YUROK TRIBE

FINAL
Macroinvertebrate Report: 2011
June 2011 – August 2011

Yurok Tribe Environmental Program
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I. Introduction

This report summarizes the methods and results of macroinvertebrate sampling conducted on tributaries of the lower Klamath River within the Yurok Indian Reservation (YIR) boundaries for water year 2011 (WY11). The Yurok Tribe Environmental Program (YTEP) collected macroinvertebrate samples at nine tributary sites starting in June and ending in August in an effort to assess the physical/habitat and biological conditions on the lower reaches of selected Klamath River tributaries during the sampling period. This data was added to previous years' macroinvertebrate data as part of an endeavor to build a multi-year data set on the Lower Klamath River. This summary is part of YTEP's comprehensive program of monitoring and assessment of the chemical, physical, and biological integrity of the Klamath River and its tributaries in a scientific and defensible manner.

II. Background

The Klamath River Watershed

The Klamath River system drains much of northwestern California and south-central Oregon (Figure 1). Thus, even activities taking place on land hundreds miles off the YIR can affect water conditions within YIR boundaries. For example, upriver hydroelectric and diversion projects have altered natural flow conditions for decades. The majority of water flowing through the YIR is derived from scheduled releases of impounded water from the Upper Klamath Basin that is often of poor quality with regards to human needs as well as the needs of fish and wildlife.

Some historically perennial streams now have ephemeral lower reaches and seasonal fish migration blockages which may be influenced by inadequate dam releases from water diversion projects along the Klamath and Trinity Rivers. The releases contribute to lower mainstem levels and excessive sedimentation which in turn causes subsurface flow and aggraded deltas. Additionally, the lower slough areas of some of the Lower Klamath tributaries that enter the estuary experience eutrophic conditions during periods of low flow. These can create water quality barriers to fish migration when dissolved oxygen levels are inadequate for migrating fish. The Klamath River is on California State Water Resource Control Board's (SWRCB) 303(d) List as impaired for temperature, dissolved oxygen, and nutrients and portions of the Klamath River were recently listed as impaired for microcystin and sedimentation.

The basin's fish habitat has also been greatly diminished in area and quality during the past century by accelerated sedimentation from mining, timber harvest practices, and road construction, as stated by Congress in the Klamath River Act of 1986. Management of private lands in the basin (including fee land within Reservation boundaries) has been, and continues to be, dominated by timber harvest for the last 100 years.

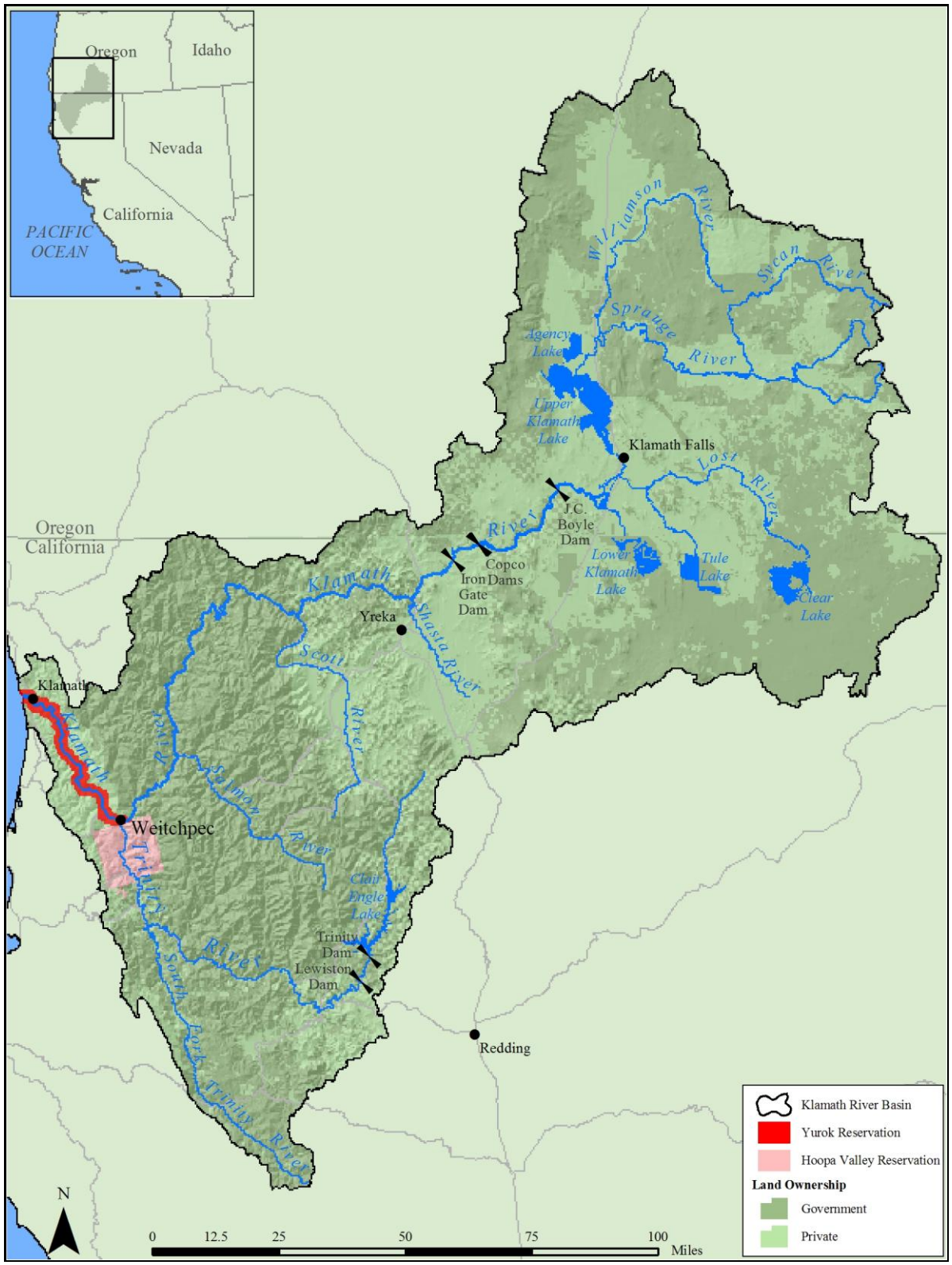

Figure 2-1. Klamath River Basin Map

The Klamath River

The health of the Klamath River and associated fisheries has been central to the life of the Yurok Tribe since time immemorial fulfilling subsistence, commercial, cultural, and ceremonial needs. Yurok oral tradition reflects this. The Yurok did not use terms for north or east, but rather spoke of direction in terms of the flow of water (Kroeber 1925). The Yurok word for salmon, *nepuy*, refers to "that which is eaten". Likewise, the local waterways and watershed divides have traditionally defined Yurok aboriginal territories. Yurok ancestral land covers about 360,000 acres and is distinguished by the Klamath and Trinity Rivers, their surrounding lands, and the Pacific Coast extending from Little River to Damnation Creek.

The fisheries resource continues to be vital to the Yurok today. The September 2002 Klamath River fish kill, where a conservative estimate of 33,000 fish died in the lower Klamath before reaching their natal streams to spawn, was a major tragedy for the Yurok people.

The Yurok Indian Reservation

The current YIR consists of a 55,890-acre corridor extending for one mile from each side of the Klamath River from the Trinity River confluence to the Pacific Ocean, including the channel (Figure 2). There are approximately two dozen major anadromous tributaries within that area. The mountains defining the river valley are as much as 3,000 feet high. Along most of the river, the valley is quite narrow with rugged steep slopes. The vegetation is principally redwood and Douglas fir forest with little area available for agricultural development. Historically, prevalent open prairies provided complex and diverse habitat.

The majority of the lands in the YIR are fee lands, (mostly owned by Green Diamond Resource Company), which are managed intensively for timber products. A small portion of the YIR consists of public lands managed by Redwood National/State Parks (RNSP), the United States Forest Service (USFS) and private landholdings. The Yurok Tribe owns approximately 13,000 acres within the YIR and manages the landscape for multiple uses to meet the needs of the Yurok Tribal membership.

