WATER DEMAND ESTIMATE FOR MARIJUANA CULTIVATION

within the

YUROK INDIAN RESERVATION

NORTHERN CALIFORNIA

February 29, 2016

Prepared for:
Yurok Tribe Environmental Program
190 Klamath Boulevard
Klamath, California 95548

Prepared by:
Stan Thiesen and Orrin Plocher

of

Freshwater Environmental Services

78 Sunny Brae Center
Arcata, California 95521
Phone (707) 839-0091

WATER DEMAND ESTIMATE
FOR MARIJUANA CULTIVATION WITHIN THE YUROK INDIAN RESERVATION
NOTHERN CALIFORNIA

Prepared for:
Yurok Tribe Environmental Program
190 Klamath Boulevard
Klamath, California 95548

February 29, 2016

Prepared by:
Stan Thiesen and Orrin Plocher
Freshwater Environmental Services
78 Sunny Brae Center
Arcata, California 95521
Phone (707) 839-0091

Stan Thiesen
PG No. 7990

Orrin Plocher
Geologist

DISTRIBUTION LIST

Suzanne Fluharty, Ph.D., Environmental Specialist
Project Manager
Yurok Tribe Environmental Program
190 Klamath Boulevard
Klamath, California 95548

Louisa McCovey, Director
Yurok Tribe Environmental Program
190 Klamath Boulevard
Klamath, California 95548

Eric Byous
Tribal 128(a) Grant Lead
USEPA Region 9
75 Hawthorne Street
San Francisco, CA 94105

Orrin Plocher
Freshwater Environmental Services
78 Sunny Brae Center
Arcata, California 95521

Stan Thiesen
Freshwater Environmental Services
78 Sunny Brae Center
Arcata, California 95521

ACRONYMS AND ABBREVIATIONS

CAMP	Campaign Against Marijuana Planting
CDFW	California Department of Fish and Wildlife
DEA	Drug Enforcement Administration
FES	Freshwater Environmental Services
GIS	Geographic Information System
JPEG	Joint Photographic Experts Group
MCSs	Marijuana Cultivation Sites
NAIP	National Agriculture Imagery Program
NCRWQCB	North Coast Regional Water Quality Control Board
NMFS	National Marine Fisheries Service
NRCS	Natural Resource Conservation Service
USDA	United States Department of Agriculture
USGS	United States Geological Survey
YIR	Yurok Indian Reservation
YTEP	Yurok Tribe Environmental Program

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF PHOTOGRAPHS

EXECUTIVE SUMMARY by Yurok Tribe Environmental Program

The significance of this report lies in the scale of the study, in its entirety over 315,195 acres were incorporated into the study area through satellite imagery. The simplistic, yet time consuming methodology of photo interpretation generates an empirical count of marijuana plants that facilitates analysis at multiple levels; the small tributary or creek watershed level, or the larger Yurok Indian Reservation (YIR), or the totality of all the watersheds that empty into the Klamath River within the exterior boundaries of YIR.

The resulting snapshot shifts the debate over the impacts of marijuana cultivation out of speculation and firmly grounds the estimate of impacts to tangible evidence. The visual counting reveals that a scattering of grow sites exist in the downriver area of the YIR, but the majority (91 percent) of all plants counted were in a clustered block of 17 percent of the study area, in the upriver region (Figure 3). Having a numeric count allows considerations of the impacts to Yurok Tribal Lands and Waters, community members, and their economic, cultural, subsistence, and ceremonial lifeways to proceed and grounds the discussion in a common baseline. What is presented in this report is a defensible number of plants and water demand. Various data sources have been compared and results are within less than a 10 percent difference of each other; a very robust range for an estimate. Furthermore, in an attempt to be impartial, Hezekiah Allen, Chair and Executive Director of California Growers Association (CGA) was contacted about the numbers that were used for plant densities and the water demands per plant. (personal communication via phone and email, January 15, 2015). According to their website, the Association represents cannabis growers and works, “actively with the legislature and state agencies to develop and implement regulations for cannabis cultivation”.

Mr. Allen’s answer to the question "how much water" was that it depends on the agricultural practices being utilized and that there exists a wide range in water usage based on the length of the growing season and the size of the plant. He explained that the growers his organization represents refer to the size of a plant by the amount of marketable product. Based on surveys and research they have completed, the best formula they’ve developed is, “1 gallon per pound of product per growing day” and that generally means, the larger the plant, then the longer the growing season, and the more water required. Most of the CGA work with commercial growers in Humboldt County are from the southern region and utilize indoor grows/greenhouses/hoop houses, with smaller plants that typically require 2 to 2 ½ or 3 pounds of product or gallons of water per day. Reportedly, this is due to the controlled conditions, plant spacing, and increased humidity of indoor grows. However, Mr. Allen commented that he’s known of some outdoor grows with plants that require up to 15 gallons a day due to their larger size and more exposed growing conditions. The final comment is that grow operations are diverse in their practices.

The communication with Mr. Allen was very informative and is included here as valuable data in our attempts to characterize the water demands of marijuana cultivation in Yurok Ancestral Territory in northern Humboldt County. It also provides supporting evidence of the plant density numbers associated with greenhouses in our study area that are higher than that reported in, Impacts of Surface Water Diversions for Marijuana Cultivation on Aquatic Habitat in Four Northwestern California Watersheds (Bauer, et al. 2015). Keeping in mind that the goal of this

report was to capture and characterize the local impacts and that most local grow sites in our study area include some combination of both greenhouses and outdoor plantings, it was decided to use field counts taken on local grows to calculate the overall number of plants. However, we have no data on local water use except for the Bauer article that utilizes one watershed that is within Yurok Ancestral Territory. It was decided to use the published number of 22.7 liters or 5.9 gallons/plant/day (Bauer et al. 2015) as it seems reasonable and falls within the mid-range of EGA reported volume of 2 to 15. This generates what is a realistic estimate of water demand in Yurok country and allows cross-comparisons and analysis of ecological and cultural impacts.

For example, the impacts to Tribal Members' domestic source water varies between the Mareep watershed with an estimated 11,681 gallons/day withdrawal from marijuana cultivation that has 7 mapped intakes, and the Burill watershed with a 5,201 gallons/day withdrawal but 5 mapped intakes. The Gist Creek watershed with only a single intake has a demand of 1,973 or nearly 2 thousand gallons a day withdrawal from marijuana cultivation, however it impacts a much larger population as it is the intake for the Weitchpec Public Water System. Ecosystem wide impacts are being felt and the water availability throughout a watershed is often diminished such as Weitchpec Creek and several important cultural springs within its watershed. The lower reaches have gone dry the last 2 years and many suspect this is the result of a daily demand from marijuana growing, now calculated in this report as 3,821 gallons a day. Tribal Members report that this is one of several creeks where water has returned after enforcement actions have removed illegal diversions and their concerns range not only for their own uses but for all life, including the plants and animals of the area that are also dependent on the watershed. It is often expressed is that the marijuana growers have brought "un-balance" to the natural world, a deep felt-cultural and ceremonial concept, central to Yurok.

Other than the water quantity issue, the water quality impacts to fish, particularly the iconic salmon, both Chinook and the endangered Coho, needs to be framed at a small tributary scale. It is not just that water doesn't make into the Klamath River mainstem, but that it is quantities of cold water that support and help sustain the fish refugia at the mouths of many creeks that are not being delivered. Eight creeks were sampled between 10:30 am and 5:30 pm on October 29, 2015 and their average temperature was 12.51o C. At the comparable times, the mainstem Klamath River at the Tully Creek gage, averaged 14.50 o C. This 2 degrees cooler is an average but Mawah Creek, that had an estimated withdrawal from its watershed of 15,897 gallons a day, was running a full 3.5 o C cooler. Those nearly, 16 thousand gallons of cool water would normally be bathing the fish as they rest in refugia away from the warm mainstem flow, lowering their critical core temperatures and allowing them the vitality to move on to their spawning grounds. In years of drought and low flows every degree of difference between survival or fish kill conditions is critical and the loss of this cold water input is something we cannot quantify.
In conclusion, the water withdrawals from marijuana cultivation have serious detrimental impacts at all scales and to every being that is dependent on the surface waters of the Yurok Indian Reservation and within Yurok Ancestral Territory.

1.0 INTRODUCTION

The following introduction was provided by the Yurok Tribe Environmental Program:

The problem of illegal marijuana cultivation on the Yurok Indian Reservation (YIR) and surrounding Ancestral Territory has reached a near-crisis level. The Yurok Tribal Council and community members not only express concern for their physical safety but have major concerns for the impacts to lands and water that have ripple effects throughout the ecosystem including the fish and wildlife that are central to their cultural, spiritual, and economic wellbeing. Fears concerning natural resources include both water quantity and quality throughout their ancestral lands, Klamath River and Pacific Ocean. The following two paragraphs capture some of their concerns and are quoted from a letter from the Yurok Tribe to the Humboldt County Planning Commission dated November 5, 2015:

> *Since time immemorial the Yurok people have lived along the Klamath River and surrounding lands in northern California. With over 6,000 members the Yurok Tribe is the largest federally recognized tribe in California. The Tribe's reservation includes 55,890 acres straddling the mouth of the Klamath River and up the River forty-four miles in a one mile wide strip on each side on each side of the River. The River and its resources are the life blood of the Yurok people and culture, and the health of the River and its tributaries and the surrounding environment are of the upmost importance to the Tribe.*
>
> *The long lasting detrimental environmental impacts of marijuana cultivation are well known to all Humboldt County communities. To combat these impacts, the Yurok Tribe has developed a zero tolerance policy when it comes to marijuana cultivation and consumption within the Reservation. However, the increase of marijuana cultivation in the area continues to wreak havoc on Tribal lands - forests lands have been cleared and graded; the River and its tributaries have been contaminated with fertilizers, pesticides and waste, wildlife has been poisoned; surface-based tribal community water systems have been contaminated or depleted; and cultural sites have been desecrated. (Yurok Tribe, 2015)*

In an effort to address these concerns the Tribe joined forces in collaborative operations in both 2014 and 2015 to eradicate large-scale, illegal marijuana grows within and adjacent to the reservation that have become known as Operation Yurok. More than a dozen enforcement agencies participated with Yurok staff including: The Humboldt County Sheriff's Drug Enforcement Unit (who coordinated the raids), California Department of Justice' North State Marijuana Investigation Team, California Department of Fish and Wildlife (CDFW), California National Guard Counterdrug Task Force, CA State Water Resources Control Board, the Campaign Against Marijuana Planting (CAMP), the Drug Enforcement Administration (DEA), the US Department of Justice, Bureau of Indian Affairs, and Bureau of Land Management. More than 45 sites were investigated in 2014 and an additional 32 in 2015 that averaged 861 plants per site with over 55 thousand plants in total eradicated.

One outcome of the Operation is the consistent observation at every site of unpermitted, illegal water diversions with miles and miles of irrigation pipes, multitudes of fertilizer mixing tanks, and impoundments of numerous types including water bladders, standard storage tanks, and dammed reservoirs, pools and ponds. Tribal members who know the local area reported that even allowing for the drought, many creeks and springs had reduced to non-existent flows compared with historic levels and that many of these returned to normal after the growing operations had ceased.

A wide range of estimates regarding the quantity of surface water being diverted by MCSs has been debated but all agencies involved agree that it is substantial. The excerpt from NOAA's National Marine Fisheries Service (NMFS) comment letter (2011) sent to California's North Coast Regional Water Quality Control Board summarizes the prevailing opinions.

> NOAA's National Marine Fisheries Service (NMFS) shares the Regional Water Board's concern that unpermitted and unregulated marijuana cultivation is degrading water quality and harming salmon/steelhead in many northern California streams and rivers...
>
> However, an equal, if not greater, concern is the illegal and unpermitted pumping of surface water that inevitably accompanies most grow site-development. During our ongoing multi-year drought, the impact of these illegal surface diversions on aquatic species, including federally threatened salmon and steelhead, has been extensive. Every summer, a growing number of streams already impacted by the drought are dewatered further by diversions supplying marijuana gardens.

A reasonable estimate of what the local surface water demand, (based on conditions in 2015) was needed to: inform the Tribe's management decisions and actions, support court cases, calculate impairments to endangered species' habitats, and assess impacts or loss of beneficial uses (not only of the primary watercourse being diverted but to the downstream receiving body and groundwater recharge). To answer this need, the Yurok Tribe Environmental Program (YTEP) contracted with Freshwater Environmental Services (FES) to prepare an estimate of the water demand from marijuana cultivation within the watersheds that discharge to the Klamath River within the YIR boundaries.

2.0 METHODS

For the purposes of this study, marijuana cultivation sites (MCSs) are defined as any area where marijuana is grown, either outdoors or inside a greenhouse, within the YIR and/or associated watersheds based on our aerial image interpretation. The Yurok Tribe provided FES with information from law enforcement actions that counted the number of plants eradicated at local sites to evaluate 14 MCSs that were contemporaneous with the aerial images. This provided data to support two major assumptions in the studies interpretation of plant density. First, is that in addition to total counts per site, the number of plants within greenhouses at two locations with multiple greenhouses was reported and used to estimate the density of plants within all greenhouses in our study area. Second, the site data was also used to estimate the number of outdoor plants grown within containers or excavated planting squares that was encountered at several of the MCSs. The plant counts based on these site interpretations were then compared to numbers utilized in “Impacts of Surface Water Diversions for Marijuana Cultivation on Aquatic Habitat in Four Northwestern California Watersheds" (Bauer et al., 2015). This comparison between plant density interpretations provides a final range of the probable number of plants growing within the study area.

