# YUROK TRIBE

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North Coast Region
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Re: Comments on *Review Draft Water Quality Restoration Plan for the Klamath River Basin in California: Draft Scoping for TMDL Implementation*

Mr. St. John:

Thank you for this opportunity to provide feedback on the *Draft Water Quality Restoration Plan for the Klamath River Basin in California.*

The Yurok Tribe's comments are primarily organized according to the comment topics suggested by the NCRWQCB staff:

- Pollutant Source Inputs Not Previously Identified
- Current Efforts to Address TMDL Identified Pollutants
- Other Existing Programs That Could Be Coordinated with Implementation
- Timeframes for Compliance
- Tracking Implementation Progress and Meeting Water Quality Standards
- Additional Potential Restoration Actions for Improving Water Quality

In addition, topics that did not fit into these categories are covered in a separate section at the end of these comments (Additional WQRP Topics). We look forward to collaborating in the implementation of the Klamath River *Water Quality Restoration Plan* (WQRP), including participating in the program of cooperative monitoring to enable adaptive management.

**Executive Summary**

The document is scientifically sound and it provides a generally workable strategy for Klamath River water pollution abatement. Some processes affecting water quality are, however overlooked. More specific monitoring guidance is needed, and some potential additional restoration options need to be explored. We are very pleased to see that Water Board staff are producing not just a high quality technical *Klamath River TMDL* but also an implementation plan in the form of the WQRP. The plan's basin-wide approach brings with it substantial challenges, but it is the only viable approach. The sense of urgency and the emphasis on the abatement of nutrient pollution and the protection of fish refugia are exactly what is needed:

> "Regional Water Board staff believe that short term measures are needed to immediately lessen the threat to the cold water fishery and tribal cultural beneficial uses, among others. The regulatory process will accommodate for short term measures working in concert with

> longer-term programs to achieve full compliance over a longer time frame. The two water quality issues staff have identified as priorities for short term implementation are the reduction of nutrients and organic matter loading and the protection and restoration of thermal refugia in the mainstem and at the mouths of tributaries." (Section 6.1.4, Page 7)

The treatment of nutrients in Klamath headwater areas where flows are lower is a sound strategy, and pollution trading for nutrient point sources seems to be an avenue worth exploring. We do express reservations with pollution trading in a section below.

On another positive note, most allocations and targets in Section 6.3 regarding the Klamath Hydroelectric Project are all strong and justified, and merit support. However, while temperature allocations seem fit, the temperature targets are monthly averages. We recommend using 7DAD/MWAT's which have established criteria for protection of salmonids. The intersection between the KHP's Clean Water Act Section 401 permit prospects and the Klamath River TMDL is clearly described, which is useful. Pollution from toxic algae is well covered.

The WQRP does, however, have a flaw in its thermal refuge protection strategy**.** It fails to recognize adequately that cumulative watershed effects can lead to higher peak streamflows, adverse changes in stream profiles, the loss of riparian vegetation and the degradation of refugia even from moderate storm events. Nor is there <u>specific</u> recognition of the need to protect summer flows in middle Klamath tributaries so that water temperatures remain cool and refugia volumes maintain their size without compromising access into the tributary offering refuge.

The WQRP description of Lost River water quality problems is accurate (Section 6.5.3.1), but the lack of the specific actions needed to remediate pollution from this sub-basin is a <u>major</u> shortfall in the document. <u>We strongly recommend that the California portions of the Lost River be included in the State's final *Klamath TMDL* implementation plan</u>.

The framework offered for restoration is sound, but we have several recommendations concerning additional strategies that should be addressed in order to abate water pollution fully.

**Pollutant Source Inputs Not Previously Identified**

In general, the WQRP does a good job of identifying pollution sources, but does not take into account nutrient transfers to the Klamath River from the Lost River other than from the Klamath Straits Drain. Deas and Vaughn (2006) point out that considerable flow contributions to the Keno Reservoir reach of the Klamath River come from the Lost River Diversion Canal (LRDC), the North Canal and the ADY Canal. The LRDC can supply Klamath River water to the Lost River, or, drainage water from the Lost River can also be pumped slightly uphill in the reverse direction into the Klamath River just above Highway 97 (Figure 1).

Flows from the Lost River to the Klamath River through the Lost River Diversion Canal between May and November 2005 were summarized by Deas and Vaughn (2006). There were flows to the Klamath of over 1,000 cfs in late May and flows of 100-200 cfs from mid-September to late October (Figure 2). These flows may contain substantial organic material that can add to biological oxygen demand. Entrained organic matter can settle and contribute to sediment oxygen demand.


Figure 1. Keno Reservoir just below Lake Ewauna on the edge of the City of Klamath Falls. The Lost River Diversion Canal and log rafts at plywood mill above Highway 97 are highlighted. Note: map is oriented with south at top, north at bottom.

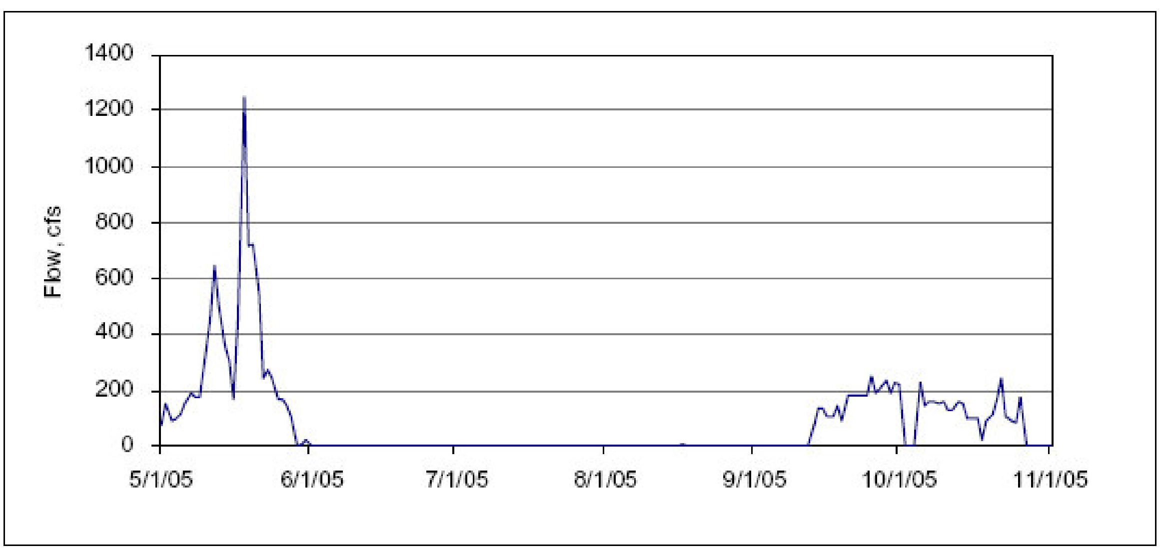


Figure 2. Flow of Lost River into the Klamath River through the Lost River Diversion Canal from May to November 2005. Note the high flows in spring and the period of 45 days in the fall when flows ranged between 100-200 cfs.