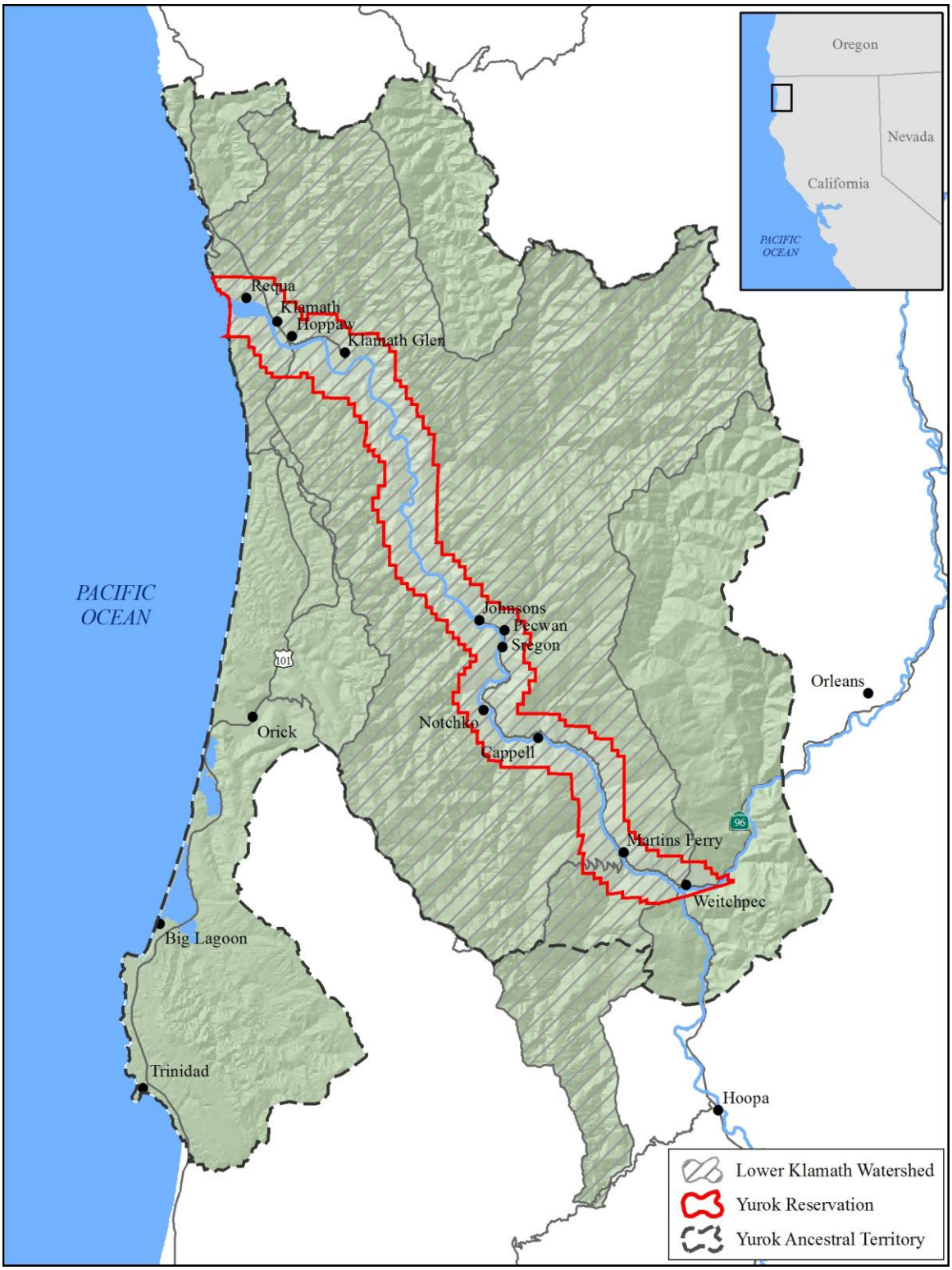

Figure 2-2. Map of Yurok Indian Reservation and Yurok Ancestral Territory

Yurok Tribe Water Monitoring Division

In 1998, YTEP was created to protect and restore tribal natural resources through high quality scientific practices. YTEP is dedicated to improving and protecting the natural and cultural resources of the Yurok Tribe through collaboration and cooperation with local, private, state, tribal, and federal entities such as the Yurok Tribe Fisheries
Program (YTFP), US Fish and Wildlife Service (USFWS), the United States Environmental Protection Agency (USEPA), Green Diamond Resource Company, the North Coast Regional Water Quality Control Board (NCRWQCB), and the United States Geological Survey (USGS). Funding allocated under the Clean Water Act Section 106 primarily funds YTEP's water monitoring activities.

Macroinvertebrate Sampling

Evaluating the biological community of a stream or river through assessments of macroinvertebrates provides a sensitive and cost effective means of determining stream condition. Macroinvertebrates, being greater than 0.5mm in size (invertebrates large enough to be seen with the naked eye) are fairly stationary, and are responsive to human disturbances. In addition, the relative sensitivity or tolerances of many macroinvertebrates to stream conditions is well known. Sampling of stream macroinvertebrates for biological assessments is an essential component of any comprehensive stream condition evaluation. The objective of studying macroinvertebrate communities is to monitor the general health and water quality conditions of tributaries to the Klamath River. According to the California Stream Bioassessment Procedure (CSBP) developed by the California Department of Fish and Game (DFG), benthic macroinvertebrate communities indicate physical and habitat characteristics that determine the stream integrity and ecological health.

III. Site Selection

Klamath River Tributaries

Site selection criteria for macroinvertebrate sampling include spatial distribution, herbicide application activity, watershed restoration activities, proposed future development, and other concurrent water quality monitoring activities. Sites are located in the lower reaches of watersheds that characterize water quality and watershed health condition. YTEP is in the process of developing baseline conditions to document the magnitude and duration of water quality impacts. The following parameters were used as selection criteria for macroinvertebrate sampling:

1. *Spatial Distribution* - Sites located in the lower reaches of watersheds that characterize water quality and watershed health condition. Areas chosen to monitor baseline and long-term trends.

2. *Activity Specific* -Sites located above and/or below herbicide applications and other activities that may potentially impact water quality.

3. *Watershed Restoration Activities*- Sites located in watersheds and sub-watersheds that have active or proposed restoration activities. Sites are selected to monitor the long-term trends by tracking the watershed's recovery.

4. *Proposed Future Development*- Sites near locations of resource and proposed resource development.

Nine tributary locations (Table 3-1, Figure 3-1) were chosen as meeting these requirements. They are: Lower Turwar (Figures 3-2, 3-3), Upper Turwar (Figures 3-2, 3-4), McGarvey (Figures 3-5, 3-6), Mainstem Tectah (Figures 3-7, 3-8), North Fork Tectah (Figures 3-7, 3-9), South Fork Tectah (Figures 3-7, 3-10), Lower Blue (Figures 3-11, 3-12), Tully (Figures 3-13, 3-14), and Johnson (Figures 3-15, 3-16).

Table 3-1. Selection criteria priority matrix for tributary macroinvertebrate sampling*

Creek	Watershed	Sub watershed	Site ID	Primary Criteria	Secondary Criteria	Other
Lower Turwar	Turwar	Turwar	Tu1	1	3	2
Upper Turwar	Turwar	Turwar	Tu2	1	3	2
McGarvey	McGarvey	McGarvey	Mc1	3	1	
Tectah Main	Tectah	Tectah	Te1	3	1	
N.F. Tectah	Tectah	NF Tectah	Te2	3	1	
S. F. Tectah	Tectah	SF Tectah	Te3	3	1	
Lower Blue	Blue	Lower Blue	Lb1	1	3	2
Tully	Tully	Tully	Jo1	2	1	
Johnson	Johnson	Johnson	Ty1	2	1	

*These criteria may change over time, this is an initial criteria designation based on current activities.

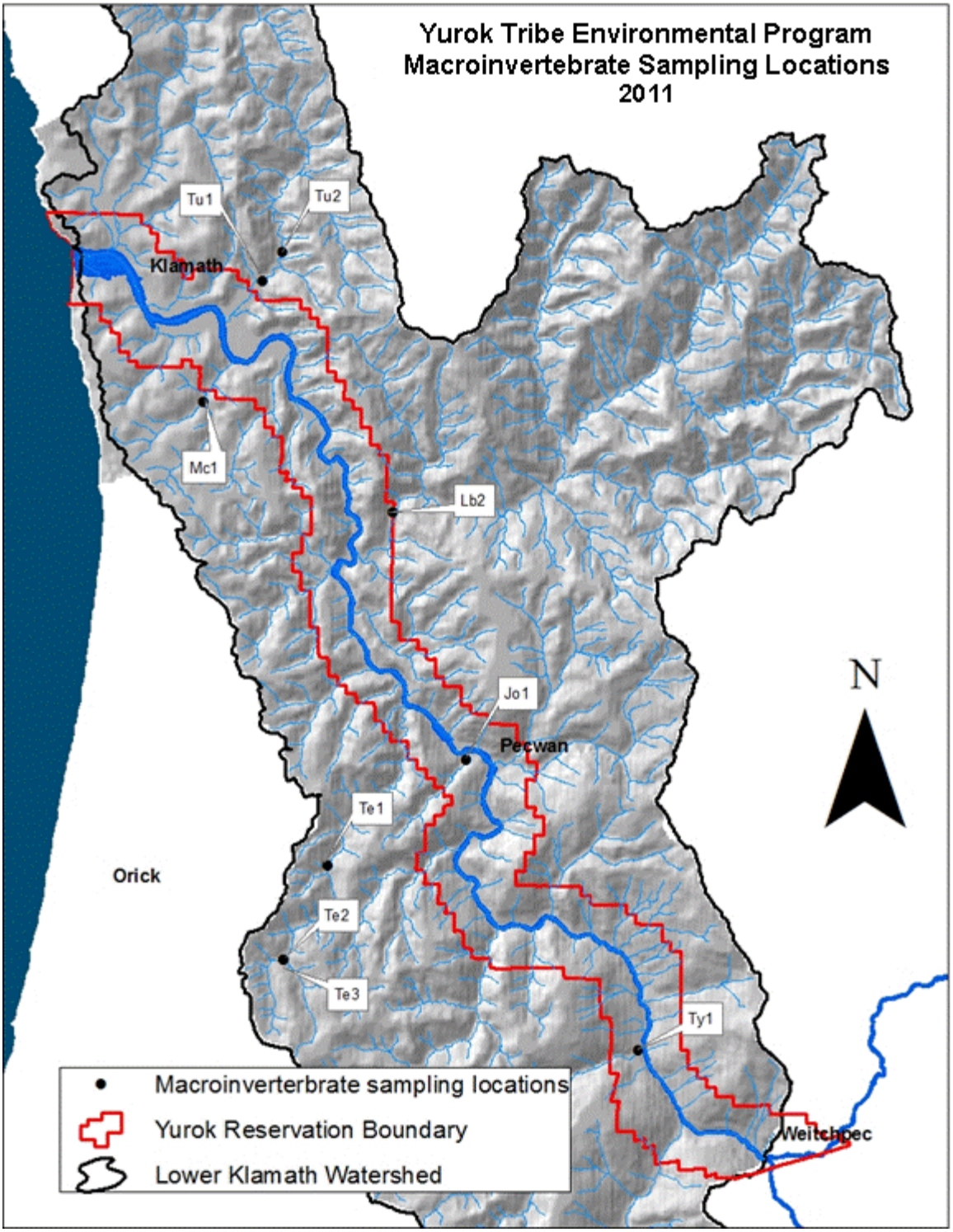

Figure 3-1. Yurok Tribe Environmental Program Macroinvertebrate Sampling Site Locations, 2011