2.1 Study Area

The study area included the YIR boundary and 56 Yurok delineated watersheds that extend onto the YIR. The reservation boundary and the 56 watersheds were provided as GIS (Geographic Information System) shapefiles to FES.

2.2 Data Collection and Mapping Overview

The data collection methods were similar to those used described in the Bauer S, Olson J, Cockrill A, van Hattem M, Miller L, Tauzer M, article (Bauer et al., 2015). The data collection methods for this study differed from Bauer et al., in the following approaches:

- We used Google Earth imagery from 2015 for most areas and 2014 for other areas;
- We extracted images from Google Earth and geo-referenced them in GIS;
- We used the extracted images in GIS for digitizing outdoor plants and greenhouses; and
- We had field data from fewer sites.

The study area's tributary watershed boundaries and the YIR boundaries were provided by the Yurok Tribe Environmental Program (YTEP). A reference grid was created by FES in GIS with one square kilometer polygons. The reference grid was imported into Google Earth as a shapefile. The reference grid was used to ensure that all areas were observed for the presence of outdoor plants or greenhouses. The individual grid polygons were examined and labeled as they were completed. All areas within the watersheds and within the reservation boundary were evaluated.

2.3 Aerial Imagery

The Google Earth images used for the aerial image interpretation were taken on July 14, 2015 except for the area which starts approximately 1.25 miles south of the southern boundary of the YIR which were taken on May 28, 2014. This area which comprises most of the Pine Creek watershed was not available from the same time frame as the majority of the study area. Approximately 380 outdoor plants and 6 greenhouses (11,055 square feet) in the Pine Creek watershed were digitized using the Google Earth May 28, 2014 imagery.

Eradication was taking place at the time of the July 14, 2015 aerial imagery and may have biased the plant counts. Some of the greenhouses that had their covers removed and were empty of plants were digitized by FES and incorporated into the plant totals based on their location on parcels where eradication was taking place. FES compared plant count data acquired during the eradication for comparison as shown in Table 4.

2.4 GIS Methods

GIS (ArcMap™ 9.3) was used to digitize outdoor plants and greenhouses and to calculate greenhouse areas in square feet. The following steps were used to digitize the outdoor plants and greenhouses:

- A GIS shapefile of 1 square kilometer (km^2) polygons covering the entire study area was created using the GIS;
- The 1 km^2 polygons were imported into Google Earth;
- Each 1 km^2 polygon area was reviewed in Google Earth to ensure that all of the study area was observed;
- If outdoor plants or greenhouses were observed in Google Earth an image was extracted of the area that the contained plants and greenhouses as a Joint Photographic Experts Group (JPEG) image from the Google Earth imagery and imported into the GIS;
- The extracted JPEG image from Google Earth was geo-referenced using June 2014 United States Department of Agriculture (USDA) National Agriculture Imagery Program (NAIP) mosaics of Humboldt and Del Norte Counties;
- The 2014 NAIP imagery was only used to geo-reference the Google Earth imagery in the GIS;
- The extracted Google Earth images were then used in the GIS to digitize individual plants and plant clusters as point data in a shapefile;
- The greenhouses were digitized as polygons in a shapefile using the rectangle tool; and
- The intersect command was used in GIS to create tables listing the number of outdoor plants and the number of greenhouses including the greenhouse areas.

Examples of the extracted images and digitized data are shown on Photos 1 through 10. Figures 6 through 12 show the distribution of outdoor plants and greenhouses. The number of outdoor plants and greenhouses including the calculated greenhouse areas are included in Tables 1 through 3. A comparison of field data with the data obtained from aerial imagery interpretation is included in Tables 4 and 5.

2.5 Outdoor Plants

The agricultural practices used for marijuana cultivation vary significantly and it is not always clear from the aerial imagery whether outdoor plants represent single plants or plant clusters as shown on Photos 1 through 5. FES counted 4,490 individual plants and 1,494 clusters (which were considered to contain 4 plants each based on data provided by YTEP and shown on Photos 19 and 20). The number of plants from the plant clusters was 5,976 (based on 4 plants per cluster), totaling 10,466 plants all together.

2.6 Greenhouses

Greenhouses that appeared active based on the condition of the tarps were digitized in GIS as polygons so their areas could be calculated. Examples of greenhouses considered active are shown on Photos 6 through 10. Inactive, or abandoned greenhouses were those that were not covered, where there were no plants visible and where there were no tarps adjacent to the greenhouses. Those greenhouses that were considered abandoned (shown in Photo 1) were not digitized. The greenhouses that had been recently eradicated based on preliminary field data provided by YTEP were digitized because they were active in 2015.

There were two greenhouses in residential areas in the Hunter Creek watershed that were digitized because they appeared to have been constructed within the last four years. There were several gardens in the residential areas that were not considered to contain marijuana plants but it was difficult to determine.

Some greenhouses in residential areas such as Klamath Glen where there appeared to be orchards or non-marijuana gardens were not digitized because it was not clear if they were being used for marijuana cultivation. These greenhouses were typically small compared to the greenhouses where marijuana cultivation was occurring. A few of the recently constructed greenhouses were digitized because they were considered more likely than not being used for marijuana cultivation.

2.7 Greenhouse Plant Density

The Yurok Tribe provided field plant counts for two sites with a total of 11 greenhouses. Aerial images from Google Earth (7-14-15) (Photos 9 and 10) show the greenhouses at the two sites. FES used this data and the GIS-calculated areas of the greenhouses to calculate an approximate density of 5.3 square feet of greenhouse area per plant.

2.8 Water Demand Estimate

The water demand estimate for marijuana plants during the growing season follow usage rates defined in Bauer et al., 2015 as 22.7 liters (5.996 gallons) per plant per day.

The growing season as defined by Bauer et al., 2015 was June through October (150 days). The growing season may not apply to greenhouses with heaters.

3.0 RESULTS

FES evaluated the entire study area of 315,198 acres and ran analysis of four primary sub-sets.

1) a total of 55,869 acres within the YIR;
2) those portions of 56 Yurok-delineated tributary watersheds (27,558 acres) within the YIR;
3) an additional 28,311 acres of Klamath River face slopes, not associated with a tributary but still within the YIR; and
4) each tributary's entire watersheds.

A summary of all plant and greenhouse data is included in Table 1. Data for specific tributary watersheds within the YIR is included in Table 2. Data for specific watersheds within and outside of the YIR (total watersheds) is included in Table 3. A comparison of field counts of plants compared to counts based on aerial imagery is included as Tables 4 and 5.

The data from Tables 1 through 3 was used to estimate the water demand from MCSs throughout the study area. The total area evaluated was approximately 315,195 acres.

The following table headings are defined below and used for the tables included within the text of this report:

Watersheds Within the YIR	Refers to the area of tributary watersheds delineated by YTEP that are within the YIR and provided to FES as a shapefile dated 12-8-15.
All Other Areas Within the YIR	Refers to the Klamath River face areas within the YIR that are outside of the YTEP-delineated tributary watersheds.
YIR Total	Yurok Indian Reservation Total refers to the 55,869 acres within the reservation boundary shapefile provided to FES by YTEP.
Entire Delineated Watersheds	Refers to the YTEP-delineated watersheds within and outside of the YIR boundaries.
Entire Study Area	Refers to the YTEP-delineated tributary watersheds within and outside of the YIR and All Other Areas within the YIR.

Summary of Plant and Greenhouse Data

	Watersheds Within the YIR	All Other Areas Within the YIR	YIR Total	Watersheds Outside the YIR	Entire Study Area
Number of outdoor plants	2,767	1,149	3,916	6,550	10,466
Number of greenhouses	23	27	50	96	146
Greenhouse area (square feet)	16,138	29,801	45,940	81,696	127,635
Number of greenhouse plants	3,045	5,623	8,668	15,414	24,082
Total number of plants	5,812	6,772	12,584	21,964	34,548
Water Demand Estimates (gallons)	34,848	40,604	75,453	131,698	207,150

Watersheds with the Largest Number of Plants and Highest Water Demand

	Watersheds Within the YIR	Entire Delineated Watersheds
Watershed with the Largest Number of Outdoor Plants	Mareep 1,489 Plants	Mawah 2,558 Plants
Watershed with the Largest Number of Greenhouse Plants	Miners 821 GH Plants	Miners 6,039 GH Plants
Watershed with the Largest Total Number of Plants	Mareep 1,707 Plants	Miners 7,945 Plants
Watersheds with the Highest Estimated Daily Water Demand (gallons/day)	Mareep 11,681 Gallons	Miners 47,639 Gallons

4.0 DISCUSSION

This study was undertaken to provide an estimation of the number of plants at the time of the July 14, 2015 aerial imagery. The imagery for the entire YIR and most of the tributary watersheds was collected on July 14, 2015 and the remaining portions of the tributary watersheds south of the YIR were collected on May 28, 2014. The results of this study are specific to the MCSs visible on these two dates.

This study relied on high-resolution aerial imagery for the identification of outdoor plants and greenhouses with limited field data. Some MCSs were inspected on the ground by the Yurok Tribe and the resulting information was compared with the data derived from the aerial imagery. Our counts of outdoor plants very likely underestimate the actual number as some are probably not readily detectable from the aerial imagery.

The recent trend in agricultural practices for marijuana cultivation appears to be a shift to larger grow sites with symmetrical planting and no attempt to camouflage the plants. These MCSs often involve recent (within the last 3 years) clearing of trees and grading as shown on Photos 11 through 18. If this trend continues it will be easier to distinguish outdoor plants.

The assumptions used in the identification and counting of outdoor and greenhouse plants are described in the following sections.

4.1 Plant Counting Assumptions

There is a range of confidence in the identification of outdoor marijuana plants from aerial imagery. Photo 1 shows approximately 2,356 counted outdoor plants. The plants are growing in recently clear-cut areas with logs, stumps, and other organic debris scattered within the planting areas. The plants at the top of the photo were planted in rows and are distinct. There are less obvious rows in other areas of the photo and some areas that do not appear to have been planted in distinct patterns. Some of these plants resemble regrowth of brush and trees after clear-cutting.

Photo 5 shows large squares approximately 9 feet by 9 feet and were probably created by excavating these areas and filling with growing media. The plantings shown on Photo 5 are very likely multiple plants. The Yurok Tribe provided Photos 19 and 20 which show clusters of plants growing in square planting areas which included 4 plants per cluster. We used this field information in our estimate of the number of plants for each interpreted multiple planting.

Most of the plants at the top of Photo 1 were interpreted to be multiple plantings based on the plant spacing of approximately 10 to 12 feet and larger leafy area compared to nearby plants counted as single. All apparent multiple plantings were counted as clusters of 4 plants based on photographs (Photos 19 and 20) obtained from the Yurok Tribe. The presumed multiple plantings at the top of Photo 1 are not planted in squares but appear larger than plants in other areas of this site. There is less confidence in counting each apparent multiple planting as consisting of 4 plants.

Photo 2 shows outdoor plants growing in the area just below the yellow outline that are very closely spaced compared to other plants shown on the photo. The yellow-outlined area probably contains plants that were not counted because they were less obvious.

The distinct plants shown on Photo 3 were counted as multiple plants based on the plant spacing. The plants in the recently graded area shown on Photo 4 are distinct and considered to be single plants based on the canopy size and spacing.

4.2 Greenhouse Plant Counting Assumptions

Most of the greenhouses digitized for this study were obvious. There was some uncertainty about the status of the greenhouses as most of them were relatively opaque due to the materials used to cover them. Eradication activities were occurring on the date of the 7-14-15 aerial imagery. The greenhouses shown on Photo 9 appeared to contain plants while the greenhouses shown on Photo 10 appeared to have been recently eradicated. The greenhouses on Photos 9 and 10 are within approximately 1,000 feet and on the same parcel.

The number of plants within the greenhouses shown on Photos 9 and Photos 10 were counted in the field by the Yurok Tribe. FES used the number of plants provided by the Yurok Tribe and the GIS-calculated areas within the greenhouses to estimate a plant density of approximately 5.3 square feet of greenhouse area per plant. The plant densities from these 11 greenhouses was used for all greenhouses digitized for this study. In comparison a greenhouse plant density of approximately 12 square feet of greenhouse per plant was used for the Bauer, et al., 2015 report for other areas in Northern California.

Photo 7 shows a greenhouse with most of the covering material removed. The number of plants in the central greenhouse was estimated to be 232 based on counts from the aerial imagery of visible plants and inferred plants. The plant density for the central greenhouse was estimated to be approximately 14.9 square feet per plant. This supports a significant variation in plant density within greenhouses between where individual plants were counted in the field and in aerial imagery. The 5.3 square feet of greenhouse area per plant density used for this study may overestimate the number of plants within greenhouses.