The emphasis on protecting cold water refugia at the mouths of Klamath River tributaries below Iron Gate Dam in the WQRP is absolutely necessary and commendable. We strongly support the Excess Sediment Load Allocation (Section 6.6.1.3, page 33) of "zero temperature increase caused by substantial human-caused sediment-related channel alteration" as well as the Excess Sediment Targets (Section 6.6.1.4).

The draft plan overlooks, however, the problem of cumulative effects and increased peak flows that can flatten a stream profile, increase the width-to-depth ratio and lead to the loss of riparian habitat, even if an increase in sediment does not occur. The Klamath National Forest January 1997 flood study (de la Fuente and Elder 1998) demonstrated that 435 miles of Klamath River tributary channels suffered scour from excess flow and sediment from a storm estimated to be of only a 35-year recurrence interval.

In a study of the Nooksack River in Washington, Harr and Nichols (1993) found that the decommissioning of old logging roads, including the removal of stream crossings, prevented debris torrents and protected tributary channels during a 50-year recurrence interval storm event in November 1989, while adjacent untreated basins suffered widespread land-sliding and significant channel damage.

The final Klamath TMDL needs to set prudent risk thresholds for watershed disturbance, so that not only will sediment pollution be controlled but so that hydrologic perturbations are minimized. Table 1 contains recommended prudent risk thresholds for disturbance, including the scientific literature supporting such guidelines. A more thorough discussion of cumulative watershed effects processes, rain-on-snow risk, and the justification for controlling watershed disturbance can be found in previously filed comments on the Scott River and early Klamath TMDL drafts (QVIC 2005, 2006, 2007). Additionally, Kier Associates (2005) demonstrated the value of using the Shallow Landslide Stability (SHALSTAB, Dietrich et al. 1998) model for identifying high risk landslide zones prior to timber harvest or road construction.

Thousands of pounds of pesticides are used by agriculture in the Klamath River Basin each year (California Pesticide Use Reporting Database) and they are likely a significant contributor to water pollution and deserve more attention in the final version of the *WQRP*.

Studies (Ewing 1999, NCAP 1999) suggest that agricultural chemicals may be more harmful to salmonids than previously thought. The National Marine Fisheries Service (NMFS 2008) recently concluded in a Biological Opinion to the U.S. EPA that products containing chlorpyrifos, diazinon, and malathion have significant adverse impacts on endangered species. These three pesticides are currently used in significant quantities in the Klamath River Basin (Pesticide Use Reporting Database: http://www.ehib.org/tool.jsp?tool_key=18).

Gilliom et al. (2006) point out that while some highly-used chemicals like hexazinone may break down quickly in the atmosphere, they can be very persistent in groundwater and that USGS surveys commonly find this substance in agricultural aquifers. Hexazinone is commonly used in the Klamath River Basin where it may have contaminated groundwater. This would pose risks both for drinking water and for the potential for leaching into surface water through springs.

Table 1. Management activities having cumulative adverse watershed impact potential, the impact of such on stream habitat suitability for salmonids and remedial measurers for reducing such adverse impacts on salmonids, including references to published science on the subjects.

| **Management Issue** | **Watershed Effect** | **Channel/Stream Effect** | **Remedy** | **Citation** |
|---|---|---|---|---|
| Timber Harvest | Increased surface erosion, landslides, and sediment yield; elevated peak discharge, decreased base flows | Widening, decreased depth and pool frequency, increased heat exchange and warming. Reduced summer carrying capacity. | Limit timber harvest to 25% of a watershed over a 25-30 year period (1% of inventory harvested per year). Maintain and restore stand conditions in rain-on-snow zone (3500-5000 ft.) | Reeves et al (1993), Berris and Harr (1987), Heeswijk et al. (1995), LaVen and Lehre (1977), Montgomery and Buffington (1993) |
| Road Density | Road failures, increased sediment yield, elevated peak discharge, decreased base flows | Widening, decreased depth and pool frequency, increased heat exchange and warming. Reduced summer carrying capacity. | Limit road density to less than 2.5 mi./sq. mi. with few or no stream side roads. Decommissioning to achieve density target with emphasis on streamside roads and those crossing unstable areas. | Armentrout et al. (1998), NMFS (1995), NMFS (1996), Jones and Grant (1996), LaVen and Lehre (1977), Harr et al. (1975,1979) |
| Stream Crossings | Major sediment contributions when culverts plug, multiple crossing failure leads to catastrophic sediment yield | Widening, decreased depth and pool frequency, increased heat exchange and warming. Loss of riparian vegetation. | Limit stream crossings to no more than 1.5 per mile of stream | Armantrout et al. (1999) |
| Management on Unstable Areas | Increased frequency of landslides with major contributions of sediment with less than natural quantities of large wood | Widening, decreased depth and pool frequency, increased heat exchange and warming. Reduced summer carrying capacity. | Reduce or eliminate timber harvest or road building on unstable areas. Use SHALSTAB as screen. | Dietrich et al. (1998) |
| Riparian Logging | Decreased thermal buffer, reduced large wood contributions, increased landslides and sediment delivery | Reduced pool frequency and cover, increased summer water temperatures and more extreme cold winter temperatures | Reduce or eliminate timber harvest within two site potential tree heights or within the inner gorge. | FEMAT (1993) |

**Current Efforts to Address TMDL Identified Pollutants**

The large Klamath River watershed has several TMDLs for its several sub-basin areas. If any of the water pollution control programs for Upper Klamath Lake, the tributaries above the lake, Lost River and Lower Klamath Lake fail to succeed, then the likelihood of clearing the mainstem Klamath River pollution are greatly diminished.