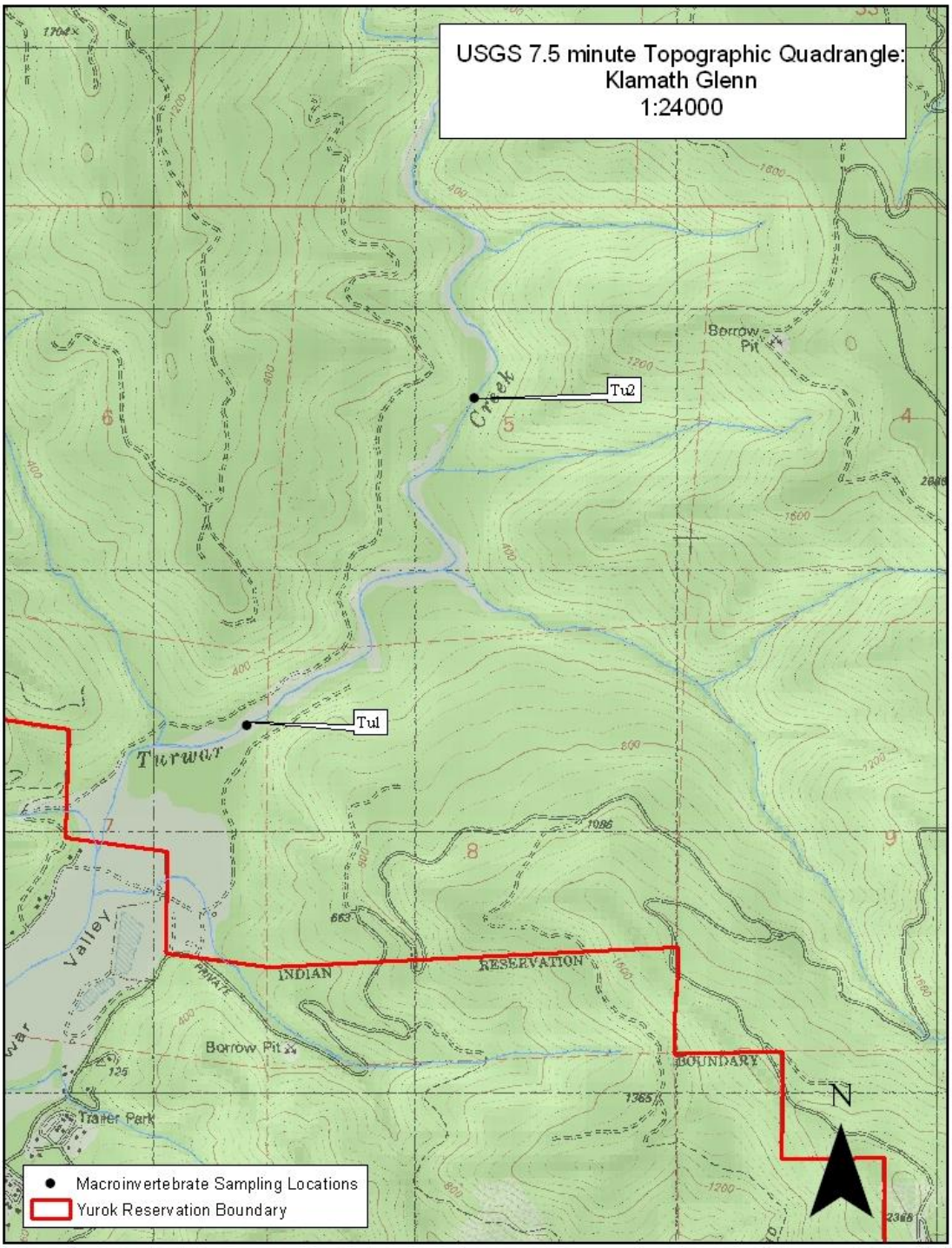

Figure 3-2. Lower (Tu1) and Upper (Tu2) Turwar Sampling Location Map, WY11

Figure 3-3. Photo of Lower Turwar (Tu1) Sampling Location, WY11

Figure 3-4. Photo of Upper Turwar (Tu2) Sampling Location, WY11

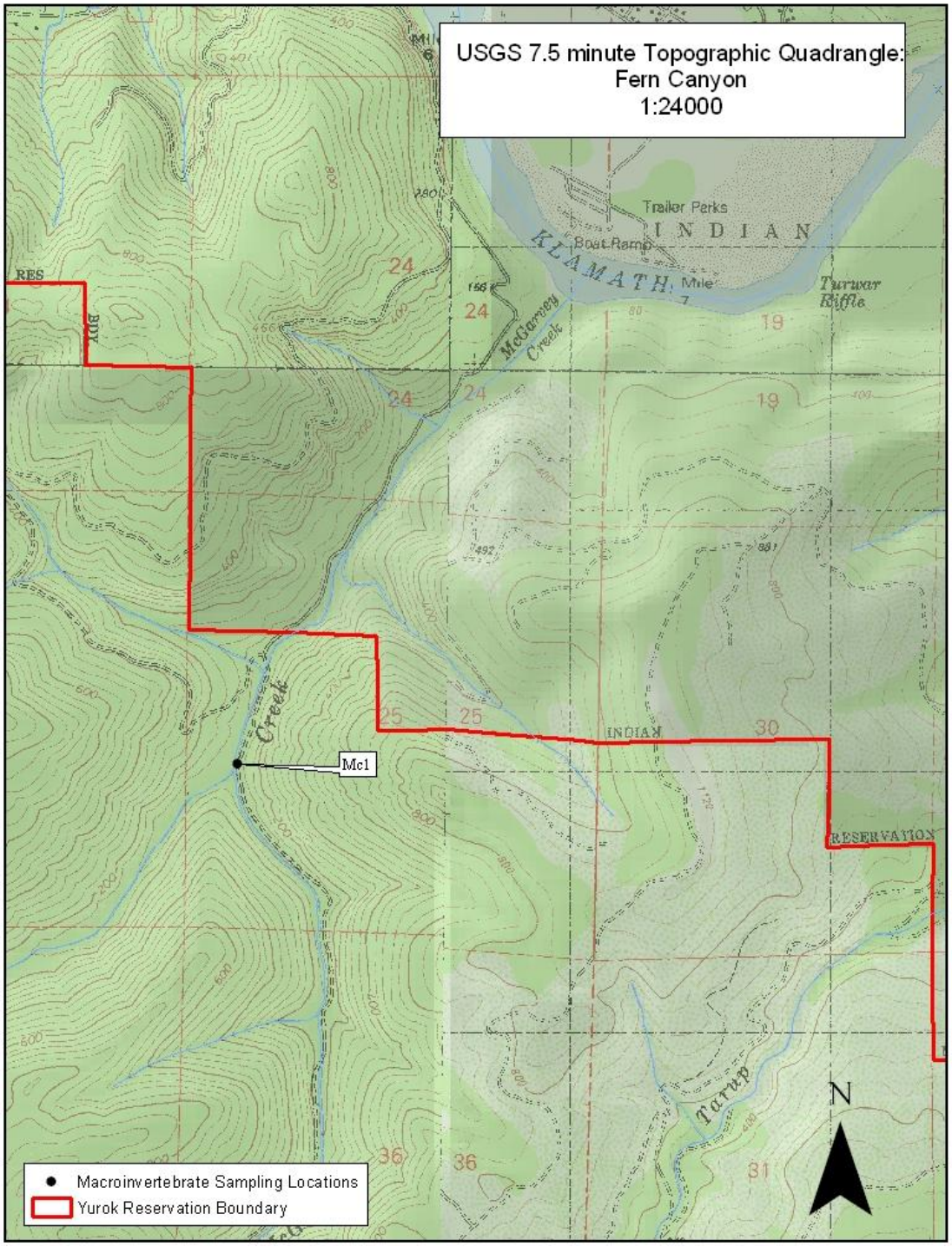

Figure 3-5. McGarvey Creek (Mc1) Sampling Location Map, WY11

Figure 3-6. Photo of McGarvey Creek (Mc1) Sampling Location, WY11

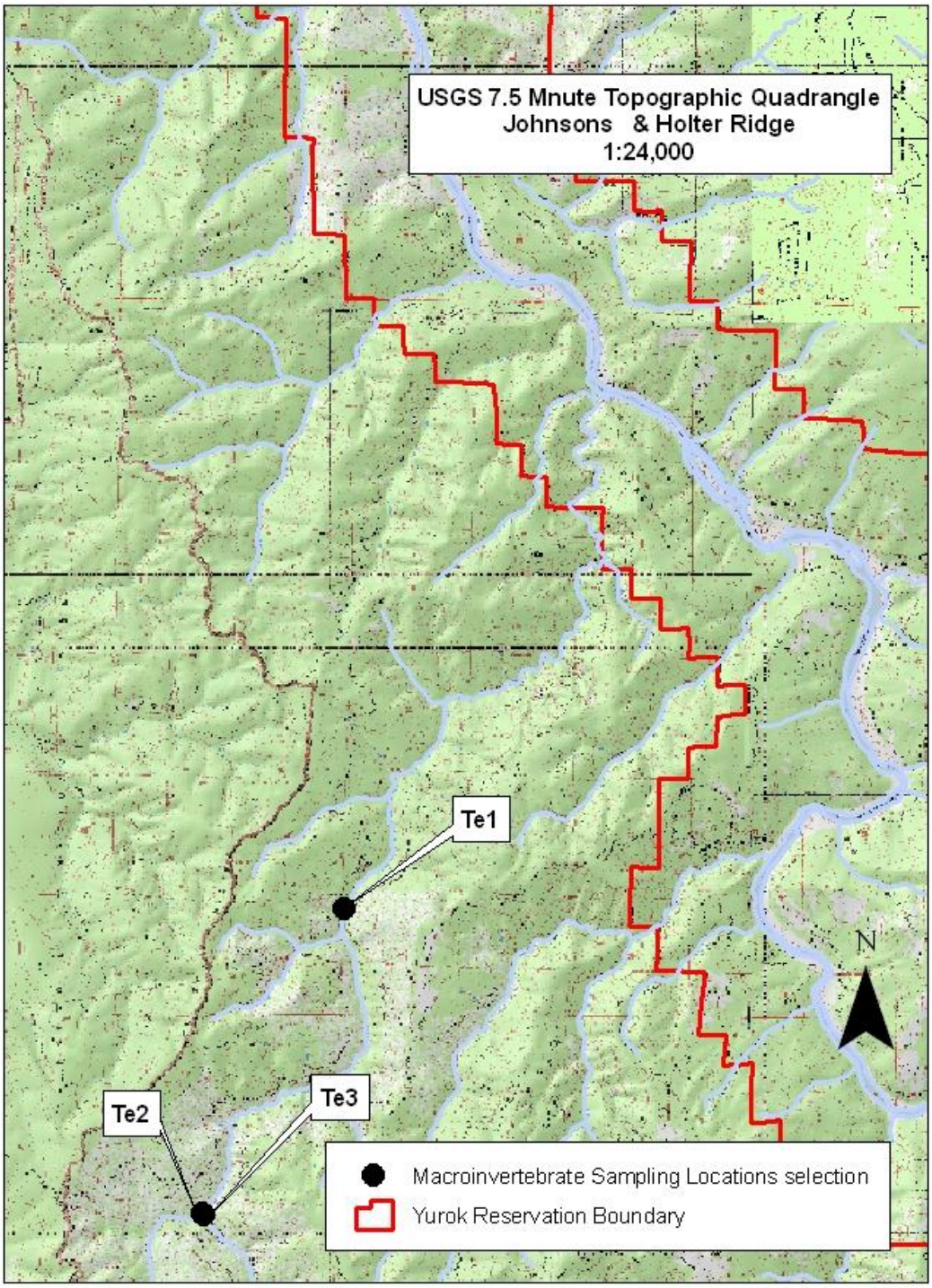

Figure 3-7. Tectah Creek (Te1, Te2, Te3) Sampling Locations Map, WY11

Figure 3-8. Photo of Mainstem Tectah Creek (Te1) Sampling Location, WY11

Figure 3-9. Photo of North Fork Tectah Creek (Te2) Sampling Location, WY11

Figure 3-10. Photo of South Fork Tectah Creek (Te3) Sampling Location, WY11

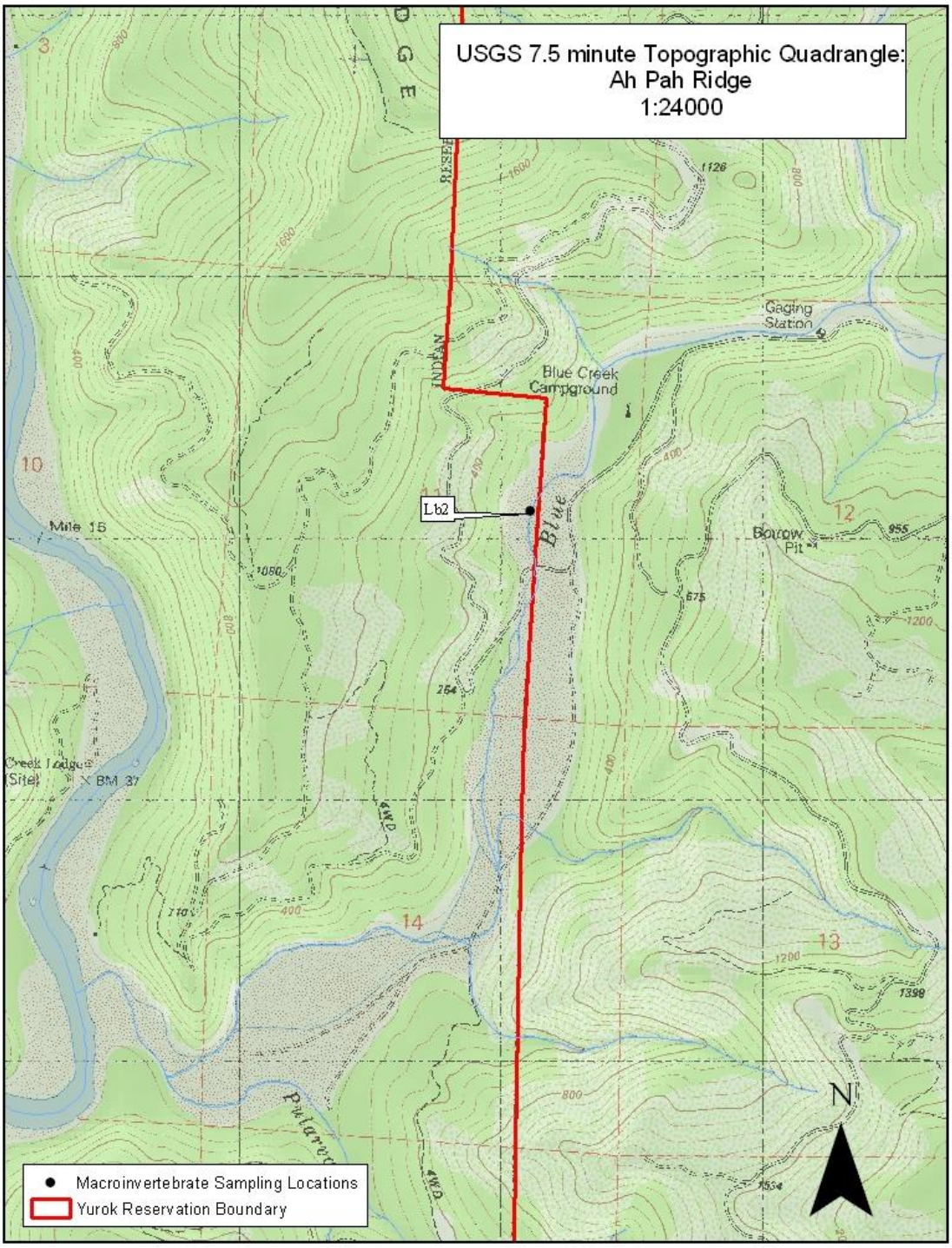

Figure 3-11. Blue Creek (Lb1) Sampling Location Map, WY11

Figure 3-12. Photo of Lower Blue Creek (Lb1) Sampling Location, WY11

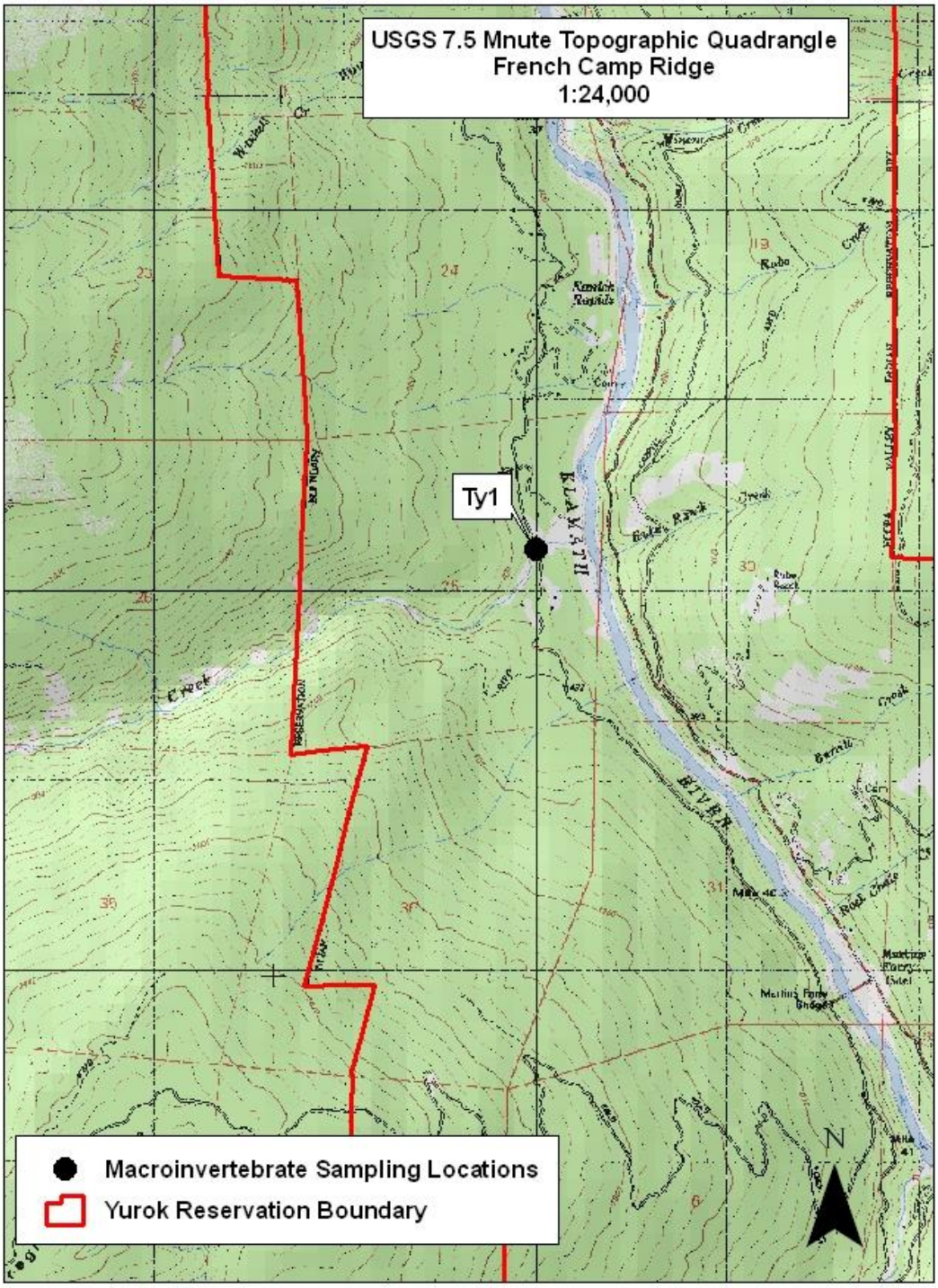

Figure 3-13. Tully Creek (Ty1) Sampling Location Map, WY11

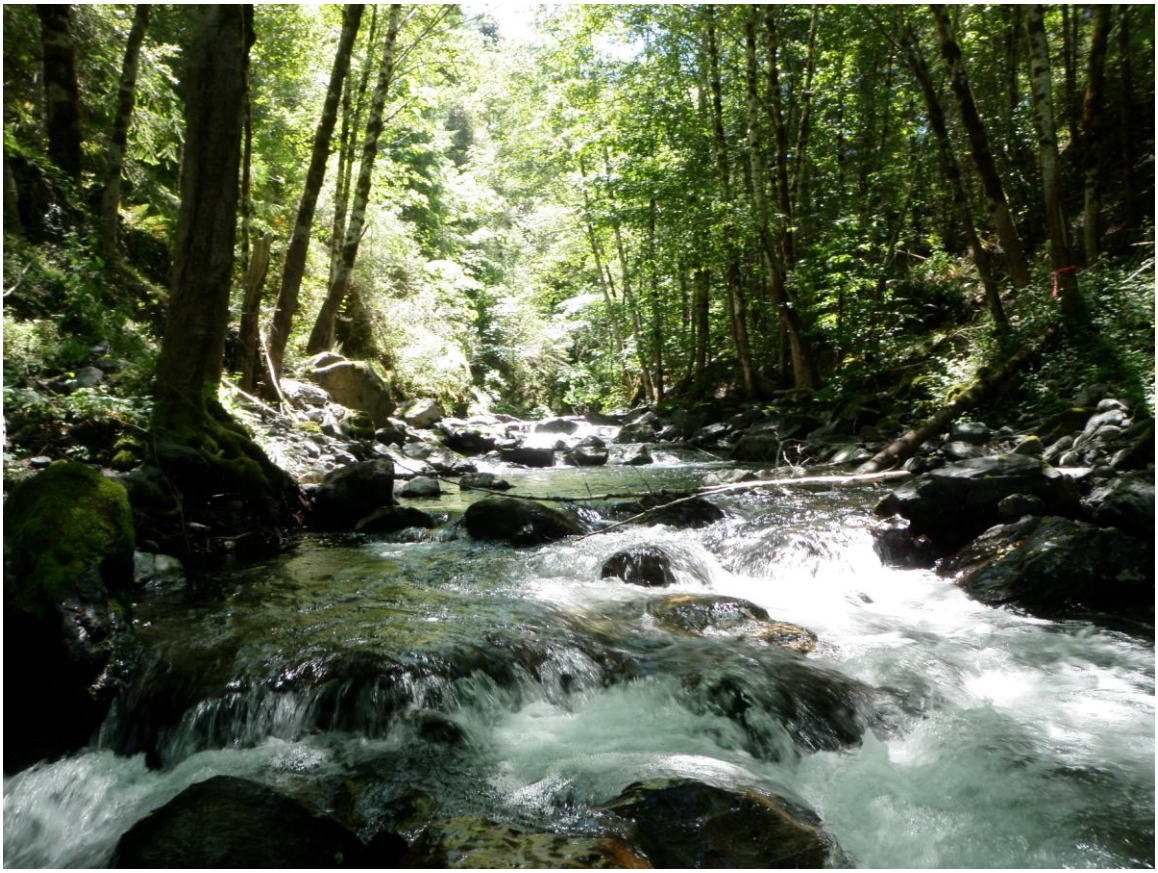

Figure 3-14. Photo of Tully Creek (Ty1) Sampling Location, WY11

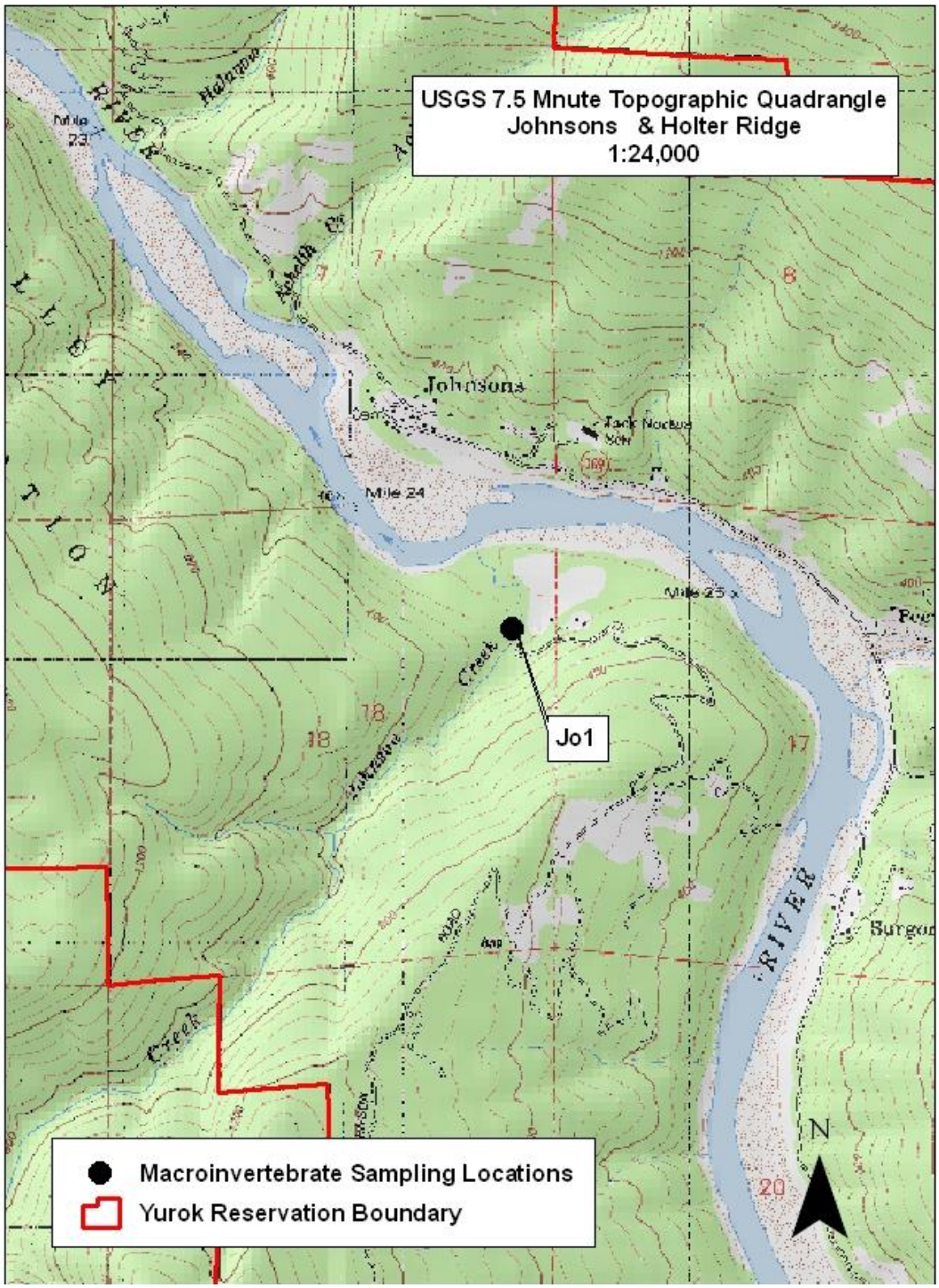

Figure 3-15. Johnson's Creek (Jo1) Sampling Location Map, WY11

Figure 3-16. Photo of Johnson's Creek (Jo1) Sampling Location, WY11

IV. Methods