Furthermore, data obtained after the completion of this study from the North Coast Regional Water Quality Control Board (NCRWQCB) provided additional field data to YTEP from 9 greenhouses within the study area. They report a total of 1,262 plants being grown in the 9 greenhouses in a total area of approximately 19,018 square feet. This results in a density of approximately 15.1 square feet per greenhouse plant. This is very close to the 14.9 square feet per plant calculated for the greenhouse shown in Photo 7 and described in the paragraph above.

4.3 Geographic Distribution of Outdoor Plants and Greenhouses

The outdoor plants and greenhouses that were mapped for this study were not distributed evenly throughout the study area. Figures 6 through 12 show the distribution of MCSs within the area evaluated for this study. These figures show that the MCSs are present in greater numbers in the vicinity of the upriver portion of the YIR and on the eastern side of the Klamath River.

The rectangle shown as a dashed line on Figure 6 contains approximately 14 percent of the entire study area, yet the rectangle contains approximately 79 percent of the total plants mapped for this study.

4.4 Comparison of Field Data and Data from Aerial Imagery Interpretation

The comparison of field data provided by the Yurok Tribe and the data derived from aerial imagery interpretation by FES is included in Table 4. The Yurok Tribe provided preliminary data including total plant counts and number of greenhouses based on enforcement activities at individual parcels. The preliminary data did not list outdoor plants and greenhouse plants separately. FES compared data for 14 of the parcels.

There were two parcels where there were field counts of plants but no plants were interpreted by FES. On one of the parcels there was a greenhouse present that was visible on the aerial imagery but was not digitized by FES. On the other parcel there was an area that probably contained outdoor plants but it did not appear distinct on the aerial imagery.

The total number of outdoor plants and greenhouse plants (based on the estimate of plant density within greenhouses) interpreted by FES for the 14 parcels was 13,903 compared to the field count of 13,645. The FES outdoor plant and greenhouse totals probably represent an overestimate of total plants as there were two parcels where there were no plants counted by FES. This results in a probable overestimate by FES of approximately 2 percent.

Table 5 lists only the parcels where plants were counted by FES and the Yurok Tribe. The total number of plants from the preliminary data provided by the Yurok Tribe was 15,256 for the 12 parcels. This results in a probable overestimate by FES of approximately 11 percent.

One of the likely reasons for the probable FES overestimate is the greenhouse plants density estimate which was based on 11 greenhouses that may have contained higher densities of plants than others within the study area. The designation of outdoor plants as multiple (4 plants) may not have been justified in some instances where it was not obvious. This gives a range in the overestimation of plants between 2-11% and considered acceptable for the purposes of this study.

5.0 CONCLUSIONS

This study was conducted to provide the Yurok Tribe with data that can be used to estimate the local water demand from the MCSs on the Lower Klamath River's tributaries and the river as the receiving body. In addition to the quantity of MCSs and plants, the geographic distribution of outdoor plants and greenhouses also provides information for determining the locations where the greatest water demand from MCSs is occurring. The geographic distribution of MCSs is concentrated in specific areas as shown on Figures 6 through 12.

The estimates of plant numbers and the resulting water demand volumes were based on significant assumptions used for this study as described in the previous three sections of this document.

Recently acquired data from the NCRWQCB on greenhouse plant density based on 9 greenhouses within the study area (15.1 square feet per plant) may be closer to the average density than the 5.3 square feet per plant used for this report.

Approximately 315,195 acres within the YIR and the within the YTEP-delineated watersheds were evaluated for the presence of outdoor marijuana plants and marijuana-related greenhouses using recent (2014 and 2015) high resolution aerial imagery from Google Earth. Approximately 10,466 outdoor plants including individual plants and multiple plant clusters were digitized using GIS. A total of 146 greenhouses were digitized with a total greenhouse area of approximately 127,635 square feet. Using field data from 10 greenhouses a plant density of approximately 5.3 square feet of greenhouses per plant was used to calculate a total number of 24,082 greenhouse plants within the study area.

A total of 34,548 outdoor and greenhouse plants was estimated to be present within the study area. We compared our data obtained from aerial imagery interpretation with field data provided by the Yurok Tribe for 14 parcels within the study area. The field data showed that a total of 13,645 total plants were present on the 14 parcels. Using the assumptions described in Section 4 we estimated a total 13,903 plants were present on the 14 parcels resulting in an approximate 2 percent overestimate of plants. There were two parcels where field data showed a total of 1,119 that we did not count. Excluding these two parcels would result in an overestimate of approximately 11 percent based on our aerial imagery interpretation.

Based on the limited amount of field data available for this study we were able to provide a reasonable estimate of the number of marijuana plants being cultivated at the time of the aerial imagery. The estimated number of plants was multiplied by an estimated consumption of approximately 6 gallons per day during the growing season to calculate water demand from marijuana cultivation. The daily water demand within the YIR was estimated to be approximately 75,453 gallons per day. The daily water demand within the entire study area was estimated to be approximately 207,150 gallons per day.

6.0 REFERENCES

Bauer S, Olson J, Cockrill A, van Hattem M, Miller L, Tauzer M, et al., 2015, *Impacts of Surface Water Diversions for Marijuana Cultivation on Aquatic Habitat in Four Northwestern California Watersheds.* PLOS ONE 10(3): e0120016. doi:10.1371/journal.

Yurok Tribe, 2015, Yurok Tribe Comments on the Regulation of Commercial Cultivation of Cannabis for Medical Use in Humboldt County, November 5, 2015.

TABLE 1
SUMMARY

Area [1]	Area (acres)	Outdoor Plants (2015 & 2014 Aerials)	Number of Greenhouses	Greenhouse Area (ft^2)	Number of Greenhouse Plants [2]	Total Plants [2]	Daily Water Demand [3]
Total Delineated Watersheds (within and outside YIR)	286,884	9,317	119	97,834	18,459	27,776	166,546
Watersheds Within the YIR	27,558	2,767	23	16,138	3,045	5,812	34,848
All Other Areas Within the YIR	28,311	1,149	27	29,801	5,623	6,772	40,604
YIR Totals	55,869	3,916	50	45,940	8,668	12,584	75,453
Watersheds Outside the YIR	259,326	6,550	96	81,696	15,414	21,964	131,698
Entire Study Area (total of YIR and entire watersheds outside of the YIR)	**315,195**	**10,466**	**146**	**127,635**	**24,082**	**34,548**	**207,150**

Notes

[1] Watersheds delineated by YTEP and provided to FES as shapefile dated 12-8-15.

[2] Project calculated greenhouse plant density 5.3 ft^2 per plant.

[3] 5.996 gallons per day (Bauer S, Olson J, Cockrill A, van Hattem M, Miller L, Tauzer M, et al., 2015)

TABLE 2
WATERSHEDS WITHIN THE YUROK RESERVATION

Watershed [1] (within YIR)	Area (acres)	Outdoor Plants (2015 & 2014 Aerials)	Number of Greenhouses	Greenhouse Area (ft^2)	Number of Greenhouse Plants [2]	Total Plants [2]	Daily Water Demand [3]
Achelth	237	0	0				
Ah Pah	1,656	0	0				
Bear	1,427	0	0				
Bens	200	34	0			34	204
Blue	1,580	0	0				
Burrill	185	0	2	2,455	463	463	2,777
China	216	0	0				
Chqui	234	0	0				
Clirliah	167	0	0				
Coon	263	58	0			58	348
Devil	163	0	0				
Gist	213	8	0			8	48
Ha Amar	243	0	0				
Halagow	379	0	0				
Hoppaw	1,220	0	0				
Hunter-Mynot-Spruce Creeks	1,067	0	0				
Johnsons	514	299	1	178	34	333	1,994
Ke'nek	440	37	1	66	12	49	297
Kep'el	459	0	0				
Knulthkarm	260	0	0				
Lewis Gulch	217	0	1	186	35	35	210
Mareep	416	1,489	2	1,156	218	1,707	10,236
Mawah	199	128	0			128	767
McGarvey	751	0	0				
Mettah	675	12	5	3,046	575	587	3,518
Miners	367	389	3	4,350	821	1,210	7,254
Morek	685	0	0				
Muddy	44	0	0				
Notchko	120	0	0				
Omogar	774	0	0				
Owl	544	0	0				
Pecwan	713	148	0			148	887
Pine	1,102	0	0				
Richardson	524	0	0				
Roach	644	0	0				
Rock Chute	179	0	4	1,724	325	325	1,951

TABLE 2
WATERSHEDS WITHIN THE YUROK RESERVATION

Watershed [1] (within YIR)	Area (acres)	Outdoor Plants (2015 & 2014 Aerials)	Number of Greenhouses	Greenhouse Area (ft^2)	Number of Greenhouse Plants [2]	Total Plants [2]	Daily Water Demand [3]
Rube	130	0	0				
Rube Ranch	185	0	0				
Saints Rest	152	0	0				
Salt-High Prairie	523	0	0				
Saugep	526	0	0				
Scaath	371	0	0				
Sippin	256	0	0				
Surpur	537	0	0				
Tarup	1,061	0	0				
Tectah	771	0	0				
Tully	304	0	0				
Turwar	1,086	0	0				
Unnamed at PM 30.5	194	17	0		0	17	102
Unnamed Downriver of Devil	315	0	1	383	72	72	434
Unnamed Downriver of Rock Chute	59	0	0				
Unnamed Downriver of Tectah	387	0	0				
Waukell, Lower	798	0	0				
Waukell, Upper	505	0	0				
Weitchpec	188	148	3	2,593	489	637	3,821
Worthla	135	0	0				
TOTALS (Watersheds Within the YIR)	**27,558**	**2,767**	**23**	**16,138**	**3,045**	**5,812**	**34,848**
TOTALS (All Other Areas Within the YIR)	28,311	1,149	27	29,801	5,623	6,772	40,604
TOTALS (within the YIR)	**55,869**	**3,916**	**50**	**45,940**	**8,668**	**12,584**	**75,453**

Notes

[1] Watersheds delineated by YTEP and provided to FES as shapefile dated 12-8-15.

[2] Project calculated greenhouse plant density 5.3 ft^2 per plant.

[3] 5.996 gallons per day (Bauer S, Olson J, Cockrill A, van Hattem M, Miller L, Tauzer M, et al., 2015)

TABLE 3
TOTAL WATERSHEDS

Watershed [1]	Area (acres)	Outdoor Plants (2015 & 2014 Aerials)	Number of Greenhouses	Greenhouse Area (ft^2)	Number of Greenhouse Plants [2]	Total Plants [2]	Daily Water Demand [3]
Achelth	507	0	0				
Ah Pah	10,303	0	0				
Bear	5,904	0	0				
Bens	856	34	0			34	204
Blue	80,167	0	0				
Burrill	664	143	4	3,840	724	867	5,201
China	298	0	0				
Chqui	274	64	0			64	384
Clirliah	500	0	0				
Coon	423	200	4	4,058	766	966	5,790
Devil	389	0	0				
Gist	786	329	0			329	1,973
Ha Amar	282	0	0				
Halagow	719	0	0				
Hoppaw	2,800	0	0				
Hunter-Mynot-Spruce Creeks	14,964	0	3	1,919	362	362	2,171
Johnsons	1,808	299	1	178	34	333	1,994
Ke'nek	856	37	1	66	12	49	297
Kep'el	5,392	0	0				
Knulthkarm	289	0	0				
Lewis Gulch	364	138	2	529	100	238	1,426
Mareep	1,728	1,536	8	2,184	412	1,948	11,681
Mawah	1,664	2,558	3	495	93	2,651	15,897
McGarvey	5,689	0	0				
Mettah	6,670	12	5	3,046	575	587	3,518
Miners	3,002	1,906	34	32,008	6,039	7,945	47,639
Morek	2,617	0	0				
Muddy	45	0	0				
Notchko	317	0	0				
Omogar	1,381	0	0				
Owl	892	0	0				
Pecwan	17,651	148	0			148	887
Pine	31,633	888	14	22,993	4,338	5,226	31,337

TABLE 3
TOTAL WATERSHEDS

Watershed [1]	Area (acres)	Outdoor Plants (2015 & 2014 Aerials)	Number of Greenhouses	Greenhouse Area (ft^2)	Number of Greenhouse Plants [2]	Total Plants [2]	Daily Water Demand [3]
Richardson	1,060	0	0				
Roach	18,668	97	5	10,839	2,045	2,142	12,844
Rock Chute	979	0	4	1,724	325	325	1,951
Rube	725	208	25	9,785	1,846	2,054	12,318
Rube Ranch	343	264	1	98	19	283	1,694
Saints Rest	325	291	0			291	1,745
Salt-High Prairie	3,776	0	0				
Saugep	752	0	0				
Scaath	395	0	0				
Sippin	256	0	0				
Surpur	3,726	0	0				
Tarup	3,469	0	0				
Tectah	12,600	0	0				
Tully	11,201	0	0				
Turwar	20,350	0	0				
Unnamed at PM 30.5	220	17	0			17	102
Unnamed Downriver of Devil	531	0	1	383	72	72	434
Unnamed Downriver of Rock Chute	59	0	0				
Unnamed Downriver of Tectah	1,687	0	1	1,096	207	207	1,240
Waukell, Lower	2,398	0	0				
Waukell, Upper	1,196	0	0				
Weitchpec	197	148	3	2,593	489	637	3,821
Worthla	135	0	0				
Total Watersheds	**286,884**	**9,317**	**119**	**97,834**	**18,459**	**27,776**	**166,546**
TOTALS (within the YIR and outside delineated watersheds)	28,311	1,149	27	29,801	5,623	6,772	40,604
TOTALS	**315,195**	**10,466**	**146**	**127,635**	**24,082**	**34,548**	**207,150**

Notes

[1] Watersheds delineated by YTEP and provided to FES as shapefile dated 12-8-15.