Previous comments offered by the Quartz Valley Indian Community (2007) detail the problems with recent work on the Upper Klamath Lake TMDL (ODEQ 2002) and streamflow and water quality improvement initiatives in tributaries above the lake. The *Sprague and Sycan River Watershed Assessment* (UKBWG, 2006) is stalled due to local resistance. Water quality management plans from the Oregon Department of Agriculture (ODA, 2004) rely heavily on voluntary measures for implementation, the monitoring required is vague, and no trend data are being collected.

Since ODA is the designated management authority for agricultural water quality impacts, the Oregon Department of Water Quality (ODEQ) is limited in its ability to deal with non-point source pollution from agriculture. The agencies and the Upper Klamath Basin Working Group (UKBWG) appear stalemated in attempts to improve water quality and increase flows into Upper Klamath Lake.

Likewise, problems in the Keno Reservoir reach of the Klamath River include extended periods of anoxia, from late July through September (Deas and Vaughn 2006), and log rafts on the mainstem above Highway 97 at the Columbia Plywood Mill (Figure 1) have been recognized as a water quality nuisance since at least 1966 (Fortune et al., 1966). Numerous studies have shown that covering the river's surface with logs reduces dissolved oxygen. Decaying bark and submerged wood waste in the reach are recognized as major drivers of sediment oxygen demand.

The ODEQ's lack of attention to the mill logs and waste is indicative of the inertia surrounding pollution abatement in the region. Section 6.2.1.1 in the WQRP on temperature allocation notes that "zero increase above natural" will be allowed at the California state line, but PacifiCorp's water quality modeling runs indicate that Keno Reservoir increases summer water temperatures at that location over what they would be without Keno Dam. The question, then, is how does Oregon plan to improve the stream temperature pollution caused by Keno Reservoir, if the dam is to remain in place? It is suggested that the final Klamath River TMDL have clear and firm language that requires Oregon to hold responsible agencies accountable for improving water quality.

The final version of the *Lost River TMDL* (U.S. EPA 2008) was improved somewhat over earlier drafts, but there is still no state-adopted plan for implementing it and all the measures for abating Lost River pollution to the Klamath River remain voluntary. <u>We strongly recommend that the California portion of the Lost River watershed be included in California's *Klamath TMDL* implementation plan</u>, even if there are not currently staff resources for adequate follow-through, as having some plan in place would be better than the current no-plan situation.

In the Lower Klamath Basin, the *Salmon River Temperature TMDL* (NCRWQCB 2005) implementation has not moved forward despite NCRWQCB and U.S. Environmental Protection Agency (U.S. EPA) approval, because no Memorandum of Understanding (MOU) with the U.S. Forest Service has been completed. Although the *Shasta River TMDL for Temperature and Dissolved Oxygen* (NCRWQCB 2006) has also been approved, its call for a 45 cubic feet per second increase in streamflow necessary to improve water temperatures in the river has not been implemented by the California State Water Resources Control Board's Water Rights Division.

On the Scott River a problem with flow depletion related to ground water extraction is known to be contributing to stream temperature problems, but the State allowed Siskiyou County to lead a study of groundwater, despite the likelihood of local political influence. Data from the California Department of Water Resources (DWR) concerning Scott Valley water well levels show long-term trends in seasonal water table depletion (QVIR 2005).

A recent study confirms that increased ground water use explains depleted surface flows in the Scott River and its tributaries (Van Kirk and Naman 2008). Critical flow levels in the lower Scott River set by the Scott River Adjudication (SWRCB 1980) are not being met even in moderately wet years and fall run chinook salmon numbers fell to all time lows of 467 fish in 2004 and 756 fish in 2005.

These are all warning signs of ecological collapse. Immediate action is needed to reduce groundwater pumping, implement water conservation, and increase streamflows in the Scott River watershed.

**Other Existing Programs That Could Be Coordinated with Implementation**

There are a number of government programs with which the WQRP should be cross-fertilized, but some of them seem almost to be at cross purpose with TMDL efforts.

U.S. Endangered Species Act (ESA): The WQRP is a perfect companion for Pacific salmon Recovery Plan implementation because improved water quality will increase habitat suitability for these at-risk fish species. This is especially true since the WQRP explicitly emphasizes protection of salmonid refugia at the convergence of tributaries, which are essential to maintaining salmon and steelhead populations when mainstem river temperatures reach acutely stressful or lethal temperatures (U.S. EPA 2003).

The short-nosed and Lost River suckers have been on the ESA list in the Upper Klamath and Lost River Basins since 1988 (USFWS 1993) yet there has been no measurable population restoration. The National Research Council (2004) recommended that Tule Lake and Lower Klamath Lake be expanded to a level that historically supported both sucker species, but no such action on the recommendation has been taken. The restoration of wetlands in the Lower Klamath Lake Wildlife Refuge and the partial refilling of Lower Klamath Lake would not only have a huge potential for nutrient removal, but would also restore sucker habitat. The *WQRP* should include wetland restoration actions to help control nutrient pollution and to restore sucker fish, which are beneficial uses of water.

California Endangered Species Act (CESA): The California Department of Fish and Game (CDFG) is currently proposing to issue Incidental Take Permits (ITP) for agricultural activities in both the Shasta and Scott river watersheds. While this would seem to be an exercise that would have overlapping objectives with TMDL implementation, in fact the draft Environmental Impact Reports (DEIR) for both sub-basins (EA 2008a, 2008b) have no targets for water quality or streamflow improvement. If adopted the Shasta and Scott ITPs will most likely confound, not assist, the *WQRP*.

Northwest Forest Plan: The U.S. Forest Service (USFS) is receiving a major increase in funding for the first time since 1994 as part of the American Recovery and Reinvestment Act of 2009 and the time may be right to move forward on attainment of the *Northwest Forest Plan* (USFS & BLM 1995) objectives that included employing displaced forest workers, decommissioning roads, restoring watersheds, improving water quality, and maintaining and restoring Pacific salmon species.

Private Land Timber Harvest Permitting: Both California and Oregon private land timber harvest permitting and oversight processes have been found deficient with regard to protecting Pacific salmon species (Ligon et al. 1999, Dunne et al. 2001, Collison et al. 2003, IMST 1999). In the case of California private timberland harvest, the *WQRP* offers a framework for water quality improvement through the issuance of waste discharge permits or of waivers, whichever is more appropriate.
In order to be fully effective in protecting refugia at the mouth of Klamath Basin tributaries, however, the prudent risk thresholds discussed earlier need to be included in the permits or waivers.

