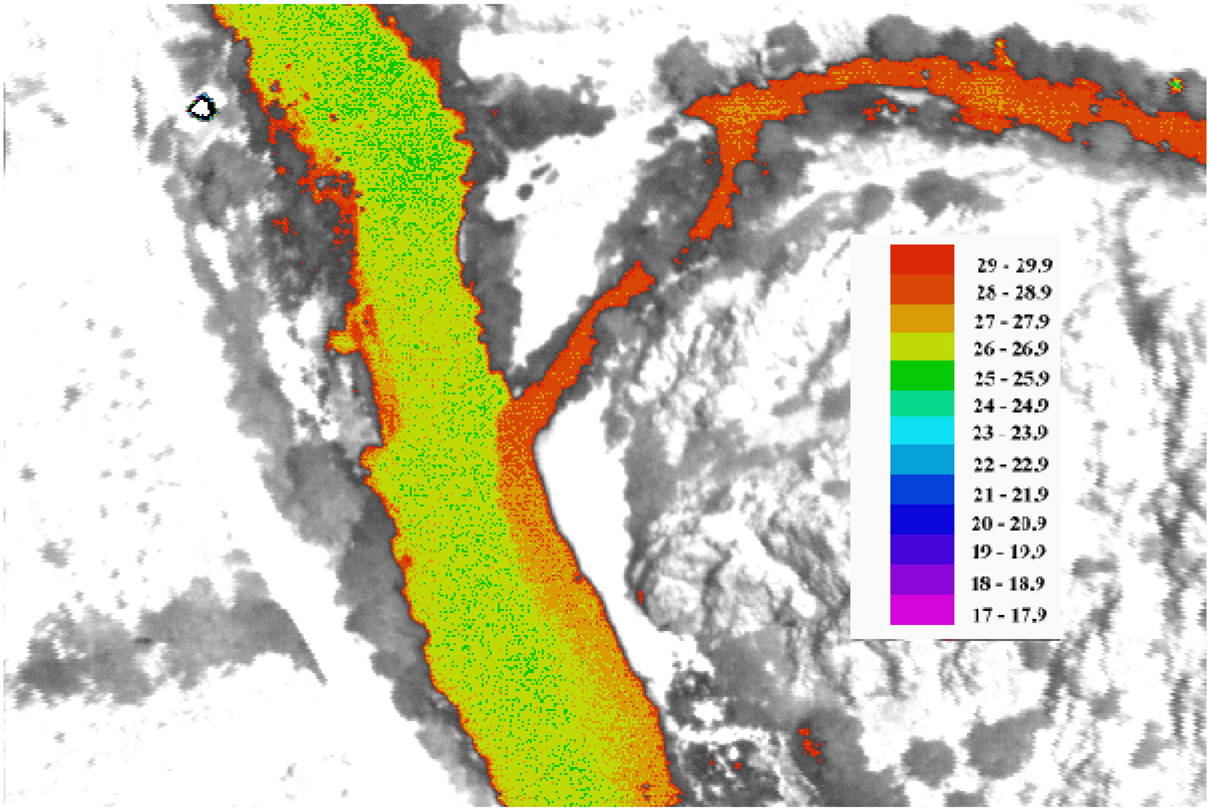

Figure 42. Thermal Forward Looking Infrared Radar Image (FLIR) showing the confluence of the Klamath River (flowing from the top of the image to the bottom of the image) and the Shasta River (flowing right to left in the image). The Shasta River is approximately 29 degrees C, which is well above lethal to salmonids. A warm water plume is observed in the Klamath River below. From McIntosh and Li (1998).

Monitoring, Data Management and Adaptive Management

Monitoring: The *Policy* calculation of protective base flows and water availability rely on fragmentary historical flow data and flawed synthetic data and "additional data collection on small stream hydrology and fish usage is needed to verify these relationships" (Lang, 2008). A major problem is that all monitoring envisioned is on winter flows (October-March) when surplus water is theoretically available, not on April-September flows that are known to be limiting fisheries.

There is a need for year around data collection in small and large streams throughout the region, with the priority identification of stream reaches where surface flows are lacking but where historically there was carrying capacity for salmon and steelhead. Band (2008) suggests gages "with real-time capability, likely co-funded with the USGS to take advantage of the National Water Information System (NWIS) real-time discharge system."