YTEP sampled benthic macroinvertebrate populations in selected tributaries to the Lower Klamath River during the spring and summer months. Sampling was performed using the multi-habitat methods located in the State of CA Surface Water Ambient Monitoring Program (SWAMP) *Standard Operating Procedures for Collecting Benthic Macroinvertebrate Samples and Associated Physical and Chemical Data for Ambient Bioassessments in California February 2009* that the DFG has adapted from the US EPA's "Rapid Bioassessment Protocols of use in Streams and Rivers". This protocol reference and internet link is located in Appendix A. This protocol also includes the collection of water quality parameters and physical habitat conditions in the channel and the riparian zone. This report does not contain this information and is available upon request.

The parameters measured include:

- Epifaunal Substrate/Available Cover
- Embeddedness
- Velocity/ Depth Regimes
- Sediment Deposition
- Channel Flow Status
- Channel Alteration
- Frequency of Riffles (or bends)
- Bank Stability
- Vegetative Protection

- Riparian Vegetative Zone Width
- Algae Presence

The Hydrologic Specialist and two AmeriCorps members collected specimens which were sent to a lab where a certified taxonomist identified and calculated the number and types of species.

A variety of Quality Control measures were undertaken in the macroinvertebrate sampling methods. Sample labels were properly completed, including the sample identification code, date, stream name, sampling location, and collector's name, then placed into the sample container. Chain-of-custody forms, when needed, included the same information as the sample container labels. After sampling had been completed at a given site, all nets, pans, and other equipment that had come in contact with the samples were rinsed thoroughly, examined carefully, and picked free of organisms and debris. The equipment was examined again prior to use at the next sampling site.

Data generated in the field and laboratory is reviewed prior to being released internally or to an outside agent. Laboratory processing is contracted to Jonathan Lee, a qualified local CSBP taxonomist and California Bioassessment Laboratories Network (CAMLnet) member. The CSBP has three levels of Benthic Macroinvertebrate (BMI) identification. Level 3 is the professional level equivalent and requires identification of BMIs to a standard level of taxonomy, usually the genus and/or species. If questionable macroinvertebrates are encountered, the CDFG Aquatic Bioassessment Laboratory is used as a reference to verify the specimens. Past review of macroinvertebrate results by CDFG have shown that all identifications and counts are accurate.

After processing the samples, the biological matrices are received from the taxonomist in an Excel spreadsheet format identifying the sample ID and the breakdown of BMI species into standard taxonomic levels.