**Timeframes for Compliance**

There are clearly recognized patterns, the Pacific Decadal Oscillation, or "PDO", of ocean productivity and precipitation that create 20-25 year cycles of favorable and unfavorable conditions for Klamath River salmon and steelhead (Hare et al. 1999). Since 1999 we have been in a wet climatic cycle paired with mostly favorable ocean conditions. This is likely to reverse, however, sometime between 2015 to 2025.

The prospect for full recovery of Pacific salmon to fishable levels that meet Tribal needs is much greater if action is taken before the PDO cycle switches to unfavorable ocean conditions and a drier climatic regime (Collison et al., 2003). TMDL implementation may stretch over decades, but the best chance to recover Pacific salmon populations may end within little more than a decade (Collison et al., 2003).

**Tracking Implementation Progress and Meeting Water Quality Standards**

The final *WQRP* and *Klamath TMDL* should be as specific as possible about monitoring methods, locations and sampling periods and frequency so that the results of actions can be gauged and the management strategy adjusted accordingly. The most sound approach would be to use methods recognized as scientifically valid that yield reliable quantitative data. We have attached a report by Kier Associates and the National Marine Fisheries Service (2008) as Appendix A because it lists just such standardized techniques, as well as providing reference values.

Monitoring is most valuable when performed at sites with long term records or where at least some baseline data has been collected.

The Importance of Klamath River Tributaries: Grant (1988) used high resolution sequential aerial photos to measure changes in delta widths at stream mouths or at the convergence of tributaries as an index of cumulative effects. This tool should be used to periodically monitor changes at the mouths of Klamath River tributaries or in alluvial reaches at convergence points upstream. If sediment yield or peak flow events cause the widening of channels, it indicates impacts associated from cumulative effects. Conversely, a channel narrowing trend indicates stream habitat recovery.

The *WQRP* should specify that temperature sensors should continue to be deployed at the mouths of Klamath River tributaries so that the progress in restoring and expanding refugia can be gauged. Streamflow measurement is needed in those Middle Klamath watersheds where streamflow is diverted for agricultural, so that flows can be guarded. Depleted streamflow flow would both increase water temperatures and decrease the volume of refugia.

Cross sections, longitudinal profiles or scour chains (Nawa and Frissell 1993) can be used to track changes in streambed profile to detect sediment flux, or to measure gravel stability for salmon spawning. Bulk gravel samples (McNeil and Ahnell 1964) are a standard measure of sediment pollution as it relates to spawning gravel quality and an excellent trend monitoring tool. In streams that can be waded, the V* technique (Hilton and Lisle 1993) is a cost-effective way to measure the volume of sediment in pools. The method has proved useful in tracking sediment reduction trends in French Creek in the Scott River Basin (Kier Associates 1999) and should be used to assess whether similar trends result from *WQRP* implementation.

Aquatic macroinvertebrates (Barbour et al. 1999) are excellent water quality indicators and sufficient sampling and analysis has been conducted in northwestern California to yield an index of biotic integrity (IBI)(Rehn and Ode 2005). This tool should be used to monitor changes over time at stations where data have already been collected. Monitoring locations on private lands should be expanded.

Lower Klamath River Mainstem: The *WQRP* should specify that additional real-time multi-parameter water quality monitoring probes be installed on the mainstem Klamath River. These gauges are needed for trend monitoring but could also provide an early warning system for water pollution events capable of causing fish kills.

**Additional Potential Restoration Actions for Improving Water Quality**

We strongly support the general concepts and framework for water pollution abatement in the WQRP and offer additional ideas below for filtering out pollutants by expanding wetland networks. The statements below are summarized or quoted from section 6.7.1 (Options for Centralized Treatment) and represent sound strategy:

- Given the magnitude of nutrient reductions necessary to restore water quality, and the long timeframes associated with implementing non-point source control programs, centralized treatment makes sense.
- In general, it is best to locate the treatment system as close to Link Dam as possible, because higher nutrient concentrations (and lower flows) are easier to reduce than diluted downstream concentrations, and the higher up in the system that nutrients are reduced the less river miles of river will remain impaired.
- "Centralized treatment options would not absolve landowners of their responsibility to control the water quality impacts associated with their land use activities. The Regional Water Board and the Oregon implementation agencies would continue to employ the traditional non-point source control program."

We offer detailed ideas about construction of treatment wetlands used for bio-filtration below, but also wish to clearly state that natural riparian wetland systems in the Keno Reservoir and the Lost River need to be restored, and that the size and bio-filtration capacity of Tule Lake and Lower

Klamath Lake need to be expanded. We do not look at constructed wetlands as a substitute for these measures but they could be used in conjunction with natural wetland restoration. Both efforts are needed because of the extremely high nutrient loading from Upper Klamath Lake and the Lost River to the Klamath River. Riparian wetland and lake expansion are also necessary to recover ESA listed sucker species (NRC 2004), which are designated beneficial uses of the Klamath River under the Clean Water Act.


Figure 3. This Google Earth oblique view of Lower Klamath Lake Refuge shows the Lost River Basin at right. Additional water would be pumped from Tule Sump (green arrow).

<u>Using Easements or Land Acquisition to Expand the Keno Reach Riparian Wetlands</u>: The Klamath River in what is now the Keno Reservoir reach was once surrounded by thousands of acres of wetlands (Figure 4) that supplied natural water filtration, water storage, and hyporheic connections that promoted river cooling. The Klamath River in Keno Reservoir is now almost completely channelized and confined. Channelized rivers have lower rates of nutrient attenuation (Bernot and Dodds 2005, Yurok 2007).

A functional riparian buffer needs to be restored adjacent to the river in addition to constructed wetlands (see below). As noted in Yurok (2007) and Karuk (2007) comments on the Lost River TMDL, marsh buffers could promote mildly acidic conditions, retarding the growth of the blue-green algal species *Aphanizomenon flos-aquae* that washes out of Upper Klamath Lake and can further proliferate and add to nutrient enrichment in Keno Reservoir. Figure 5 shows the Keno Reservoir reach with remnants of natural marsh areas, but mostly agricultural development with no riparian buffer strip.

Several flat benches exist below Lake Ewauna that could be used to set up pilot scale and, then, larger constructed wetlands. Remnant intact marshes and wetlands extend northward from the Straits Drain to Miller Island, where wetlands are fragmented, but where a large contiguous riparian wetland area could potentially be restored. If the terrace north of Gore Island and across from the Straits Drain were reclaimed as wetlands, sinuous multiple channels of the Klamath River could be reconfigured. This would slow transit time and assist with nutrient removal.