[2] Project calculated greenhouse plant density 5.3 ft^2 per plant.

[3] 5.996 gallons per day (Bauer S, Olson J, Cockrill A, van Hattem M, Miller L, Tauzer M, et al., 2015)

TABLE 4
PLANT COUNT COMPARISON FOR 14 PARCELS

APN	# MJ Plants (based on field counts) [1]	FES Outdoor Plants (based on aerial imagery)	# Green-houses (based on field counts) [1]	FES Greenhouses (based on aerial imagery)	FES Greenhouse Area (square feet)	FES Greenhouse Plants using Field-Verified 5.3 square feet per plant)	FES Total Plants (Field verified GH plant count)	# MJ Plants (based on field counts) [1]	FES Plant Count plus GHs (5.3)/Field Plant Count (percent)
530-141-002	5,110	612	20	20	20,307	3,832	4,444	5,110	87%
534-191-003	1,930	2,356	0	0	0	0	2,356	1,930	122%
531-082-003	1,322	0	2	3	10,564	1,993	1,993	1,322	151%
530-082-008	735	0	2	0	0	0	0	735	0%
530-082-020	670	148	3	3	2,593	489	637	670	95%
531-073-003/005	667	93	7	18	4,526	854	947	667	142%
531-102-007	638	0	5	5	8,091	1,527	1,527	638	239%
534-152-014	523	356	0	2	1,156	218	574	523	110%
531-011-009/010	521	380	0	0	0	0	380	521	73%
531-074-004-000	105	11	0	1	1,107	209	220	105	209%
531-074-007	304	264	0	1	98	18	282	304	93%
531-083-003	327	0	0	4	1,724	325	325	327	99%
531-085-012	409	218	0	0	0	0	218	409	53%
532-143-009	384	0	0	0	0	0	0	384	0%
Totals	**1,529**	**4,438**	**39**	**57**	**50,166**	**9,465**	**13,903**	**13,645**	**102%**

Notes

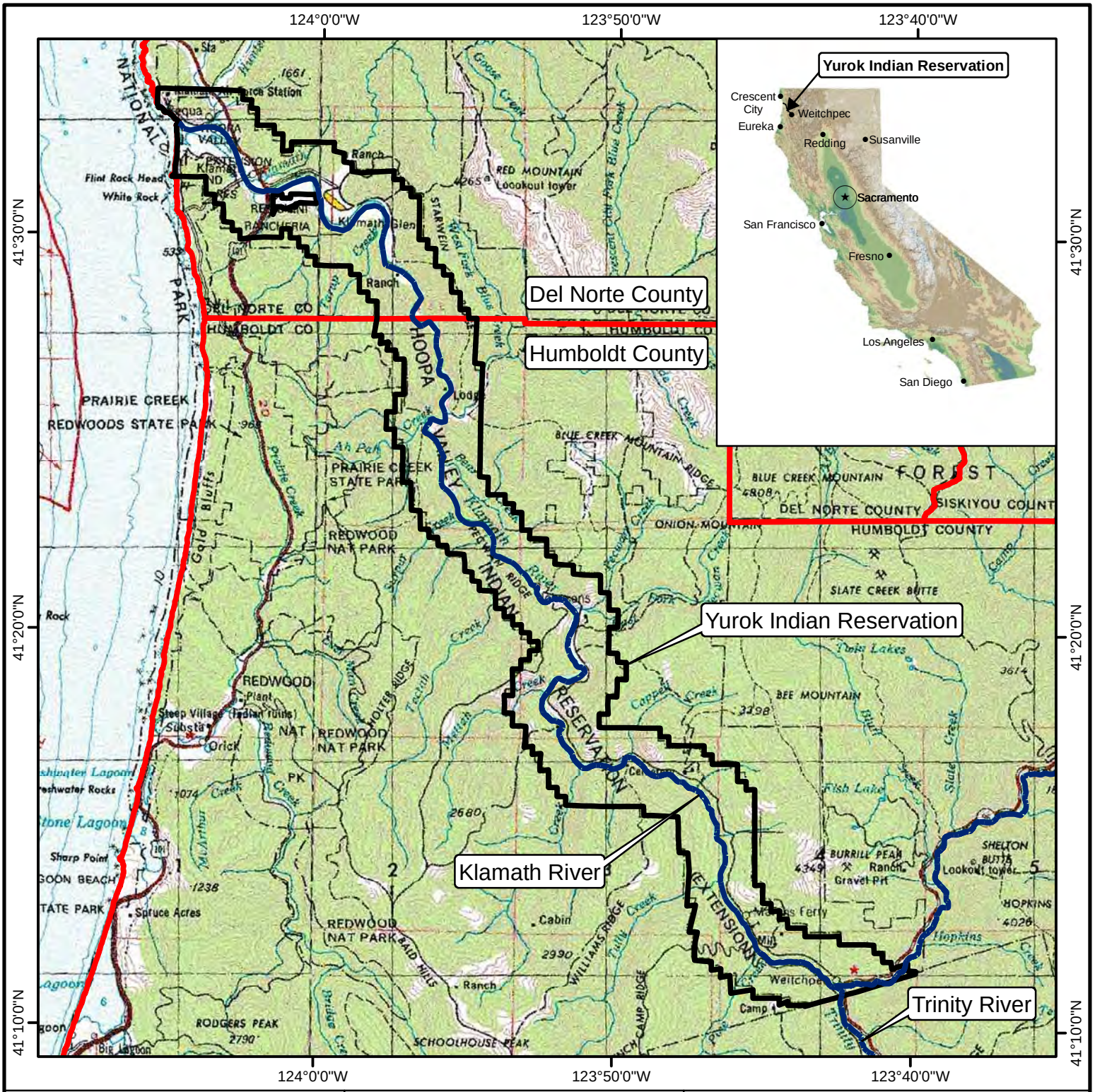
[1] Counts were conducted in the field and provided to FES by the Yurok Tribe.

TABLE 5
PLANT COUNT COMPARISON FOR 12 PARCELS

APN	# MJ Plants (based on field counts) [1]	FES Outdoor Plants (based on aerial imagery)	# Green-houses (based on field counts) [1]	FES Greenhouses (based on aerial imagery)	FES Greenhouse Area (square feet)	FES Greenhouse Plants using Field-Verified 5.3 square feet per plant)	FES Total Plants (Field verified GH plant count)	# MJ Plants (based on field counts) [1]	FES Plant Count plus GHs (5.3)/Field Plant Count (percent)
530-141-002	5,110	612	20	20	20,307	3,832	4,444	5,110	87%
534-191-003	1,930	2,356	0	0	0	0	2,356	1,930	122%
531-082-003	1,322	0	2	3	10,564	1,993	1,993	1,322	151%
530-082-020	670	148	3	3	2,593	489	637	670	95%
531-073-003/005	667	93	7	18	4,526	854	947	667	142%
531-102-007	638	0	5	5	8,091	1,527	1,527	638	239%
534-152-014	523	356	0	2	1,156	218	574	523	110%
531-011-009/010	521	380	0	0	0	0	380	521	73%
531-074-004-000	105	11	0	1	1,107	209	220	105	209%
531-074-007	304	264	0	1	98	18	282	304	93%
531-083-003	327	0	0	4	1,724	325	325	327	99%
531-085-012	409	218	0	0	0	0	218	409	53%
Totals	**1,145**	**4,438**	**37**	**57**	**50,166**	**9,465**	**13,903**	**12,526**	**111%**

Notes

[1] Counts were conducted in the field and provided to FES by the Yurok Tribe.



LEGEND

- Yurok Indian Reservation
- County Boundary

Base Image Data Source:
1:250,000 topographic map images.

ALL LOCATIONS APPROXIMATE

Yurok Tribe Environmental Program

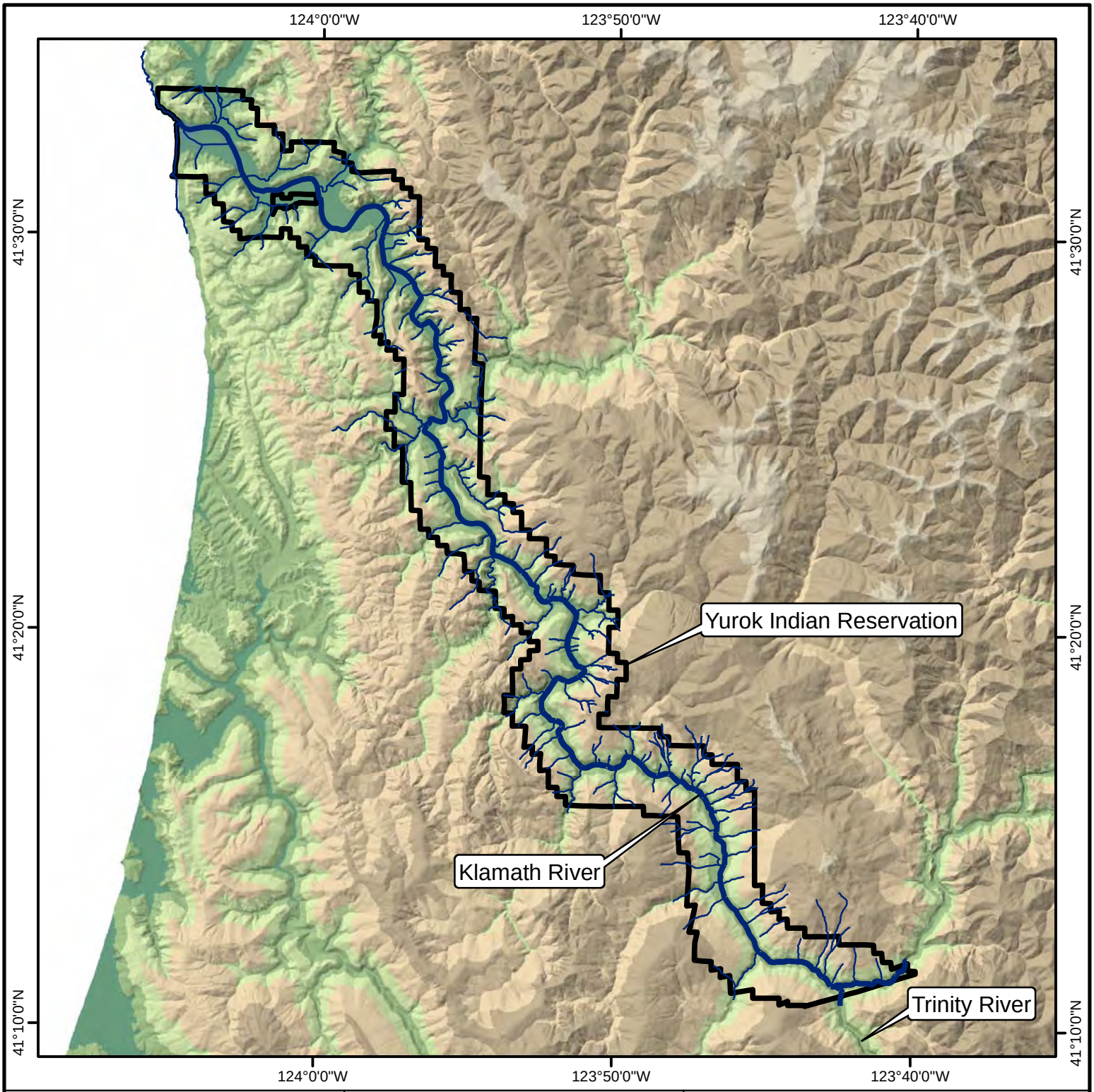
Figure 1

Yurok Indian Reservation Humboldt and Del Norte Counties, California

Freshwater Environmental Services

Date: 1-4-16

By: SJT



N
W E
S

Miles
0 1 2 4 6 8

LEGEND

Yurok Indian Reservation

USGS "Blue-Line Stream"