V. Results

Metric scores can be used to describe macroinvertebrate community structure and determine disturbance status of a stream habitat.

The following is a brief description of metrics calculated for YTEP's results obtained from WY11 tributary sampling efforts which have proven to be useful in the Pacific Northwest (Fore et al. 1996; Karr and Chu 1999) and northern California (Harrington et al. 1999).

- *Taxa Richness:* A richness measure. The total number of distinct taxa in a sample. Reflects health of the community through measurement of the variety of taxa present. Generally increases with increasing water quality, habitat diversity, and/or habitat suitability (Plafkin et al. 1989) (Table 5-1, Figure 5-1)

- *EPT Taxa Richness:* A richness measure. The total number of Ephemeroptera (Mayfly), Plecoptera (Stonefly), and Trichoptera (Caddisfly) taxa present. These orders are considered generally sensitive to disturbance. Expected to decrease with human induced disturbance (Table 5-1, Figure 5-2)

- *Percent Sensitive EPT Index:* A composition measure. Proportion of sample composed of Ephemeroptera, Plecoptera and Trichoptera taxa which have been assigned a tolerance value of 0 to 3. Expected to decrease with degraded habitat (Table 5-1, Figure 5-3)

- *Percent Dominant Taxon:* A Tolerance/Intolerance measure. Percent contribution of the most numerous taxon present in a sample. A community dominated by relatively few taxa would indicate environmental stress (Plafkin et al. 1989). Expected to increase with stress (Table 5-1, Figure 5-4).

- *Tolerance Value:* A tolerance/intolerance measure. A biotic index which evaluates tolerance of benthic macroinvertebrate to organic enrichment. Taxa tolerant of organic enrichment are also generally tolerant of warm water, fine sediment, and heavy filamentous algal growth (Wisseman 1996). Scale is 0 through 10, 0 being highly intolerant and 10 being highly tolerant of organic enrichment. The tolerance value is calculated as: TV=_(n_i t_i)/N, where n_i is the number of individuals in a taxon, t_i is the tolerance value for that taxon, and N is the total number of individuals in the sample. Value expected to increase with stressed environment. Tolerance values are from California Department of Fish and Game (2003) listed values, however are subject to modification as more data is gathered (Table 5-1, Figure 5-5).

- *Shannons Diversity Index (H):* A diversity index is a mathematical measure of taxa diversity in a community. Shannons index accounts for both abundance and evenness of the taxa present. The proportion of taxa *i* relative to the total number of taxa (p_i) is calculated, and then multiplied by the natural log of this proportion (lnp*i*). The resulting product is summed across taxa, and multiplied by -1: ***H***=-_$p_i$lnp_i ; Diversity is expected to decrease with disturbance (Table 5-1, Figure 5-6)

Karr and Chu (1999) consider relative abundance to be a poor candidate for use in stream monitoring because of the great natural variation that can occur. Low relative abundance during rapid flow may, in fact, be related to sediment input. The primary disturbance within the study streams is expected to be an increase in fine sediment. Fine sediment reduces the area of substrate available for colonization by macroinvertebrates. Areas of fine sediment in running water are unstable and do not allow a foothold for macroinvertebrates. Fine sediment also fills in areas around cobble substrates reducing usable habitat. Lenat et al. (1981), in North Carolina streams, found that during high flows the addition of sediment simply reduced the available habitat and therefore invertebrate density. Exposed cobble/rubble substrates act as refugia but the number of exposed surfaces is reduced by sediment input.

Lenat et al. (1981) also noted a stable sand community which developed during low flow conditions. This consisted of tolerant small grazers capable of rapid colonization and reproduction which utilized increased periphyton growing on the stable sand. Relative abundance and tolerance values would increase in stable sand.

Table 5-1. Reported macroinvertebrate metrics for Lower Klamath tributary sites sampled in WY11

Site	Sample Date	Total # of Specimens	Taxa Richness	EPT Richness	Sensitive EPT	% Dominant Taxon	Tolerance Value	Shannon's D.I.	Est Relative Abundance
Lower Turwar	6/9/2011	500	32	19	16.00	66.60	5.05	1.54	1769
Upper Turwar	6/20/2011	500	35	21	21.80	52.00	4.55	2.00	4600
McGarvey	6/2/2011	500	41	24	42.60	15.00	3.41	2.94	1845
Main stem Tectah	7/1/2011	500	42	23	47.00	20.40	3.06	2.80	4992
NF Tectah	6/27/2011	500	40	23	26.00	53.00	4.42	2.14	5251
SF Tectah	6/27/2011	500	43	28	47.60	28.20	2.85	2.62	2923
Blue Creek	8/4/2011	500	48	24	22.00	22.40	4.59	2.81	2128
Tully	6/21/2011	500	46	21	21.60	35.60	4.24	2.68	1271
Johnsons	6/23/2011	500	44	26	23.60	44.80	4.51	2.35	2750

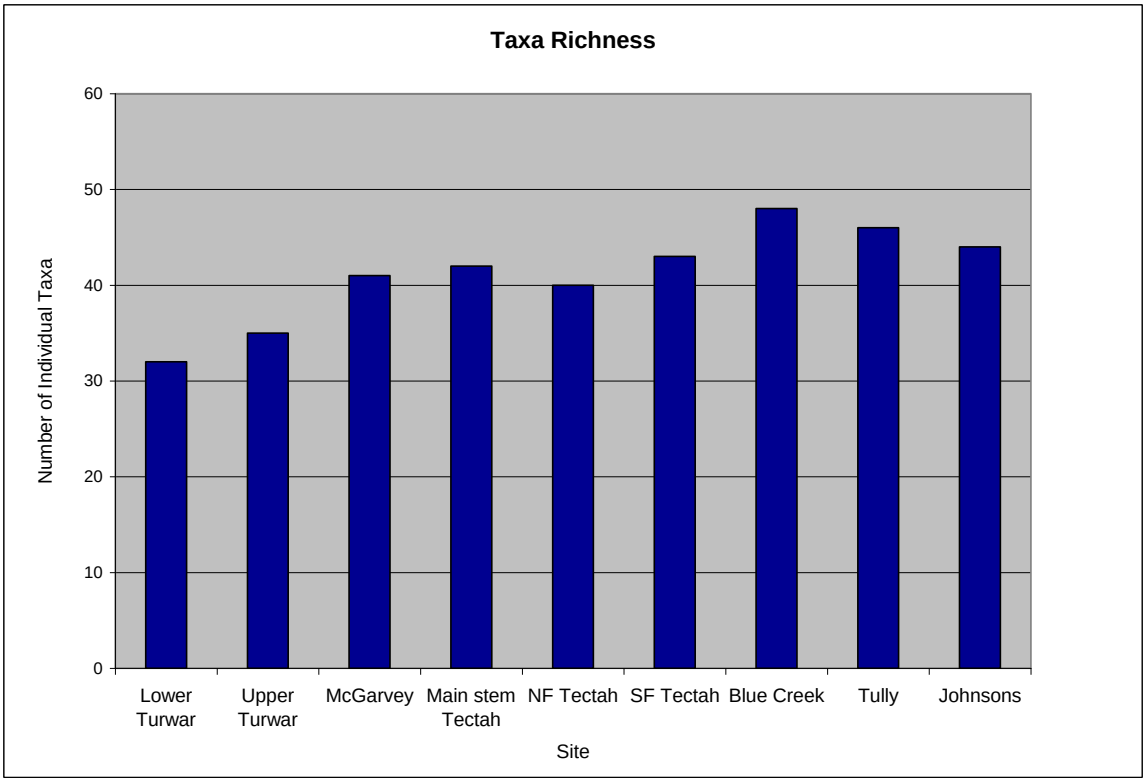

Figure 5-1. Taxa Richness for Klamath River Tributaries, WY 11.

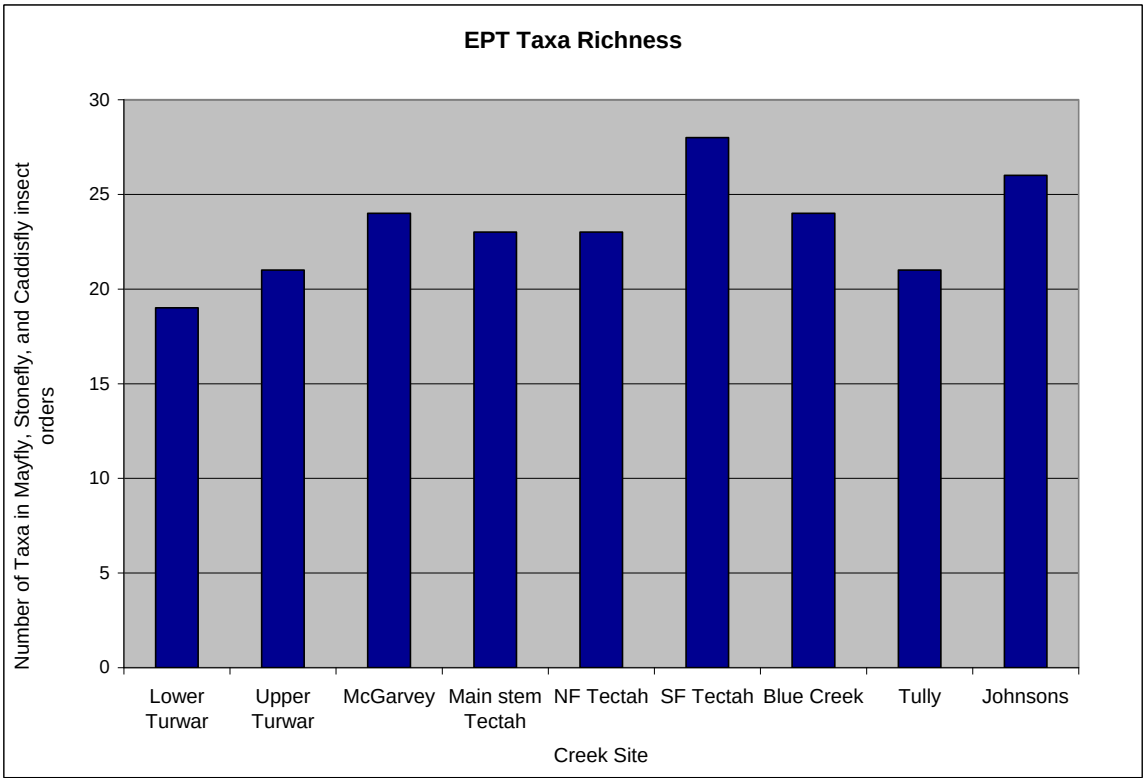

Figure 5-2. EPT Taxa Richness for Klamath River Tributaries, WY 11.