McMahon (2008) recommends installation of inexpensive stage height and temperature sensors (www.trutrack.com) that can be purchased inexpensively ($200) and are easy to install. He also recommends that monitoring be focused on key salmon and steelhead reaches (biological hotspots). Band (2008) pointed out the necessity of monitoring for *Policy* implementation:

> "Monitoring and management of the finite water resource network calls for the development of a more advanced sensor network to monitor stream temperature, turbidity, suspended sediment transport in addition to flow. The State of California should be in the position to develop and implement this type of network in collaboration with federal agencies and the university system."

In other words, to fully deal with the questions of cumulative effects of water diversion and water supply, many similar data elements are needed to those of other processes like the Clean Water Act (TMDL), Endangered Species Act (ITP) and the National Forest Management Act. The SWRCB WRD needs to co-participate with other agencies so that multiple objectives of different processes can be met and the WRD benefits from corollary data collected by its partners.

The SWRCB WRD shows little technical capacity, other than that provided by consultants, and no track record of extensive field data collection. There is no commitment to a schedule for monitoring and the effectiveness monitoring section of the Policy shows bureaucratic reluctance. DWR shows a similar lack of capacity with regard to ground water monitoring and regulation. Consequently, the State should solicit emergency help from the U.S. Geological Survey to assess water supply and surplus availability (see Conclusion for discussion on the need to re-organize WRD and DWR).

<u>Data Management</u>: Regardless of how data collection and agency coordination are structured, there needs to be a common database for sharing results, trend monitoring and implementation of adaptive management. KRIS projects submitted with these comments supply a great deal of useful data, including GIS information The SWRCB Water Rights Division should consider using this tool, already subsidized with over $1 million in public money, especially since the KRIS software allows easy cost-effective updating capacity for trend monitoring.

If *Policy* implementation involves partnerships with private parties or groups, all raw data, computer codes for models and other related information must be available to the scientific community and to the public in electronic form. Without full transparency, no model or study output is scientifically valid (Collison et al., 2003) and history shows that public trust resources, such as salmon and steelhead, cannot be fully protected without the ability of the public to participate in oversight.

Band (2008) envisions using the data collected in the field to increase the predictive capacity of the flow model:

> "An integrated GIS-spatial watershed model that incorporates natural runoff production, stream routing and all water diversions and return flows should be developed……As part of an adaptive management approach, the modeling system would provide a formal set of expectations of different water resources policies in the watersheds."

<u>Adaptive Management</u>: The National Research Council (2004), in recommending that adaptive management be used to recover the endangered fishes of the Klamath basin, described it as follows:

> "Adaptive management is a formal, systematic, and rigorous program of learning from the outcomes of management actions, accommodating change, and improving management (Holling, 1978). Its primary purpose is to establish a continuous, iterative process for increasing the probability that a plan for environmental restoration will be successful. In practice, adaptive management uses conceptual and numerical models and the scientific method to develop and test management options."

Dr. Carl Walters (1997) is credited with having coined the term adaptive management and has followed 25 case studies of riparian and coastal ecosystem restoration projects around the world, but found "only seven of these have resulted in relatively large-scale management experiments, and only two of these experiments would be considered well planned in terms of statistical design." He notes that too little change in anthropogenic stressors is carried out in most cases so that natural variation are not distinguishable from project effects.

> "Various reasons have been offered for low success rates in implementing adaptive management, mainly having to do with cost and institutional barriers" (Walters, 1997).

The cost of monitoring associated with *Policy* implementation is not estimated nor are sources of funding identified. The institutional barriers that might impede successful adaptive management are well described above. The attempt to pass of monitoring costs to diverters (watershed groups) in exchange for their helping shape water management is unacceptable. The WRD needs to calculate staffing costs and define a partnership structure with other agencies that will satisfy data needs for adaptive management.

If 500 or 1,000 illegal dams are removed, we would have the potential to make a difference on the problem and would also frame an interesting and valid adaptive management exercise.