Base Image Data Source:
USGS 30-Meter Digital
Elevation Model

ALL LOCATIONS APPROXIMATE

Yurok Tribe
Environmental Program

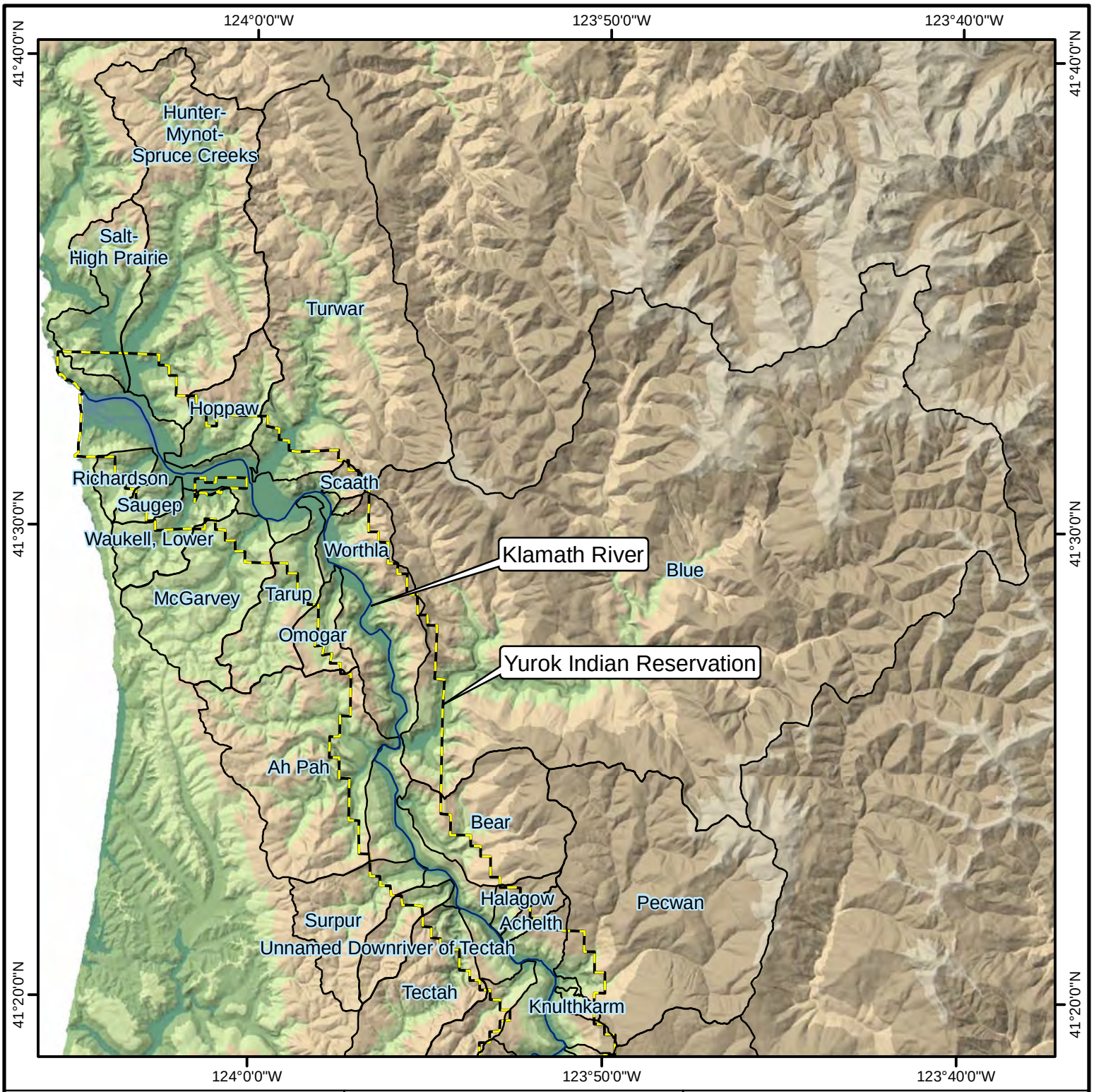
Figure 2

Stream Channels shown as
"Blue-Line Streams"
on USGS Topographic Maps

Freshwater Environmental Services

Date: 1-4-16

By: SJT



N
W E
S

Miles

0 1 2 4 6

LEGEND

Yurok Indian Reservation
Watersheds

Base Image Data Source:
USGS 30-Meter Digital
Elevation Model

ALL LOCATIONS APPROXIMATE

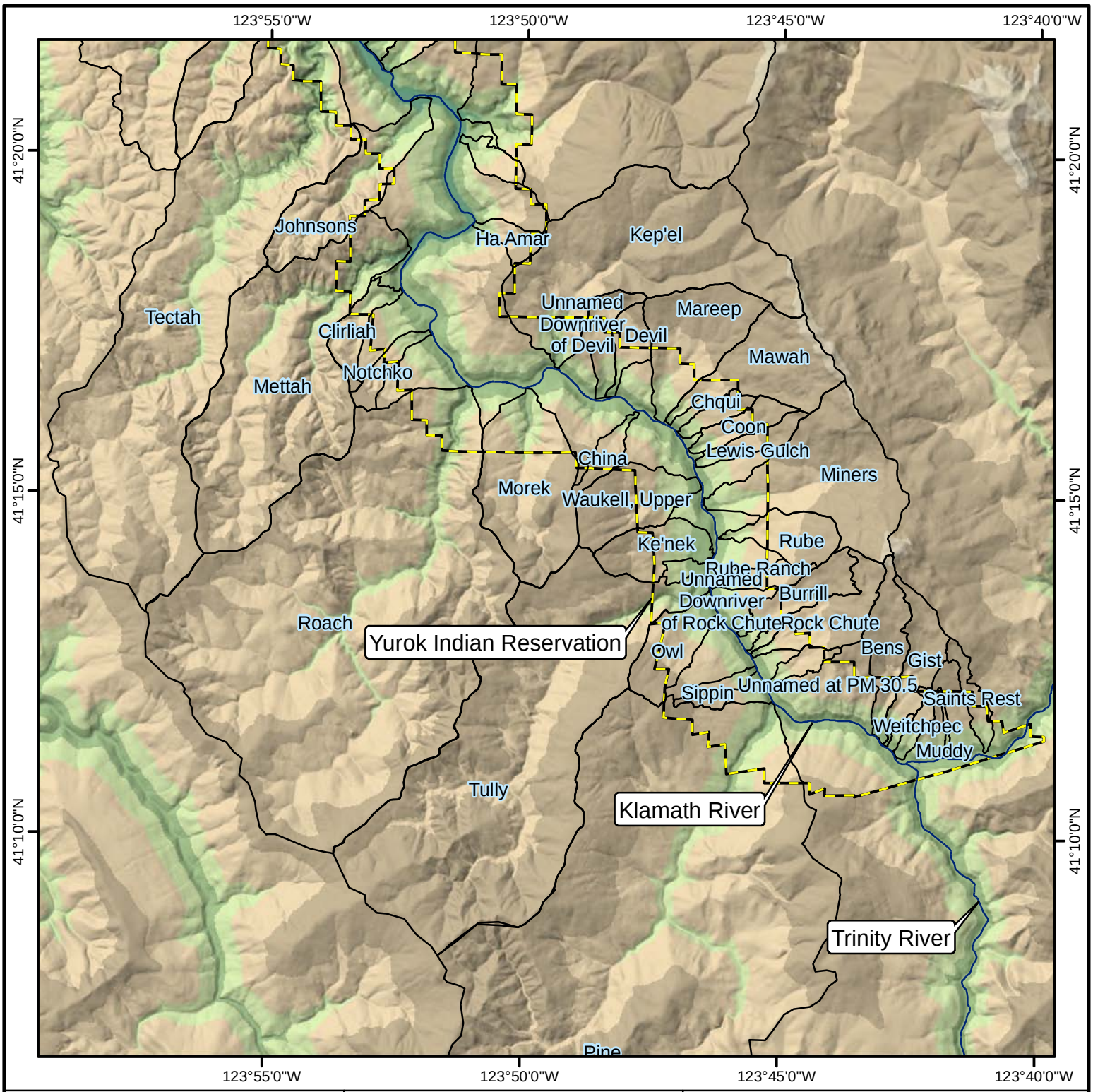
Yurok Tribe
Environmental Program

Figure 3
Downriver Watersheds

Freshwater Environmental Services

Date: 1-4-16

By: SJT



N
W E
S

Miles
0 1 2 4

LEGEND

Yurok Indian Reservation
Watersheds

Base Image Data Source:
USGS 30-Meter Digital
Elevation Model

ALL LOCATIONS APPROXIMATE

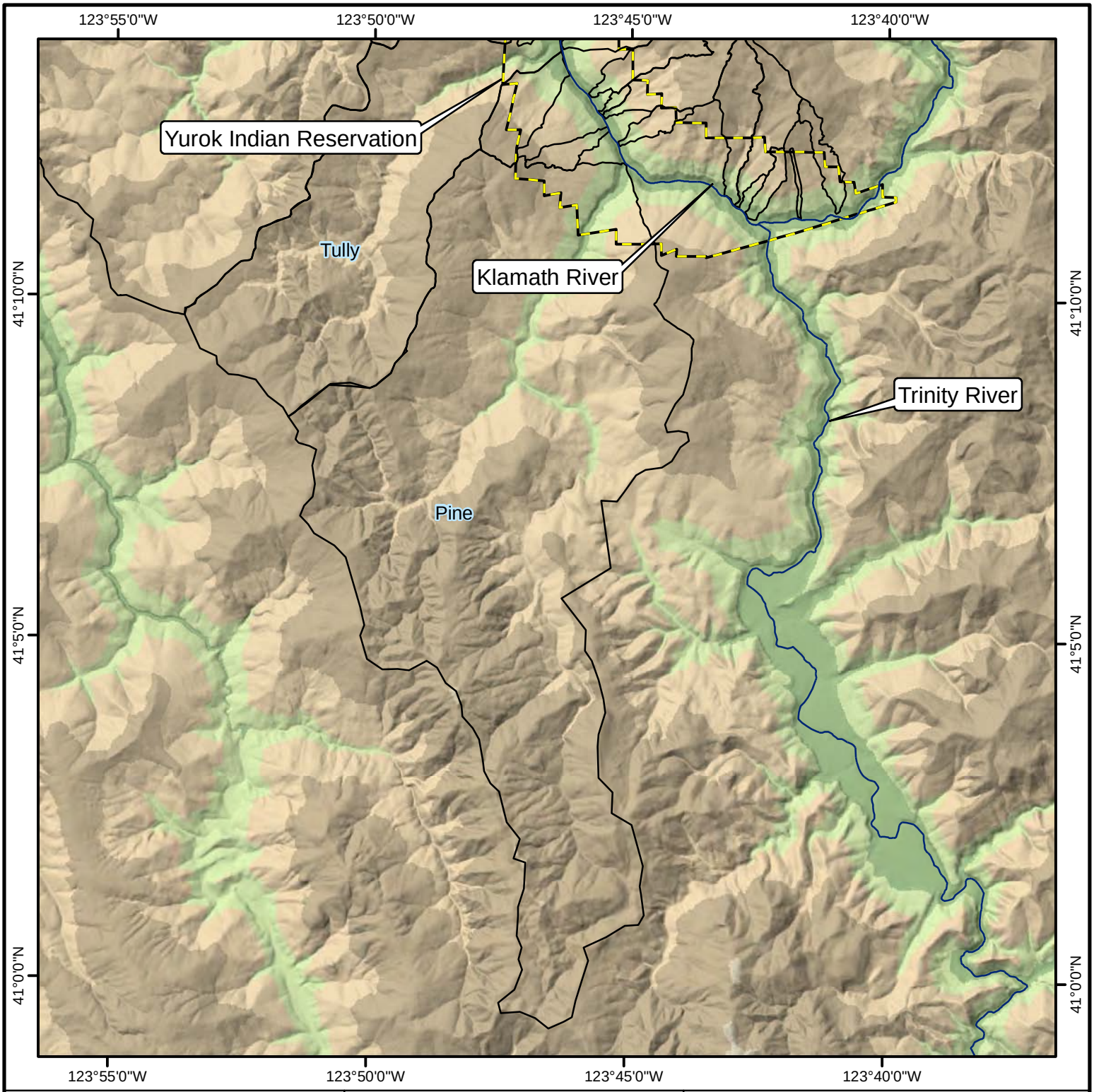
Yurok Tribe
Environmental Program

Figure 4
Upriver Watersheds

Freshwater Environmental Services

Date: 1-4-16

By: SJT



N
W E
S

Miles
0 1 2 4

LEGEND

Yurok Indian Reservation
Watersheds

Base Image Data Source:
USGS 30-Meter Digital Elevation Model

ALL LOCATIONS APPROXIMATE