Reconnecting floodplains to riparian marshes can also increase water storage capacity and foster surface water and groundwater connections (hyporheic zone) that can moderate water temperatures and provide refugia (ODEQ 2008). Such an area could also provide optimal sucker habitat.

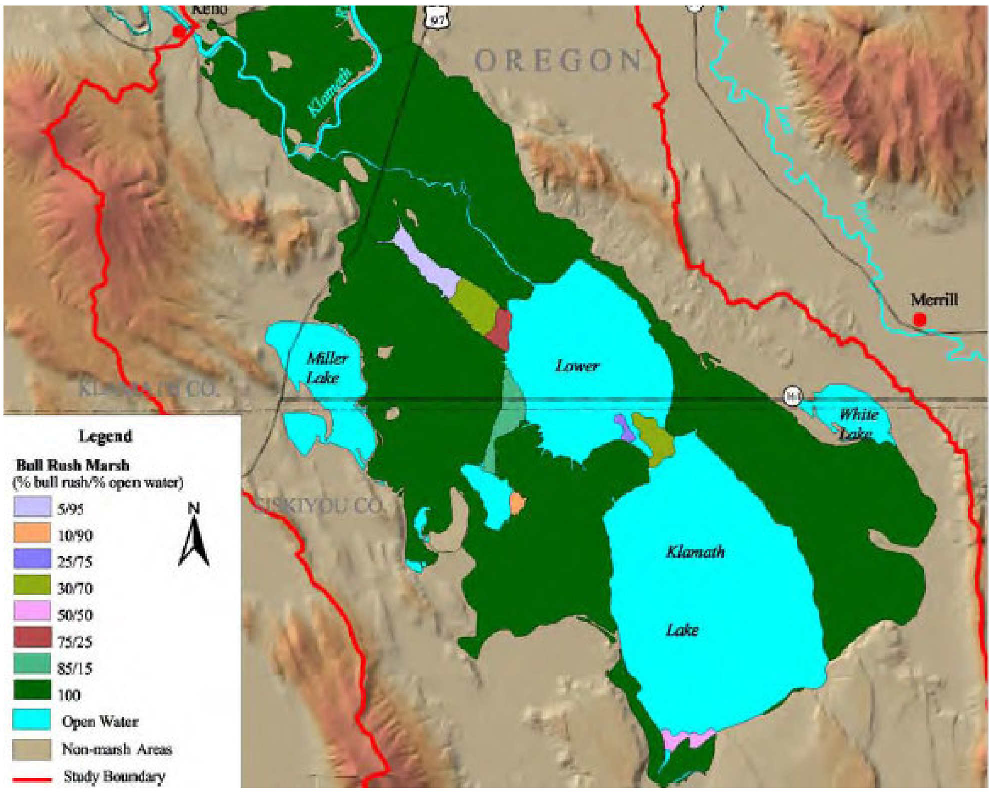


Figure 4. Historic size of Lower Klamath Lake and associated wetlands are shown in the map above, with wetlands broken down by percentage of cover by bulrushes. Note extensive marsh areas surrounding the Klamath River at upper left. Map from U.S. BOR (2005).

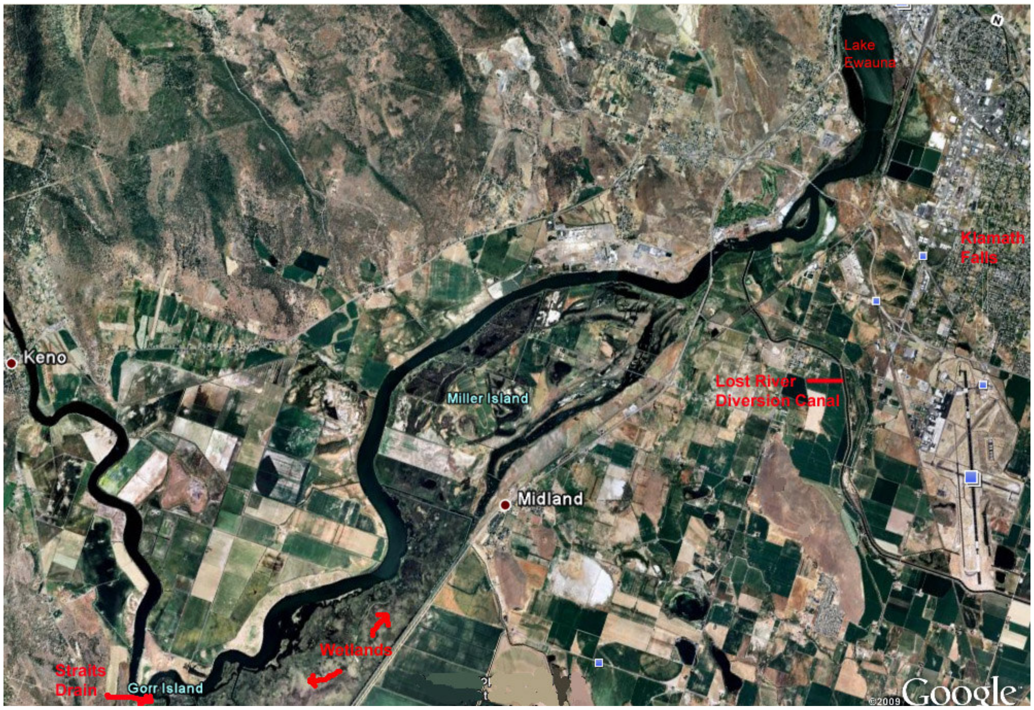

Figure 5. Klamath River in the Keno Reservoir reach from Google Earth.

Regulation of Agricultural Non-Point Source Pollution in Lost River and Lower Klamath Lake Basin in California: ODEQ and ODA do not have strong authority to regulate waste discharge. California does, however, have effective regulatory tools that should be applied to reduce nutrient pollution in the California portion of the Lost River and Lower Klamath Lake Basins. California should use waste discharge requirements (WDRs), or similar tools, on appropriate parties to regulate discharges at key points at the California/Oregon border.

