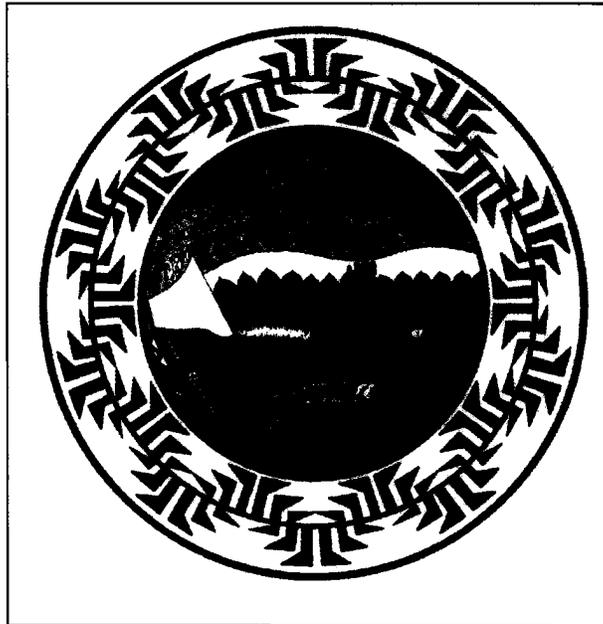


**Klamath River
Blue-Green Algae Bloom
Report**



Water Year 2005

Prepared by:

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Yurok Tribe

Environmental Program

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Acknowledgements

The Yurok Tribe Environmental Program (YTEP) would like to thank those that contributed to the data collection efforts that occurred during the blue-green algae bloom on the Klamath River during September and October 2005. Both Paul Zedonis and Randy Turner of the United State Fish and Wildlife Service (USFWS) were instrumental in organizing sampling events with Tribal staff. In addition to coordinating events, USFWS staff collected samples at the Upper Reservation sites in the Trinity and Klamath Rivers at Weitchpec. Tommy Wilson of the Yurok Tribe Fisheries Program (YTFP) was extremely helpful in collecting Chinook salmon tissue samples in Weitchpec and delivering them to YTEP staff in Klamath. A big thanks also goes out to Aaron Martin, Yurok Tribe Fisheries Program biologist, who was very eager and successful in line sampling two steelhead in the Klamath River at Weitchpec. YTEP also appreciates the assistance from California Department of Fish and Game staff at Iron Gate Dam Hatchery that ensured two adult Chinook salmon samples could be picked up by YTEP staff after hours. YTEP would also like to thank CyanoHAB Services at Wright State University and Aquatic Analysts in White Salmon, WA for processing our samples in a timely manner.

I. Introduction

This report summarizes the occurrence and extent of the blue-green algae bloom on the Klamath River within the Yurok Reservation boundaries. In Water Year 2005 (WY05), YTEP, Karuk Tribe and USFWS routine water quality monitoring samples indicated that water quality in the Klamath River was negatively impacted by levels of the cyanobacterium *Microcystis aeruginosa* and its resultant toxin, microcystin; with some levels exceeding World Health Organization (WHO) risk guidelines in all reaches of the Klamath River from Copco Reservoir to the mouth of the Klamath River. WY05 was the first year that microcystin or microcystin was sampled for and detected below Irongate Dam, and YTEP staff were integral in collecting this data and sharing results with the local community.

Information on *microcystis aeruginosa*

Microcystis is a type of blue-green algae which, upon death and decomposition, releases the hepatotoxin microcystin, which can cause any of the following reactions in humans and/or animals: rash, irritation, conjunctivitis, nausea, vomiting, diarrhea, liver damage, tingling, numbness, paralysis, and death. Microcystin bioaccumulates in the liver, organs, and to a certain degree the muscle mass of living animals. Microcystin is not excreted by animals, and dosage over time will eventually cause liver damage, decreased liver function and increased liver size, and eventually death. Mortality in fish, domestic animals, and humans have been recorded following exposure to microcystin resultant from both single-dose events and long-term exposure.

The toxin microcystin can produce negative health effects from contact with impaired waters, from incidental nasal/oral ingestion of impaired waters, and, most seriously, from swallowing or drinking impaired waters. Microcystin can be found in the organs and muscle meat of fish who feed in impaired waters. Continued exposure to even low levels of microcystin can produce harmful cumulative response in humans and animals. Because the timing for likely bloom occurrence coincides with the annual salmon runs along the Klamath River, there is significant cause for concern; Tribal subsistence fishers not only have increased contact with impaired waters due to subsistence fishing methods, they are also more frequently visiting impaired waters than recreational or sport users.

Microcystis can be assumed to be present whenever there is a blue-green algal bloom. Initial bloom characteristics are green, green-blue, yellow, or whitish waters; blooms of increasing severity can form algal mats or visible surface scum, initially in nearshore areas and backwaters or where winds cause surface detritus to accumulate, and steadily progressing to cover open areas of still or slow-moving waters. Odor and taste changes may become noticeable at any time as decomposition of organisms sets in, but should not be used as an indicator for cellular mortality.

Microcystin Toxin Information

The World Health Organization has established minimum tolerance levels for recreational contact with microcystin. Because of the time it takes to analyze water samples for the presence of microcystin, WHO recommends the use of cell counts per milliliter of water as a crude surrogate for concentrations of microcystin. However, because the toxin is released as the organism decomposes, the risk from microcystin presence in waters is at its greatest after the bloom has initially begun to decompose and increases until well after the last cells are observed in samples.