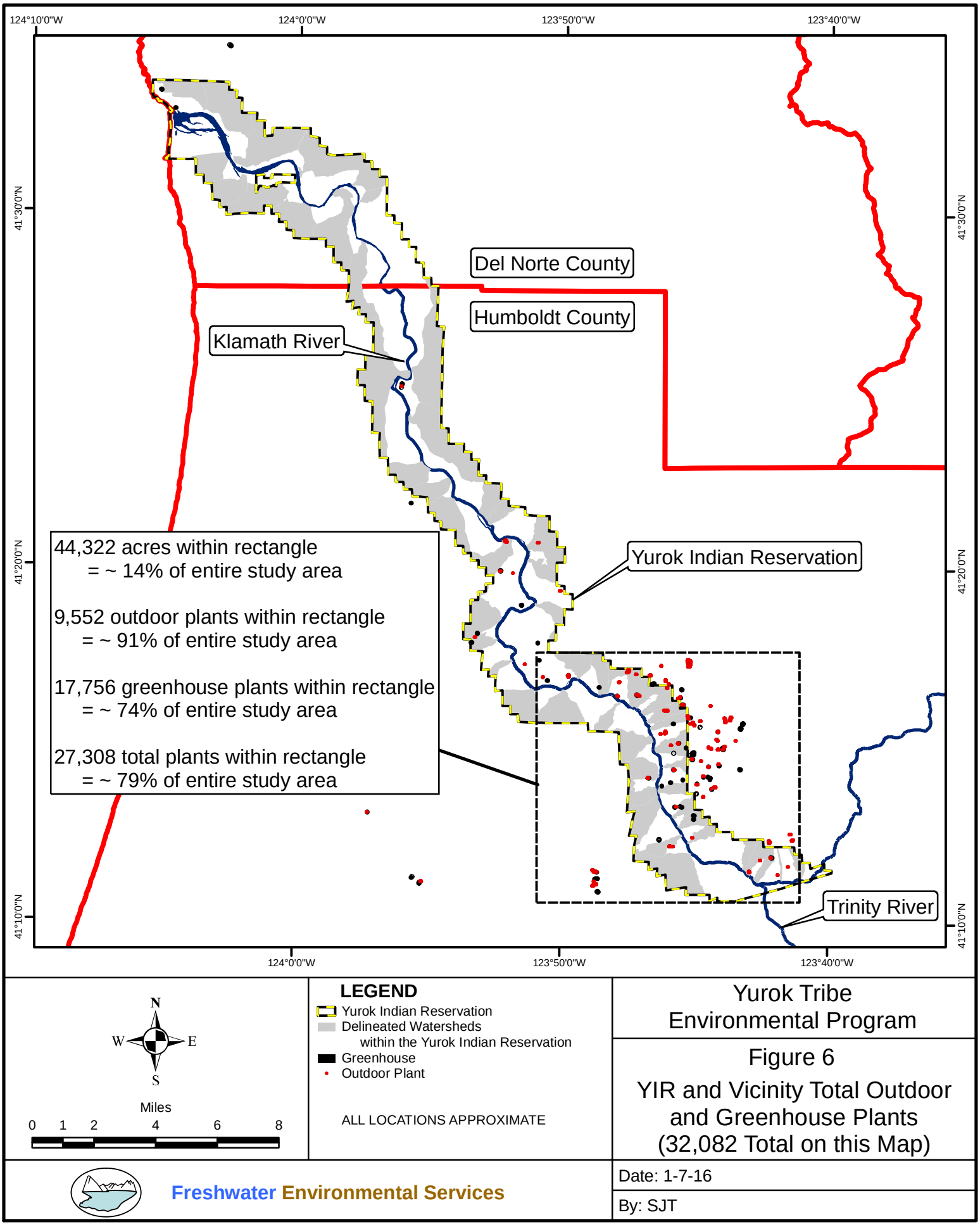
Yurok Tribe
Environmental Program

Figure 5
Pine Creek Watershed

Freshwater Environmental Services

Date: 1-4-16

By: SJT



N
W E
S

Miles
0 1 2 4 6 8

LEGEND

- Yurok Indian Reservation
- Delineated Watersheds within the Yurok Indian Reservation
- Greenhouse
- Outdoor Plant

ALL LOCATIONS APPROXIMATE

Yurok Tribe
Environmental Program

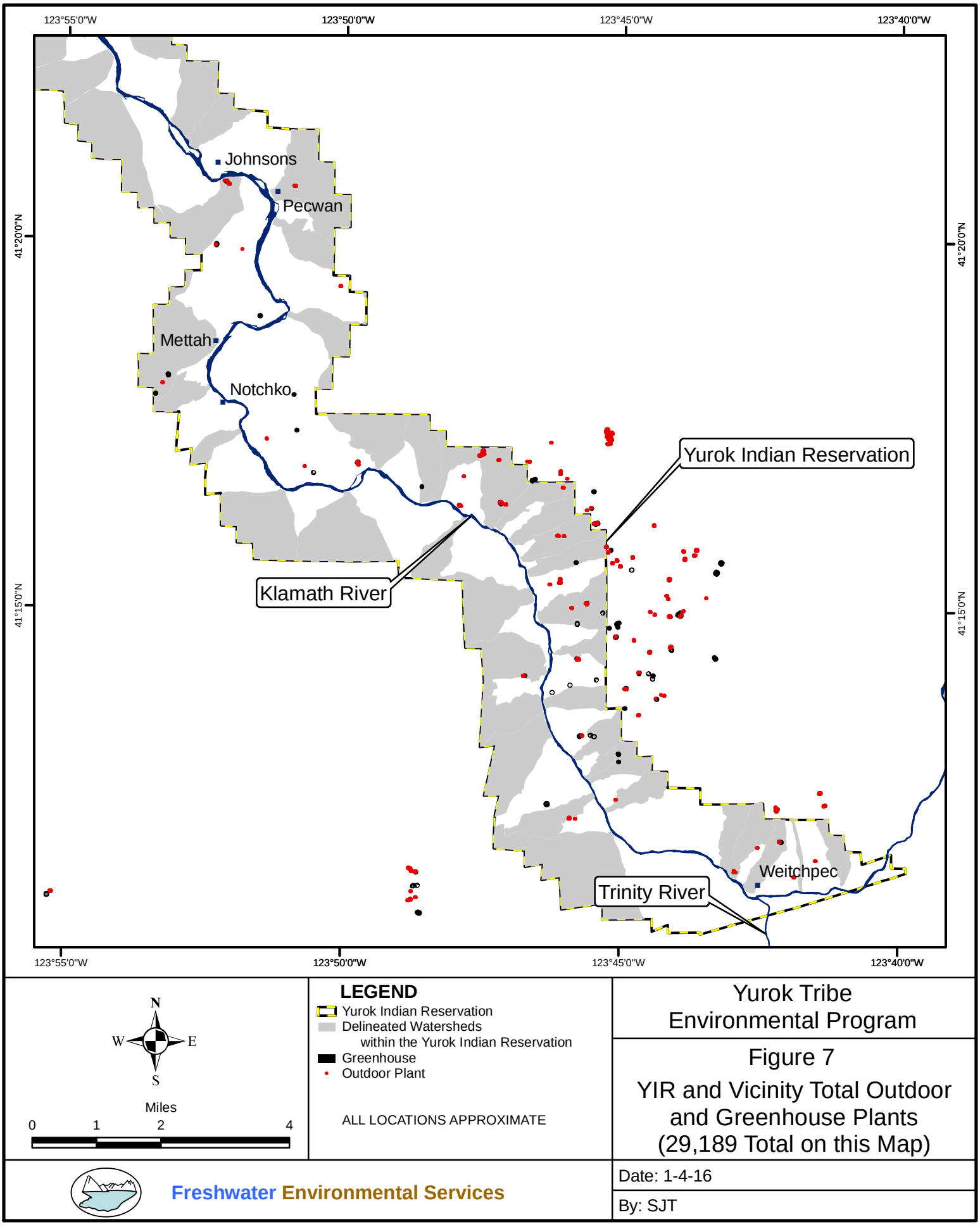
Figure 6

YIR and Vicinity Total Outdoor and Greenhouse Plants (32,082 Total on this Map)

Freshwater Environmental Services

Date: 1-7-16

By: SJT



N
W E
S

Miles
0 1 2 4

LEGEND

- Yurok Indian Reservation
- Delineated Watersheds within the Yurok Indian Reservation
- Greenhouse
- Outdoor Plant

ALL LOCATIONS APPROXIMATE

Yurok Tribe
Environmental Program

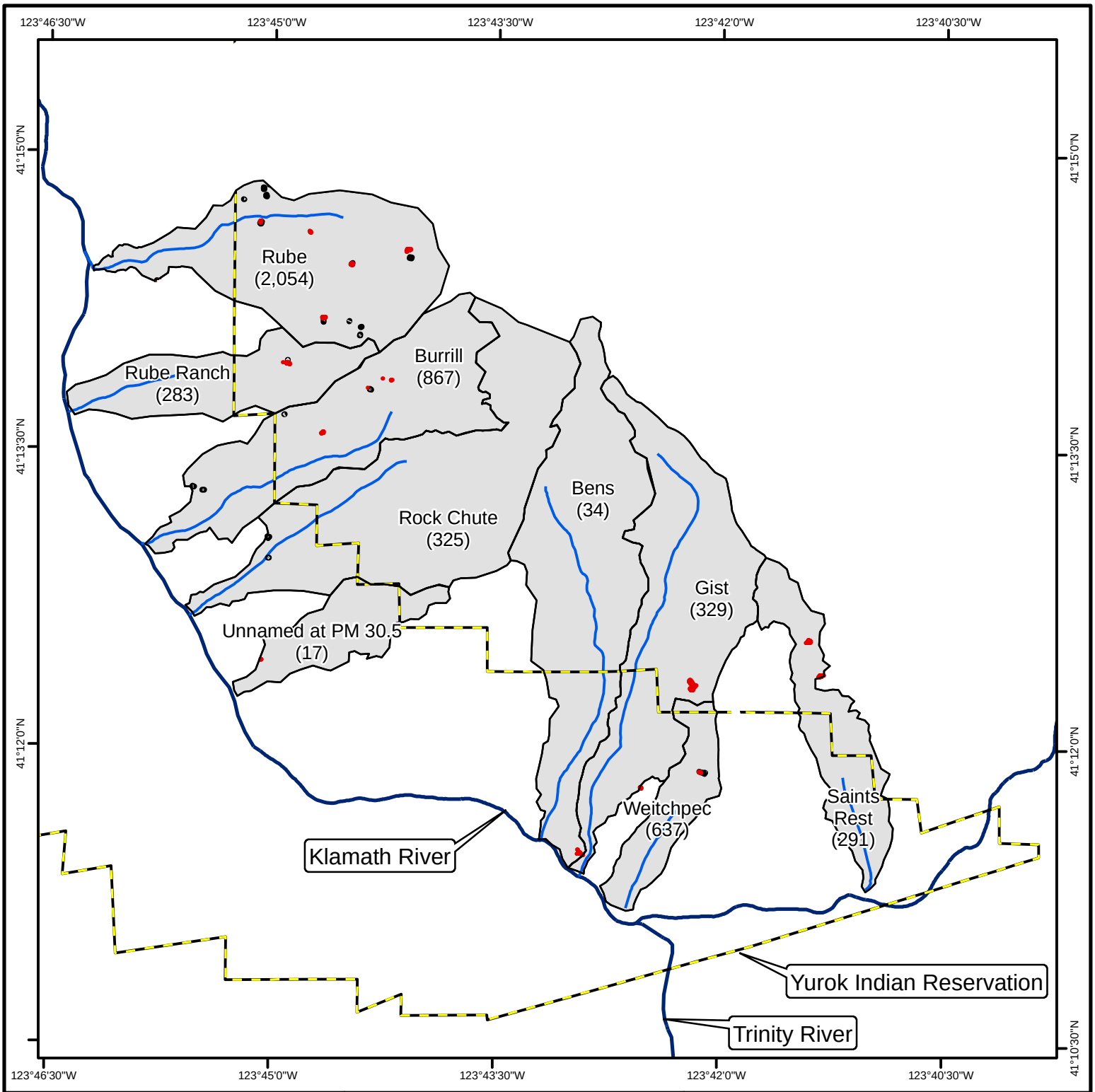
Figure 7

YIR and Vicinity Total Outdoor and Greenhouse Plants
(29,189 Total on this Map)

Freshwater Environmental Services

Date: 1-4-16

By: SJT



N
W E
S

Miles
0 0.25 0.5 1 1.5

LEGEND

- Yurok Indian Reservation
- Watershed Boundary
- Yurok Tribe Ancestral Stream
- Outdoor Plant
- Greenhouse