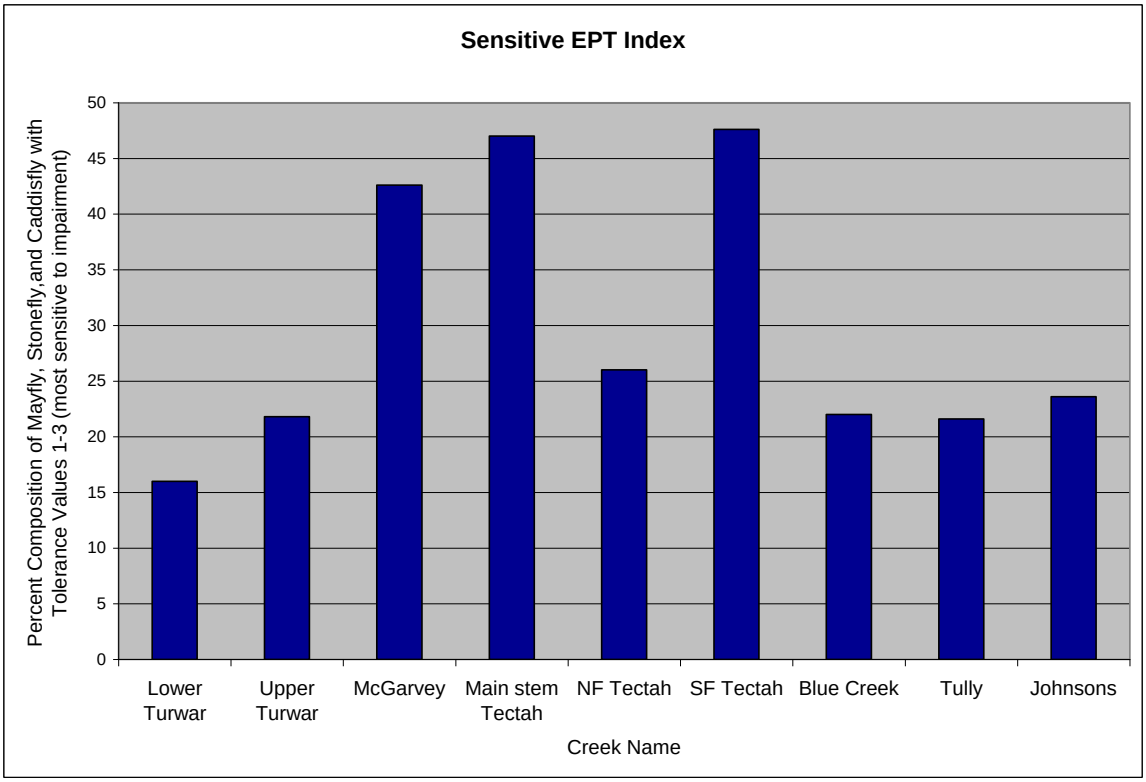

Figure 5-3. Sensitive EPT Index (%) for Klamath River Tributaries, WY 11.

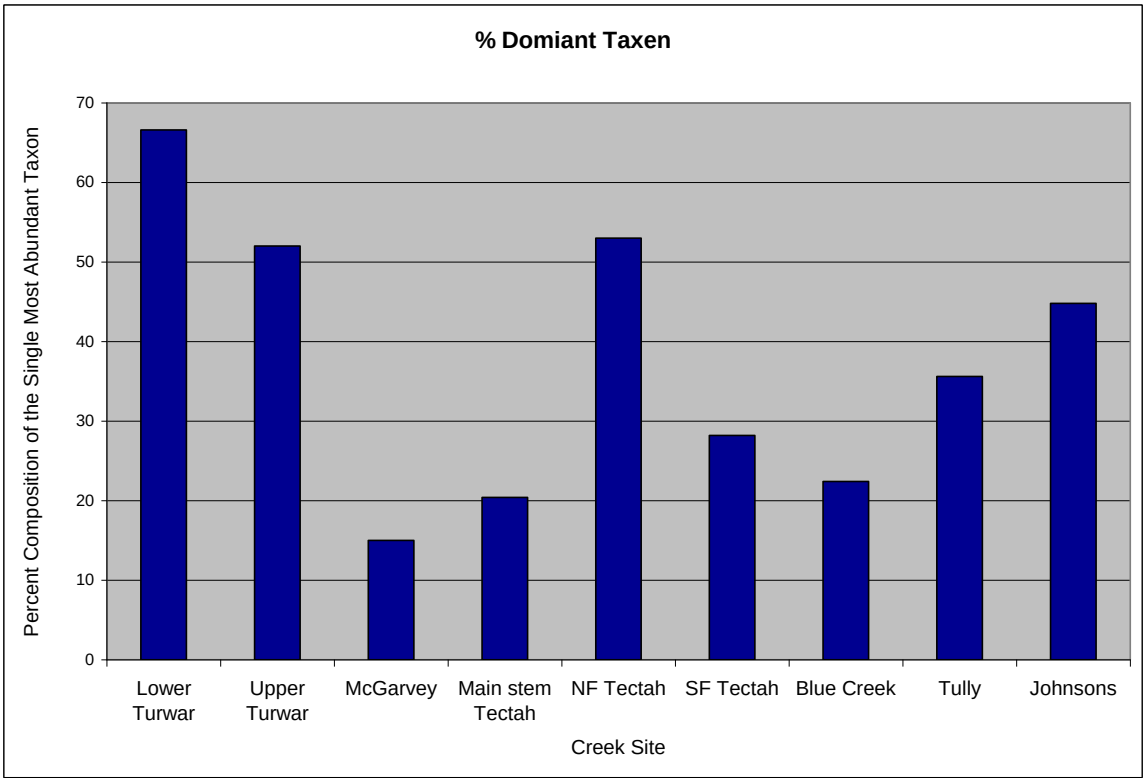

Figure 5-4. % Dominant Taxon for Klamath River Tributaries, WY 11.

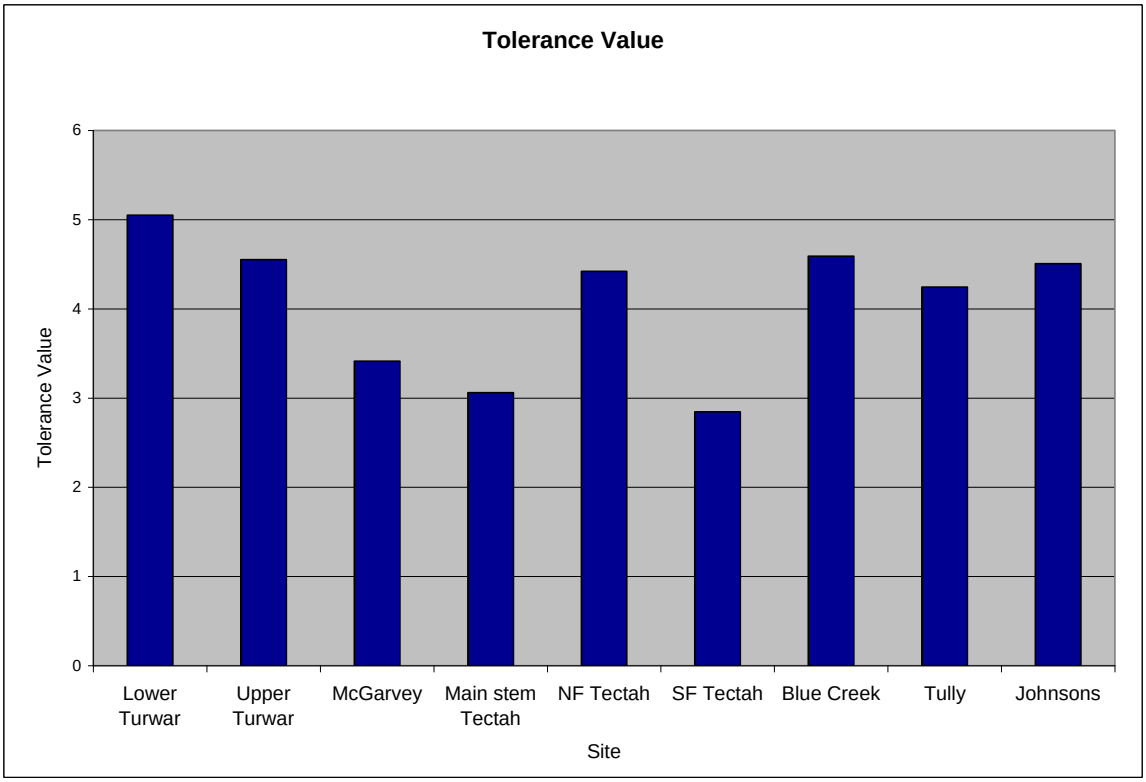

Figure 5-5. Tolerance Values for Klamath River Tributaries, WY 11.