Constructed Wetlands: The Work Group has previously submitted extensive comments regarding the role of wetlands in response to previous *Klamath TMDL* drafts (e.g. Implementation Must Have Wetland Restoration Emphasis section of Quartz Valley's 2007 comments). We will not repeat those same comments here but instead we refer Regional Board staff to them and also provide some updated information below.

*Design Considerations for Constructed Wetlands:* The optimal wetland design characteristics (e.g. depth, area, volume, hydraulic residence time, and vegetation) for nutrient removal vary depending upon climate, the concentration of the various chemical forms of nutrients and organic matter in the inflowing water, the desired levels of reduction of such chemical constituents, and the volume of water requiring treatment. We will not attempt to address wetland design considerations in detail in these comments; however, there are many relevant studies available for the Regional Board staff to review (Kadlec and Knight 1996; Phipps and Crumpton 1994; U.S. EPA 1993, 1999, 2000; WHG and TP 2007) including several specific to the Klamath Basin (Deas and Vaughn 2006, Lyon et. al 2009, Lytle 2000, Mahugh et. al 2008).

*Best Locations for Constructed Wetlands:* We recommend treatment wetlands with different types of characteristics depending upon their location along the Klamath River. During summer, the Klamath River near Link Dam, Lake Ewauna, the Straits Drain, and the upstream portion of Keno Reservoir have very high levels of organic particulates, thus the treatment wetlands constructed there should have relatively short hydraulic residence time (~3 day) designed to maximize removal of particulate organic matter (reducing oxygen demand as well as nitrogen and phosphorus).

Treatment wetlands with longer residence time (~7 days or longer) are effective at removing dissolved inorganic forms of nutrients, especially nitrate (through the process of denitrification). During summer, the reach from the upstream extent of J.C. Boyle Reservoir to the upstream extent of Copco Reservoir has the highest concentrations of nitrate of anywhere along the mainstem Klamath River[1]. Nitrate is the form of nitrogen most easily removed in wetlands[2], so this reach provides unique opportunities for nitrogen removal. Thus, treatment wetlands with longer residence time (~7 days or longer) should be constructed along that reach for the purpose of removing nitrate (and secondarily, other forms of nitrogen and phosphorus). Flat land suitable for wetland construction is currently scarce in that reach, largely limited to several hundred acres on PacifiCorp's ranch located between Stateline and Copco Reservoir (for example, see Figure 6). If J.C. Boyle and Copco Dams were removed, however, a substantial amount of relatively flat land, currently submerged under the reservoirs, would become available for wetland construction. The area submerged under Iron Gate Dam is much steeper, and probably is not suitable for wetland construction. J.C. Boyle Reservoir would be the most optimal location, as it is located above the high-volume springs that dilute nutrient concentrations.

***Previous and Ongoing Klamath River Studies Regarding Constructed Wetlands for Nutrient Removal:***

The U.S. Bureau of Reclamation (USBR) and PacifiCorp have each conducted studies regarding the use of wetlands for nutrient removal in the Upper Klamath River Basin.

Lytle (2000) applied the Kadlec and Knight (1996) model to calculate the area of treatment wetlands required to treat the 70 to 133 cfs flows of the Klamath Straits Drain prior to its discharge into the Klamath River, concluding that an area of between 1,633 and 3,114 acres could achieve "a 61% reduction in total P concentration (0.41 to 0.16 mg/L) and a 90% reduction in total nitrogen including NH3-N [ammonia]."

Deas and Vaughn (2006) did literature research and calculations to investigate the potential of wetlands to remove particulate organic matter between Link Dam and Keno Dam. Their estimated scale for significantly reducing nutrients was 1400 acres and a 5,000 acre marsh was thought sufficient to filter the entire upper Klamath River flow. However, they recommended that a pilot scale project be constructed to test effectiveness before large scale construction is considered.

Mahugh et. al (2008) inventoried potential sites around Keno Reservoir for possible placement of pilot and full-scale treatment wetlands, and modeled potential effectiveness of such wetlands, and the team has submitted a proposal to USBR to construct a pilot project, but we are unclear if the project has been funded or not.

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[1] During summer, water released from Keno Dam has high levels of ammonia and organic matter, with most of the organic matter in dissolved, not particulate, form (Sullivan et al., 2008). In the five miles of river between Keno Dam and J.C. Boyle Reservoir, most of the ammonia is converted to nitrate. Additionally, a portion of the organic matter is transformed into inorganic nutrients. These trends continue in the J.C. Boyle Reservoir, the dewatered J.C. Boyle Bypass Reach, and the J.C. Boyle Peaking Reach downstream.

[2] For example, Lyon et al (2009) states: "Ammonia will require approximately 10 times the wetland area (or HRT) of that needed to process nitrate since it must be nitrified to nitrate under oxidized conditions." (p. 6)