ALL LOCATIONS APPROXIMATE

Yurok Tribe
Environmental Program

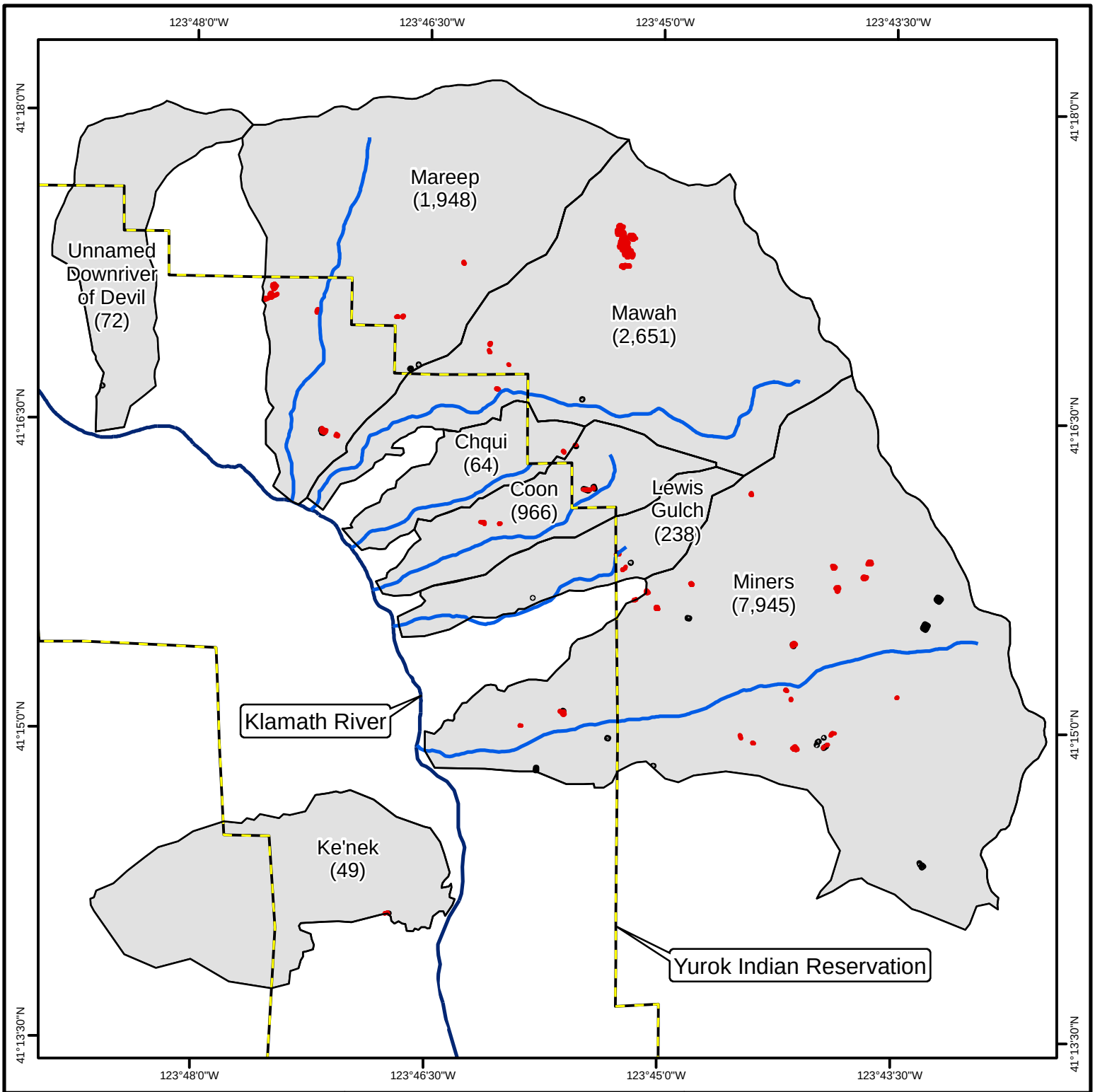
Figure 8

Watersheds with Total Outdoor and Greenhouse Plants
(4,837 Total on this Map)

Freshwater Environmental Services

Date: 1-4-16

By: SJT



N
W E
S

Miles

0 0.25 0.5 1 1.5

LEGEND

- Yurok Indian Reservation
- Watershed Boundary
- Yurok Tribe Ancestral Stream
- Outdoor Plant
- Greenhouse

ALL LOCATIONS APPROXIMATE

Yurok Tribe
Environmental Program

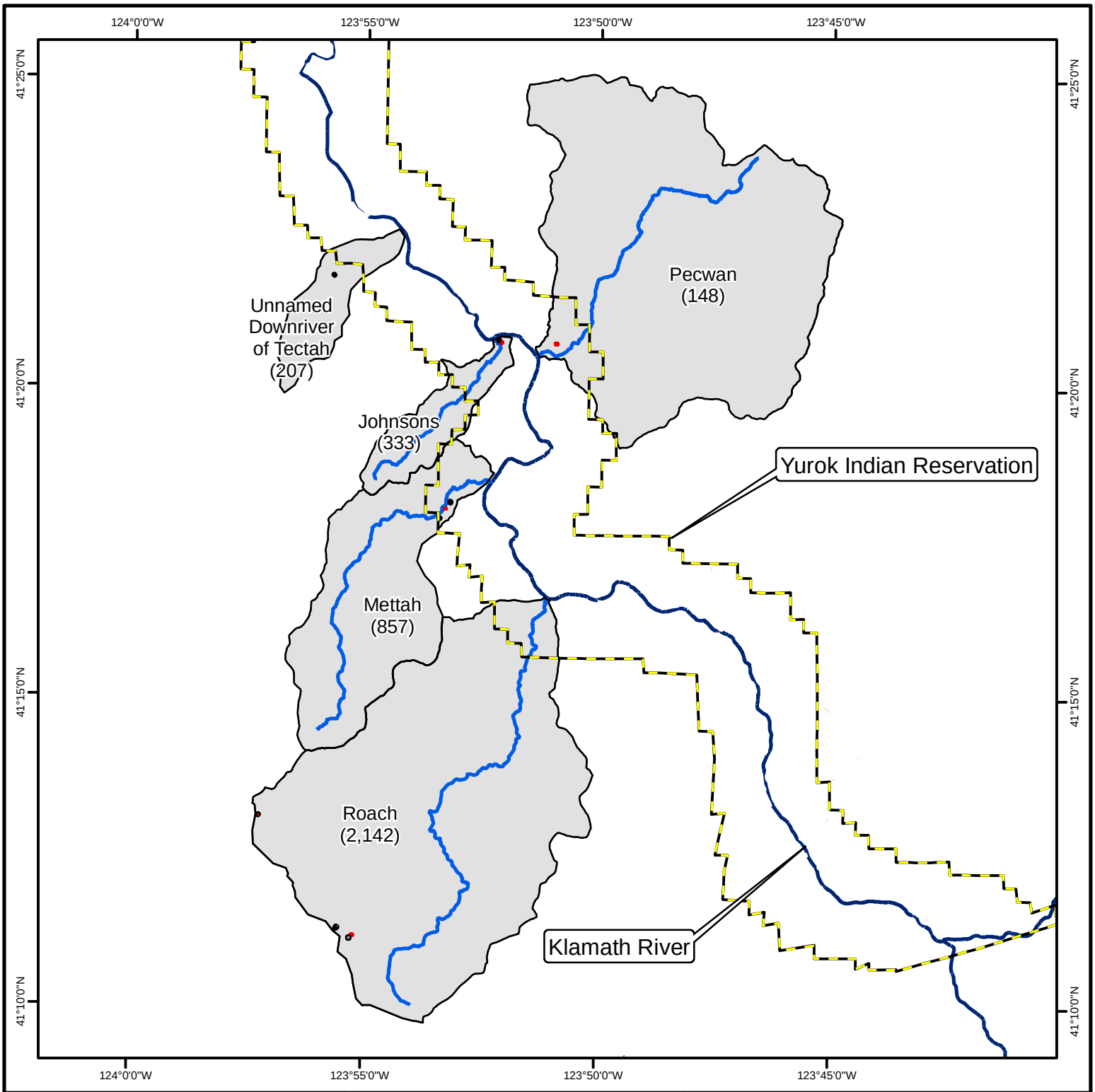
Figure 9

Watersheds with Total Outdoor and Greenhouse Plants
(10,037 Total on this Map)

Freshwater Environmental Services

Date: 1-4-16

By: SJT



N
W E
S

Miles
0 1 2 4

LEGEND

- Yurok Indian Reservation
- Watershed Boundary
- Yurok Tribe Ancestral Stream
- Outdoor Plant
- Greenhouse

ALL LOCATIONS APPROXIMATE

Yurok Tribe
Environmental Program

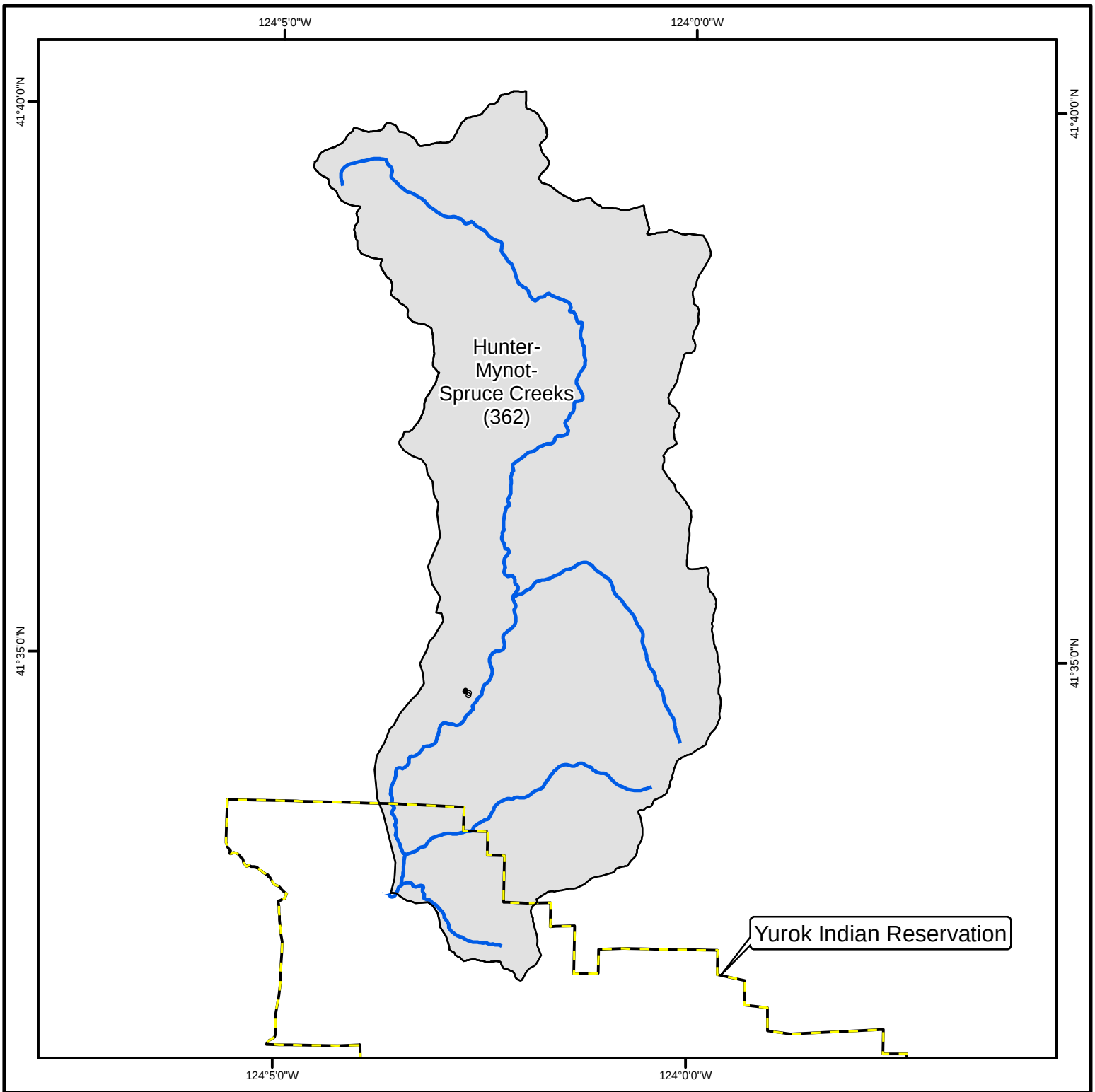
Figure 10

Watersheds with Total Outdoor and Greenhouse Plants
(3,687 Total on this Map)

Freshwater Environmental Services

Date: 1-4-16

By: SJT



N
W E
S

Miles
0 1 2

LEGEND

- Yurok Indian Reservation
- Watershed Boundary
- Yurok Tribe Ancestral Stream
- Outdoor Plant
- Greenhouse