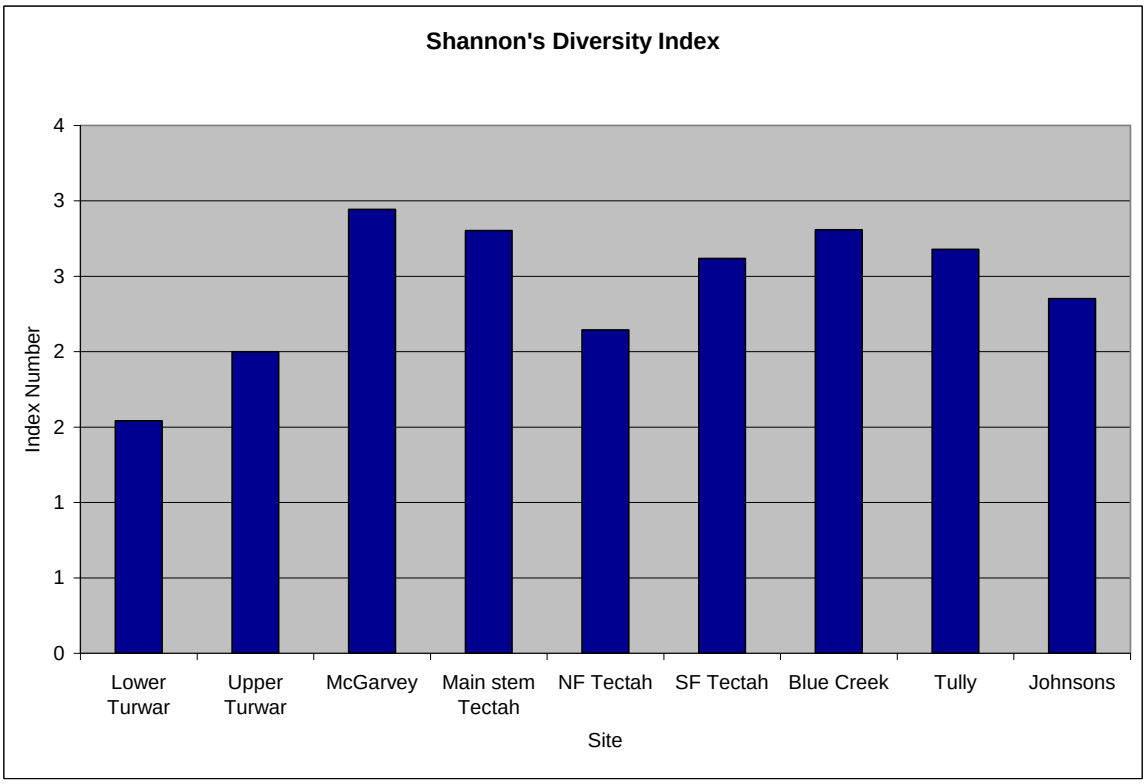

Figure 5-6. Shannon Diversity Index for Klamath River Tributaries, WY 11.

Macroinvertebrate results are presented for WY11 using the North Coast IBI. DFG developed the North Coast IBI to generate a single value to gauge stream health. Among the metrics used, 6 of the 8 were statistically different than the reference sites in early development of the IBI index for the Klamath region. A separate scoring scale was created to correct these statistical differences for streams that fall within the Klamath and North Coast mountain regions. In order to insure the greatest quality control, this separate scoring system was used when generating the metric for WY11. The results of this ranking method are as follows, along with the IBI scoring key.

Table 5-2. IBI Scoring Key

Total Metric Score	Value
0-20	very poor
21-40	poor
41-60	fair
61-80	good
81-100	very good
>52	"unimpaired"

Table 5-3. North Coast IBI Scores for Klamath River Tributaries WY 11

Site	Date	EPT Richness	Coleoptera Richness	Diptera Richness	% Intolerant	% non-Gastropod Scrapers	% Predator	% Shredder	% non-Insect	Score Total
Lower Turwar	6/9/2011	7	3	6	5	2	7	10	8	60
Upper Turwar	6/20/2011	8	9	5	6	7	8	6	9	72.5
McGarvey	6/2/2011	9	5	5	9	2	9	7	7	66.25
Mainstem Tectah	7/1/2011	9	10	5	10	10	7	8	8	83.75
NF Tectah	6/27/2011	9	9	5	5	2	5	10	8	66.25
SF Tectah	6/27/2011	10	10	5	10	3	5	10	9	77.5
Blue Creek	8/4/2011	9	9	9	6	6	10	5	7	76.25
Tully	6/21/2011	8	10	9	5	10	8	7	8	81.25
Johnsons	6/23/2011	10	7	5	5	3	5	9	8	65

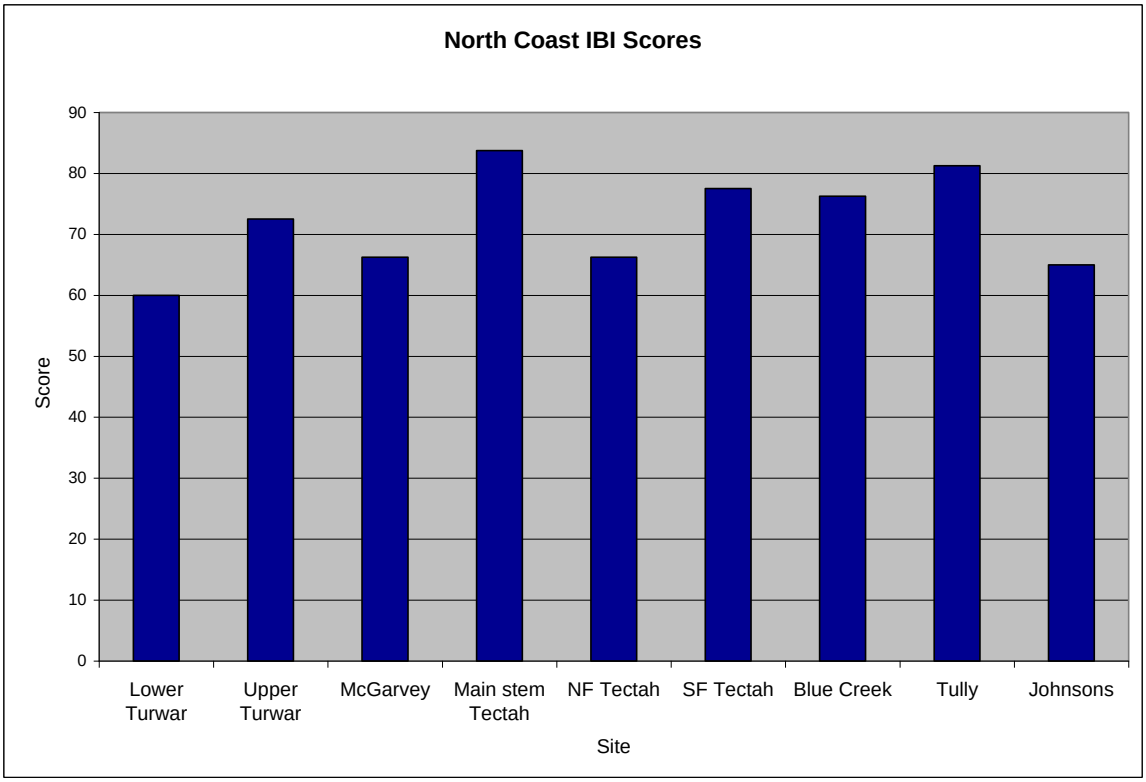

Figure 5-7. North Coast IBI Scores for Klamath River Tributaries, WY 11.

VI. Discussion

YTEP strides to collect the most credible data possible, and to accomplish this YTEP follows the SWAMP protocol. This protocol requires a minimum of 450 total numbers of specimens to generate appropriate statistics for the stream, giving us a statistically significant sampling set from which results were generated. All sampling sites for the WY 11 yielded over 450 total specimens. All data for Klamath River tributaries is summarized to assess the overall health of these sub-watersheds for the water year 2011.

The North Coast IBI index scores provide a single numerical value for accessing stream health using a combination of metric parameters. The IBI single scoring criterion provides an efficient and effective tool for conclusions about each tributary's overall stream health, and will be the primary focus of this discussion. The majority of the sites scored in the "good or "very good" rating value categories using the NC IBI metrics, the lone exception being Lower Turwar Creek that scored a 60, which is one point below the "good" scoring value and into the "fair" category.

In 2009 and 2010, Lower Turwar was rated "fair" and as an impaired stream using the NC IBI metrics. In 2011 it is still rated as "fair" but it is no longer rated as impaired, since its score was greater than 52. There have been multiple restoration projects around Lower Turwar over the past couple of years, which may have contributed to the improved health of the stream. 2010 and 2011 had considerable wet Spring seasons and may have also contributed to the higher scores since the channel did not go dry as early as previous years. The factors that may have brought down Lower Turwar's IBI score are Coleoptera richness and percent non-gastropod scrapers because they are such low numbers, 3 and 2 respectively.

Mainstem Tectah and Tully sampling sites were found to have the healthiest stream habitat with IBI scores ranking "very good" of 83.75 and 81.25, respectively. The North Fork of Tectah scored in the middle range of "good" with a value of 66.25 and the South Fork of Tectah scored in the upper range of "good" with values of 77.5. In 2007 the three branches of Tectah, the Mainstem, the North and South Fork, had the three highest scores of all sampling sites with values of 82.5, 77.5, and 88.75 respectively. The Tectah sites had high ratings in 2009 as well, the Mainstem with a score of 87.5, the North Fork with 72.5, and the South Fork with 76.25. These numbers indicate that the greater Tectah watershed has overall maintained healthy aquatic habitats since 2007.

All of the tributary sampling sites were found to be in the "unimpaired" range. The index for IBI scores defines "impaired" as a score of 52 or below. Of the nine tributary sites sampled two scored as "very good," six were scored as "good," and only one was scored as "fair." All of these sample sites exist in areas of either historic and or active logging operations.

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Appendix A

To view the sampling protocol that YTEP employed in collecting its macroinvertabrate samples in 2011 please view the pdf titled "Standard Operating Procedures for Collecting Benthic Macroinvertebrate Samples and Associated Physical and Chemical Data for Ambient Bioassessments in California". Or follow link: http://swamp.mpsl.mlml.calstate.edu/wpontent/uploads/2009/04/swamp_sop_bioassessment_collection_020107.pdf