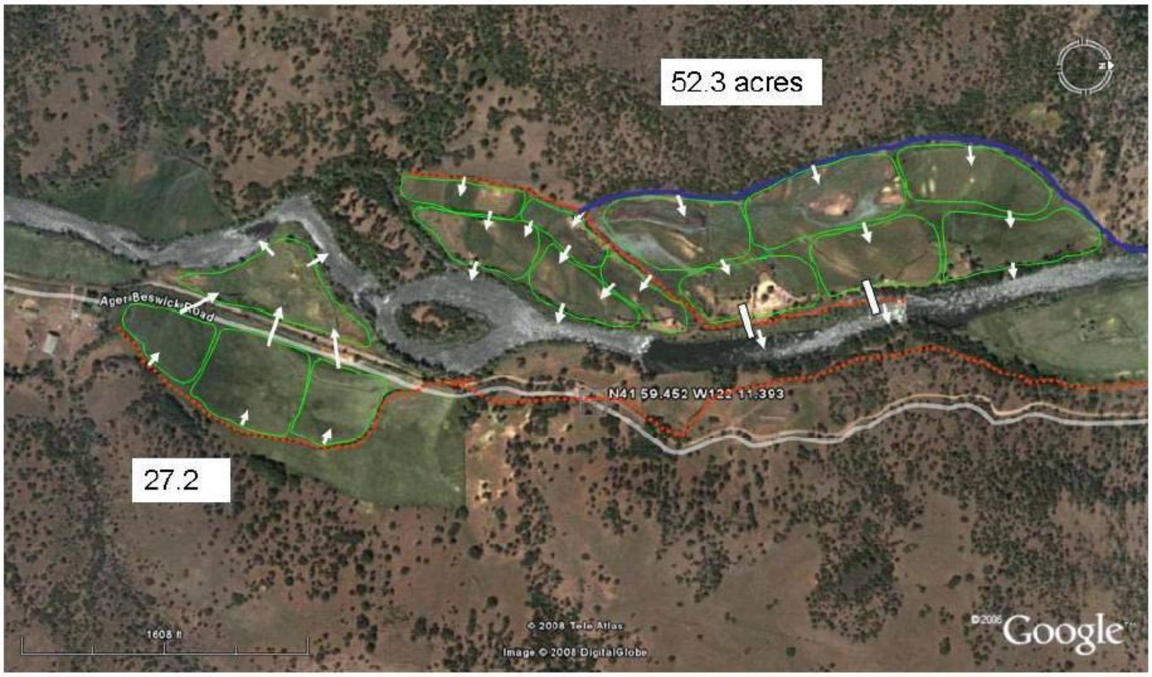



Figure 6. A gently-sloping area on PacifiCorp's ranch upstream of Copco reservoir that is suitable for placement of constructed wetlands. Figure from Lyon et al. (2009), accompanied by the following caption: "Conceptual layout of surface flow wetlands at Site 013 on the Klamath River upstream of Copco reservoir. As much as possible, this makes use of the pre-existing gravity fed canals (in red) and when necessary, installs new channels (in blue)."

Lyon et. al (2009) conducted a similar study, but in addition to Keno Reservoir, also included areas between Keno and Iron Gate Dams.

***Constructed Wetland Outflows as Water Quality Refugia:*** Given the poor water quality conditions that exist during the summer and early fall periods in the Klamath River, access to water quality refugia are extremely important to juvenile and adult salmonids. The mouths of tributaries, in particular, provide critical thermal refugia in many rivers (U.S. EPA 2003), including the Klamath (Belchik 1997, 2004; Sutton 2004). During the summer season, Lake Ewauna and Keno Reservoir have the worst water quality in the entire mainstem Klamath River. Due to the extreme oxygen demand imposed by the organic matter in the water and sediments, the entire water column of the reservoir can be nearly devoid of dissolved oxygen for weeks at a time, and fish kills are common (FERC 2007). Also, due to its location, Keno Reservoir lacks the cool oxygen-rich refugia provided in downstream reaches by mountain tributaries.

If properly designed and located, the outflows from treatment wetlands could serve as critical thermal refugia along those Klamath River reaches that now lack refugia in summer, such as Keno Reservoir. In treatment wetlands with complete canopies of emergent vegetation (e.g. cattail and bullrush), the plants and thatch (accumulated dead plant material) intercept the incoming solar radiation and prevent it from warming the water below. Given sufficient hydrologic residence time (will vary according to factors such as inflow temperature, is was ~5 days in the Tres Rios wetland in Arizona described by Kadlec 2005), temperatures in fully vegetated wetlands in arid climates converge to a "balance temperature" which is typically several degrees lower than mean air temperature due to evaporative cooling[3] (Kadlec 2005). Thus, wetland outflow temperatures can be substantially lower than wetland incoming temperatures, as has been demonstrated in municipal wastewater treatment systems in Tres Rios (Kadlec 2005), Imperial Valley (Kadlec 2005), Sacramento (Kadlec 2005, Nolte and Associates 1998), Gustine/Los Banos (Gearheart, pers. comm.) and Arcata (Gearheart, pers. comm.).

One important conclusion that can be drawn from this science is that anywhere where mean air temperatures are less than or equal to mean water temperatures in the river, and there is relatively flat land available for wetlands to be constructed, outflows from constructed wetlands have the potential to provide thermal refugia. We have not exhaustively compared air at water temperatures across the basin (that should be done), but are assuming that this potential is greatest in higher-elevation areas (e.g. upstream of J.C. Boyle). Air/water temperature differential also exist near the Klamath Estuary due to ocean air influences, but there may not be enough suitable land due to existing land uses, topography, and extreme winter floods could destroy wetland infrastructure (i.e. levees) placed too close to the stream channel.

Since none of the local reports investigating the potential for treatment wetlands in the Klamath (Deas and Vaughn 2006, Lyon et. al 2009, Lytle 2000, Mahugh et. al 2008) predicted wetland outflow temperatures, we did some "back-of-the-envelope" calculations using air and water temperature data from 2007-2008 to provide a rough assessment of what constructed wetland temperatures might be in the Upper Klamath Basin, and how they compare to current river water temperatures (Table 1). The results are striking, suggesting strong potential for wetlands to provide thermal refugia. During months where high temperatures are a potential concern (May-October), mean monthly air temperatures at Klamath Falls Airport are ~3.4˚C cooler than mean monthly water temperatures at Keno Dam. Assuming that treatment wetland outflow temperatures are several degrees cooler than air temperature in arid climates such as the Upper Klamath (see discussion above), that would suggest that treatment wetland outflow temperatures could be on the order of ~5.4˚C cooler than Keno Dam water temperatures (Table 1). This temperature differential is high enough to have potential to serve as significant thermal refugia. We emphasize here that these are preliminary results and that more in-depth calculations (e.g. applying the equations supplied by Kadlec 2005) should be refine these estimates, as these initial estimates may only be within +/- approximately 3˚C of reality.

Table 2. Comparison of 2007-2008 monthly mean air temperatures (from the Klamath Falls Airport: http://www.wunderground.com/history/airport/KLMT), estimated constructed wetland outflow

[3] In contrast, balance temperatures in humid climates can be higher than mean air temperature (Kadlec 2005).

temperatures (estimated from air temperatures), and Keno Dam water temperatures (from USGS: http://or.water.usgs.gov/proj/keno_reach/monitors.html).

| | | Temperature ˚C | | |
|---|---|---|---|---|
| Month | Air | Estimated Wetland (Air minus 2) | Keno Dam Water | Difference of Estimated Wetland & Keno Dam |
| May | 12.0 | 10.0 | 15.8 | -5.8 |
| Jun | 15.1 | 13.1 | 19.0 | -5.9 |
| Jul | 20.3 | 18.3 | 22.9 | -4.6 |
| Aug | 18.7 | 16.7 | 22.1 | -5.4 |
| Sep | 14.4 | 12.4 | 18.0 | -5.6 |
| Oct | 7.5 | 5.5 | 10.8 | -5.3 |
| Mean | 14.7 | 12.7 | 18.1 | **-5.4** |

Due to the decomposition of organic matter within treatment wetlands, dissolved oxygen in wetland outflows are typically low (though not zero) and may therefore require re-aeration prior to discharge back to the river, if the outflow were intended to serve as water quality refugia. Aeration could be accomplished either through a weir structure (if there is enough gravity fall) or mechanical re-aeration. If wetlands discharged into a high gradient river reach (such as near site of J.C. Boyle Dam), re-aeration may not be required prior to discharge (low D.O. may be tolerable because water would quickly re-aerate as water flowed downstream).