ALL LOCATIONS APPROXIMATE

Yurok Tribe
Environmental Program

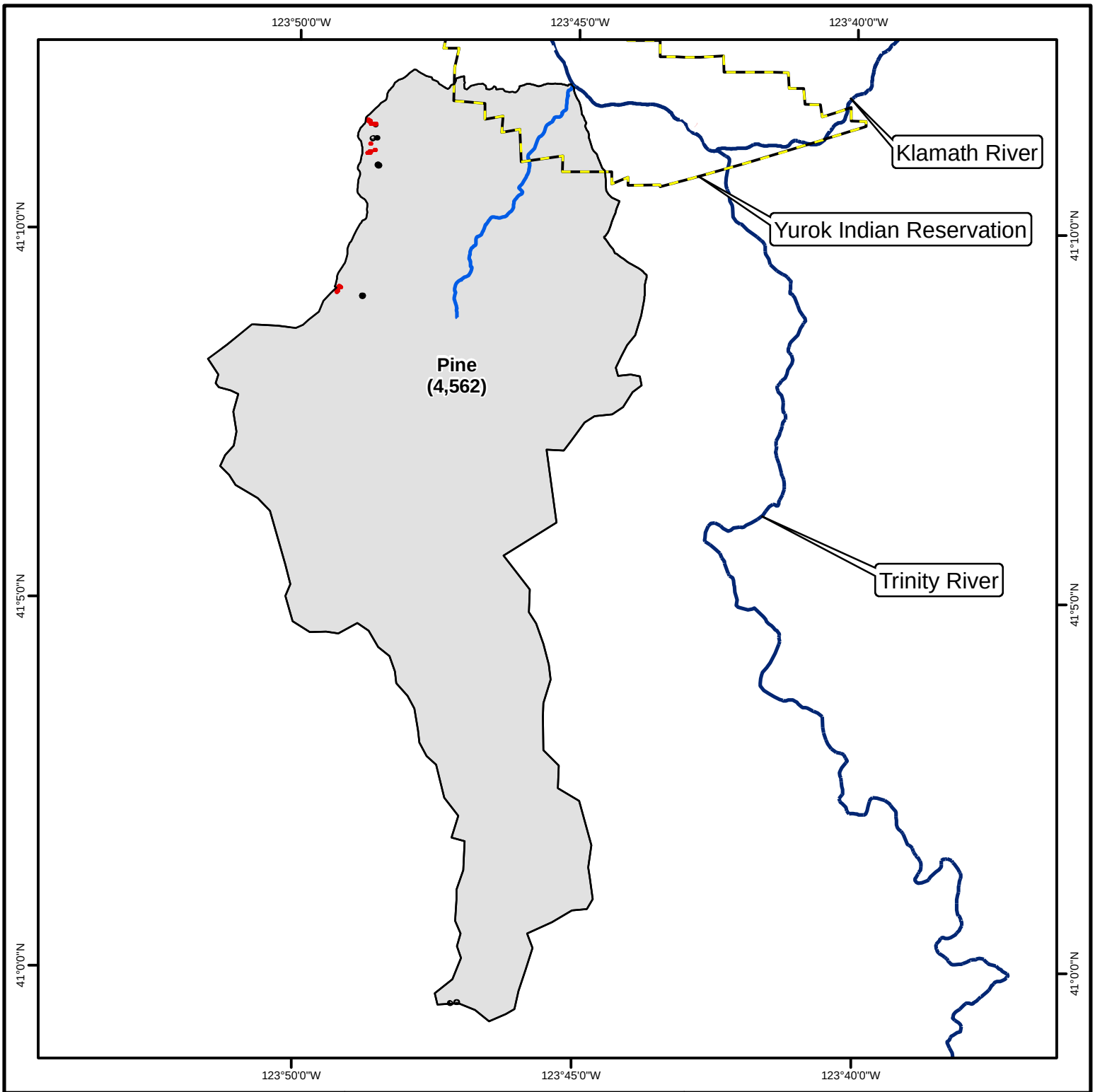
Figure 11

Watersheds with Total Outdoor and Greenhouse Plants (362 Total on this Map)

Freshwater Environmental Services

Date: 1-4-16

By: SJT



N
W E
S

Miles
0 1 2 4

LEGEND

- Yurok Indian Reservation
- Watershed Boundary
- Yurok Tribe Ancestral Stream
- Outdoor Plant
- Greenhouse

ALL LOCATIONS APPROXIMATE

Yurok Tribe
Environmental Program

Figure 12

Watersheds with Total Outdoor and Greenhouse Plants
(4,562 Total on this Map)

Freshwater Environmental Services

Date: 1-4-16

By: SJT

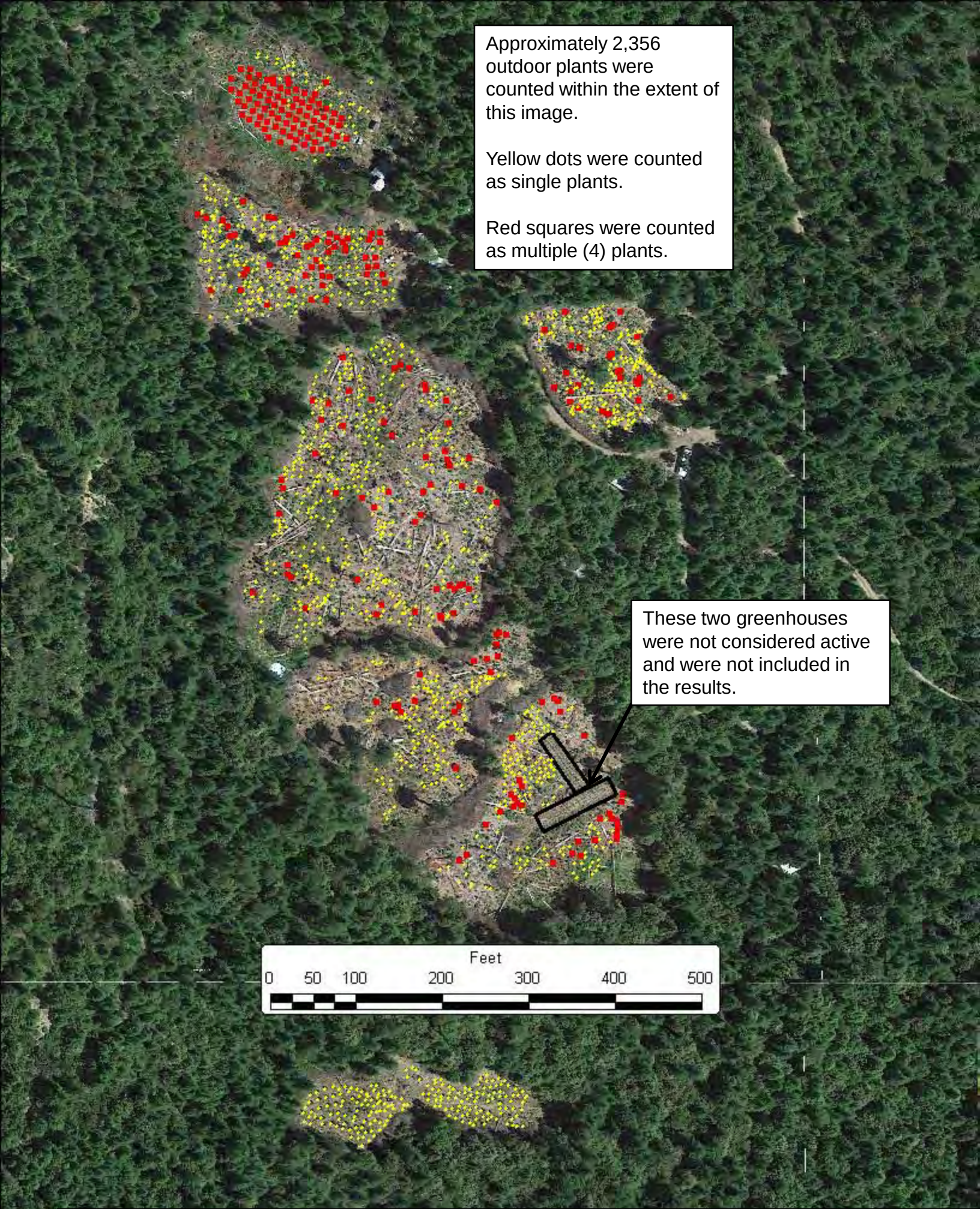


Photo 1. Large outdoor grow in the Mawah Creek watershed external to the Yurok Indian Reservation. Image date: July 14, 2015.

Photo 2. Outdoor grow site partially within the Saints Rest watershed and external to the Yurok Indian Reservation. Image date: July 14, 2015.

Photo 3. Outdoor grow site partially within the Miners Creek watershed and external to the Yurok Indian Reservation. Image date: July 14, 2015.

Photo 4. Recently cleared outdoor grow site outside of delineated watershed and within the Yurok Indian Reservation. Image date: July 14, 2015.
.

Photo 5. Outdoor grow site within the Miners Creek watershed and external to the Yurok Indian Reservation. A photograph of similar plantings is included as Photo 19. Large square plantings estimated to contain 4 plants per excavated square. Image date: July 14, 2015.

Photo 6. Greenhouses outside of delineated watersheds and within the Yurok Indian Reservation. Image date: July 14, 2015.

Photo 7. Greenhouses outside of delineated watersheds and within the Yurok Indian Reservation. Image date: July 14, 2015.

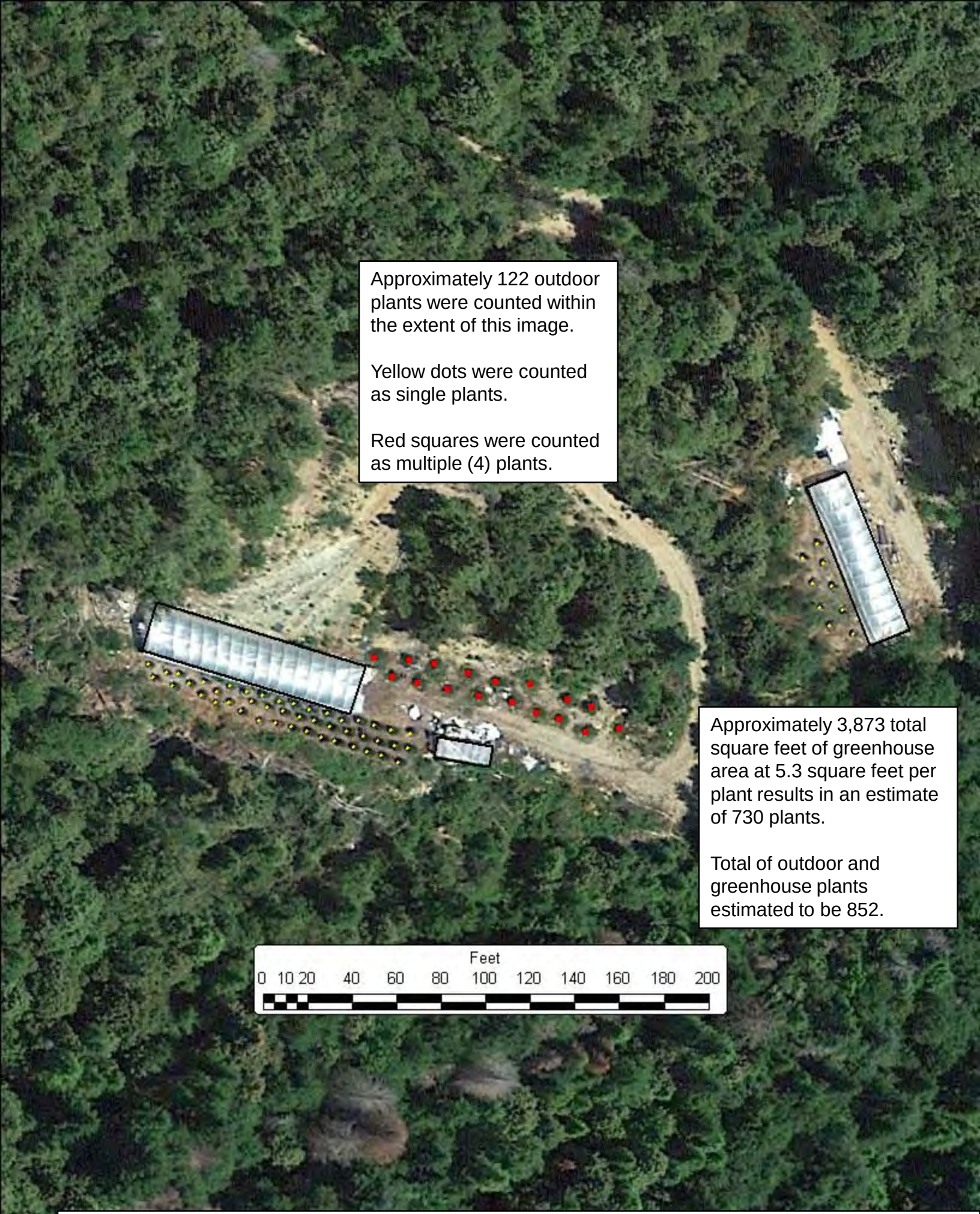


Photo 8. Greenhouses and plants within the Coon Creek watershed and external to the Yurok Indian Reservation. Image date: July 14, 2015.

Photo 9. Greenhouses within the Miners Creek watershed and external to the Yurok Indian Reservation. The number of plants within the greenhouses (1,872) were provided to FES by the Yurok Tribe. The total area of the greenhouses on this photo and the greenhouses shown on Photo 10 were used to estimate a plant density of approximately 5.3 square feet per plant.
Image date: July 14, 2015.

Photo 10. Greenhouses within the Miners Creek watershed and external to the Yurok Indian Reservation. The number of plants (prior to eradication)within the greenhouses (2,200) was provided to FES by the Yurok Tribe. Image date: July 14, 2015.

Photo 11. Forested area within the Miners Creek watershed and external to the Yurok Indian Reservation. Image date: October 12, 2006.

Photo 12. Same area as Photo 11 in 2015 with multiple cultivation sites. Image date: July 14, 2015.

Photo 13. Cleared areas present within the Miners Creek watershed and external to the Yurok Indian Reservation. Image date: June 6, 2013.

Photo 14. Same area as Photo 13 with multiple cultivation sites. Image date: July 14, 2015.

Photo 15. Partially cleared areas within the Miners Creek watershed and external to the Yurok Indian Reservation. Image date: June 6, 2013.

Photo 16. Same area as Photo 15 with multiple greenhouses. Image date: July 14, 2015.

Photo 17. Forested areas within the Mawah Creek watershed and external to the Yurok Indian Reservation. Image date: June 6, 2013.

Photo 18. Same area as Photo 17 with approximately 2,356 outdoor plants counted from aerial imagery for this study. Image date: July 14, 2015.

Photo 19. Large square plantings (prior to eradication) probably similar to aerial view shown on Photo 5. Photo provided by YTEP dated July 14, 2015.

Photo 20. Large square plantings (after plants were cut down during eradication) probably similar to aerial view shown on Photo 5. Photo provided by YTEP dated July 14, 2015.