Instead of adaptive management, the SWRCB WRD has been exhibiting what NRC (2004) terms deferred action:

> "In the deferred-action approach, management methods are not changed until ecosystems are fully understood (Walters and Hillborn, 1978; Walters and Holling, 1990; Wilhere, 2002). This approach is cautious but has two notable drawbacks: deferral of management changes may magnify losses, and knowledge acquired by deferred action may reveal little about the response of ecosystems to changes in management. Stakeholder groups or agencies that are opposed to changes in management often are strong proponents of deferred action."

Conclusion

When one studies Appendix E (Stetson Engineering, 2007a), it becomes apparent that Dr. Bob Gearheart's (2008) characterization of his experience with water rights in the Upper Klamath in Oregon apply to the *Policy* area: "water rights were 1) over allocated, 2) unmeasured, and 3) mostly unregulated." Implicit in the *Draft Policy* is that there is surplus water in North Coast streams in the geographic area in question. An accurate inventory of water resources might find that many or most streams are fully allocated, given changes in watershed hydrology and channel morphology in conjunction with existing levels of diversion and groundwater use. When the geographic extent and severity of the problem is fully assessed, one can see that Pacific salmon species will not thrive or even survive into the future without profound change in California water policy and management.

<u>Recommendations</u>: If the *Policy* goes forward under current agency framework:

- Only consider diversions after December 15.
- WRD works with USGS to set up gauges for year around flow measurement region wide, share all data in the public domain.
- No additional permits issued by WRD for streams that formerly supported juvenile salmonid rearing but now are dry for any period of the year and were not historically intermittent.
- Conduct full inventory of all water extraction on the ground in cooperation with USGS, including riparian rights, pre-1914 and illegal diversions within one year.
- Stop post-permitting of illegal diversions and make fines sufficient to be a disincentive.
- Work cooperatively w/ CDFG using 5937 and get flows back. Don't reign in the wardens.
- DWR needs to work with USGS on collection of ground water data and more actively manage the resource and data needs to be made public.

- DWR should re-establish Watermaster Service so that it is done by a government agency not a private party due to public trust protection needs and provide more effective service.
- WDR, DWR, CDFG and NOAA Fisheries need to create a participatory data management system that has all data for the region, including spatial data, and can be used for adaptive management.

In light of over-diversion, critical shortages of water for fish, inexorably rising demand for water, and the rampant lawlessness of both surface and ground water diversion, it is clear that we have a regional crisis. The data and the case studies above show that there is a complete dereliction of duty by the WRD and a similar lapse in management of ground water by DWR.

In fact, much more profound reform is likely necessary, although there will be considerable opposition from agricultural interests and intransigent bureaucracies involved. What is really necessary is:

1) Change California Water Law to make riparian diversions require a permit,
2) Have Legislature request Attorney General investigation into lack of enforcement of SWRCB codes (1052, 1055, 1243, and 1375), including illegal extraction of ground water that is connected to surface water (i.e. Big Springs, Shasta River)
3) Consolidate surface water and ground water management and Watermaster Service under one State agency that has public trust as its over-riding objective, such as CDFG or Cal EPA.
4) Integrate planning with TMDL (Regional Boards), ESA/CESA (CDFG, NMFS), watershed restoration efforts (NRCS/NGO's), and NFMA and Northwest Forest Plan (U.S. Forest Service/Bureau of Land Management) implementation to pool resources and all agencies and processes targeting Pacific salmon recovery.

Given the institutional incapacity of both the SWRCB WRD and DWR, it is hard to recommend either as a future lead agency under which water management would be carried out, and it is time to consider shifting authority. Regardless of how bureaucratic responsibility might be reallocated, the new management perspective must hold public trust protection as a priority and allow water extraction only when it does not harm fisheries and water quality. Also under any scenario the USGS is needed immediately to lead data collection and analysis.

Urgent action is needed in reform of water management to avoid a wave of Pacific salmon stock losses due to climate change and recognized shifts in climatic regimes, such as the Pacific Decadal Oscillation (PDO) cycle (Hare et al., 1999). That means substantially improved freshwater habitat conditions by 2015-2025. It is time for State agencies to uphold the law, to begin cooperative work to remediate over-diversion of surface and groundwater, and to not only prevent fish stock extinctions, but to aim for restoration that provide a harvestable surplus of fish. Restoration of recreational beneficial uses will improve regional quality of life. Healthier rivers will also contribute to economic development related to tourism.

I would be happy to discuss any aspect of my comments with your staff.

Sincerely,

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