*Recommendations for Action:* We recommend that as soon as feasibly possible, several small-scale pilot wetland treatment systems by constructed. The highest priority system with short residence times (~3 days) optimized for removal of particulate organic matter is in the vicinity of Link Dam. Second priority would be a system with longer residence times (~7 days) optimized for nitrate removal on PacifiCorp's ranchlands upstream of Copco Reservoirs (this area already has gravity-feed diversions for irrigation that could be readily adapted to deliver river water to wetlands, as noted by Lyon et. al 2009).

Pilot projects could be used not only to demonstrate the effectiveness of treatment wetlands, but also to determine the best methods to implement, maintain, and operate larger-scale systems (Deas and Vaughn 2006). Following a successful pilot project, larger scale treatment systems for removal of particulate organic matter should be constructed around Keno Reservoir. Then, following dam removal, treatment systems for nitrate removal should be constructed in the former beds of Copco and J.C. Boyle Reservoirs as well as on PacifiCorp's ranchland upstream of Copco. The outflow of all these wetland treatment systems should be all optimized to serve as thermal refugia, if that concept proves feasible.

This information should be provided at the wetland feasibility workshop that is mentioned in the AIP. We look forward to the Regional Board's efforts to ensure this workshop occurs in a timely manner.

**Additional WQRP Topics**

Responsible Parties Implementation: Section 6.3.4
Language should be added to clarify that whenever feasible the AIP will be used as a vehicle to fund an expedited implementation of the TMDL.

Iron Gate Hatchery: Section 6.4 on Iron gate Hatchery is somewhat contradictory -- or at least unclear. Section 6.4.1.1 Temperature Allocation states that "The temperature load allocation to the Iron Gate Hatchery equals zero temperature increase above natural temperatures." The following paragraph then discusses current temperatures (not natural temperatures):

> "The discharge of elevated temperature waste to the Klamath River is prohibited by the state Thermal Plan. Iron Gate Hatchery discharges elevated temperature waste when the hatchery discharge is warmer than the Klamath River. Thus, there is no allowable temperature increase that can be allocated to Iron Gate Hatchery. "

This is confusing because it is unclear whether Iron Gate Hatchery discharges must be equal to natural temperatures or current temperatures.

Then section 6.4.1.2 Temperature Targets states that "The numeric temperature targets assigned to the Iron Gate Hatchery (Table 6.11) are expressed as monthly average temperatures, equal to the temperatures associated with the Klamath River downstream of Iron Gate Dam." Are the Iron Gate Dam temperatures referred to section 6.4.1.2 current temperatures or natural temperatures? That should be clarified. The language regarding nutrient and organic matter loading in sections 6.4.1.3 Nutrients and Organic Matter (CBOD) Allocation and 6.4.1.4 Nutrients and Organic Matter (CBOD) Targets is similarly confusing, and should be clarified.

In section 6.4.3, the WQRP states: "Staff are considering the potential for the Hatchery to achieve some or all of their load reductions through pollutant trading with upstream dischargers." This is a good idea, given the relatively minor contribution of Iron Gate Hatchery to Klamath River nutrient pollution.

Pollutant Trading to Reduce Nutrient Loading (Section 6.7.2): If we are correctly interpreting what Regional Board staff is proposing, the concept of crediting to a watershed wide nutrient reduction system is a good one. Additionally, we recommend that "pollution trading" be re-phrased because the term is confusing and can be interpreted/ misinterpreted in a variety of ways. We suggest the term nutrient crediting system be used to minimize confusion. Criteria should require adequate entities to carry out such treatment, a permanent solution and a material reduction in pollutants. An analysis needs to be made as to the numbers of point and non-point source discharges which could realistically contribute to such a system.

Thermal Refugia (Section 6.6.2): In discussions regarding strategies to protect thermal refugia at tributary mouths, the WQRP states: "In addition to land use related actions, it may be necessary to provide further protections in the immediate area surrounding thermal refugia to prevent disturbance to their critical function in mitigating elevated mainstem temperatures. To this end, Regional Board staff are considering the establishment of a buffer in and around the mouths of tributaries that provide these refugia." (p. 33). We agree that tributary mouths warrant special protection, but the word "buffer" is vague and it is unclear exactly what staff are referring to; therefore, we request clarification of this point.

Secondly, we fully support limiting suction dredge mining to only portions of the river. However, we do not support **any** suction dredge mining in thermal refuges. One of two restoration goals for thermal refugia listed in section 6.1.4.2 of the WQRP, states "restoration of the structure of the refugia themselves". The potential suction dredge mining impacts listed in the draft WQRP are:

1. streambed and bank de-stabilization,
2. changes to surface substrate composition,
3. replacement of natural spawning gravels by unstable dredge tailings,
4. destruction and/or redistribution of existing spawning riffles

Based on the refugia restoration goal and the potential suction dredge mining impacts from the WQRP, it seems that suction dredge mining at any time of year in refugia could potential alter the structure of the site, thereby putting the refuge in jeopardy. Therefore, as part of the WQRP, suction dredge miners should not be allowed in any cold water refugia during any part of the year. Additionally, buffers above and below the refugias of at least 200 meters should be included to adequately protect these sensitive areas.

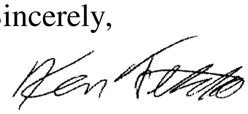
Restoration work for cold water refugias may need to include the addition of cover. From work done by Karuk Fisheries, cover added to regugias is utilized by rearing fish. Otherwise there may be an area that provides adequate cold water but not protection from predators.

**Grazing on Non-Federal Land (6.6.4.1)**

Private Timber Company's that own lands in the Klamath Basin lease out grazing on their lands. We encourage the RWB staff to become familiar with **all** non-federal grazing lands, not just ranches, with the ability to potentially impact water quality of the Klamath River.

Please contact me at 707-954-1523 if you have any questions or concerns.

Sincerely,



Ken Fetcho
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Yurok Tribe Environmental Program

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