The World Health Organization has set the following thresholds for microcystis/microcystin concentrations in recreational waters:

	<u>Microcystis cells/milliliter</u>	<u>Microcystin micrograms/liter</u>
Low Risk:	20,000	4
Moderate Risk:	100,000	20
Severe Risk	10,000,000 <i>or</i> visible scum	200

The consumption limit for microcystin is set as 0.04 micrograms per kilogram of bodyweight per day. However, because even the consumption of relatively low doses of microcystin over time will damage the liver of animals, continued consumption of known contaminated food sources is not be recommended.

II. Methods

At each sample site, sample water was collected with a pre-rinsed churn splitter. The churn was rinsed with deionized water followed by three rinses with site river water. Samples were drawn in a moving portion of the river in an attempt to collect water samples to represent the river as a whole. This did not preclude sampling crews from collecting additional samples from edgewater or areas where algal scum lines are forming. The churn splitter allowed for distribution of the same water mixture into sample bottles used for speciation work and testing for microcystin.

The filled churn was used to fill the sample bottles for determination of algal species and microcystin concentrations. The sample bottle for determination of algal species contained Lugol's preservative and the toxin sample water was preserved by freezing the bottle. Both of these samples were drawn from the same churn of water because they are complementary to one another. All samples were labeled with the following information: date, time, sampler, sample site, study name. The sample ID was comprised of a two digit site ID and the date (e.g. TG090105).

If a sampling crew member identified an area along the river that had scum lines, an additional sample was collected at this site. The sample was labeled appropriately and photographs of the sample area were taken. Additional quality control measures were included in the sampling. At one site a duplicate sample was sent to the laboratory to assess laboratory performance and to gain improved confidence in our datasets.

Environmental information was also recorded at the time water samples were collected. The data included water temperature, pH, specific conductance, dissolved oxygen and other observational notes. Lastly, chain-of-custody (COC) sheets were also filled out to document the handling of the samples from the time of collection to the time of laboratory analysis. This is a standard procedure for handling samples.

Water samples that were collected for algae speciation and enumeration were mailed overnight to Aquatic Analysts in White Salmon, WA for analysis. This analysis identified and enumerated all algal species present in the water sample submitted to the lab. Water samples that were collected for algae toxin processing were mailed on ice overnight to CyanoHAB Services at Wright State University in Dayton, OH for analysis using the enzyme linked immunosorbent assay (ELISA) method. These methods have been adapted to a commercial ELISA kit (Microcystin Plate Kit, EP-022) that is produced by Envirologix, Inc. (Portland Maine), which CyanoHAB Services employs.

Fish tissue samples were collected at three different locations on the Klamath River. At the Klamath River below Weitchpec site, salmon were retrieved from a gill net, processed on site and immediately placed on ice in a plastic bag and delivered to YTEP in Klamath. At the Klamath River at Weitchpec site, steelhead were caught by line, processed on site and immediately placed on ice in a plastic bag and delivered to YTEP in Klamath. At the Klamath River at Iron Gate Dam Hatchery site, salmon were held in holding pens while they waited until they were spawned. CDF&G staff then held the dead salmon on ice before they could be picked up by YTEP staff. The salmon were stored on ice while they were delivered to the Yurok Tribe's Klamath office. Once the two salmon were delivered to the Yurok Tribe's Klamath office filets and livers were removed and frozen before being delivered to Wright State University. Fish tissue samples that were collected for algae toxin processing were mailed on ice overnight to CyanoHAB Services at Wright State University in Dayton, OH for analysis using the ELISA method.

III. Site Selection

The USFWS and YTEP collected water samples for toxin and speciation analysis at the following locations:

- ES - Lower Estuary Surface
- **TG - Klamath River at Turwar Gage**
- EWB - Klamath River edgewater below mouth of Blue Creek
- **KBW - Klamath River below Weitchpec**
- **WE - Klamath River at Weitchpec (above Trinity River confluence)**

- **TR - Trinity River at Weitchpec (above Klamath River confluence)**

The sites in bold indicate established sampling locations for the collection of water samples for nutrient analysis. Samples were collected at these sites and additional sites to determine the extent and occurrence of the algae bloom. The Lower Estuary Surface site was chosen because of concern that *Microcystis aeruginosa* bloom may increase once it reached the estuarine habitat. Three samples were collected along a river cross section at the Turwar site on September 8th, to represent the left and right edges and the middle of the river. This site was chosen because of convenient access and it represents an area of great abundance of fall-run salmon during this time of the year. These samples were used to provide an estimate of the variation in algal abundance and microcystin across the Klamath River. On September 8th, one water sample was collected in an edgewater habitat approximately one mile downstream of the mouth of Blue Creek. This site was selected to determine if algal abundance and toxin concentrations were higher in slower moving waters along the shores of the Lower Klamath River.

YTFP and YTEP collected fish samples for toxin analysis at the following locations:

- Klamath River below Weitchpec
- Klamath River at Weitchpec (Above confluence with Trinity River)
- Iron Gate Dam Fish Hatchery

These sites were selected because they were sites in which adult salmon and steelhead were known to be. Salmon and steelhead from these locations had been exposed to river water that had significant levels of *Microcystis aeruginosa* and microcystin present.

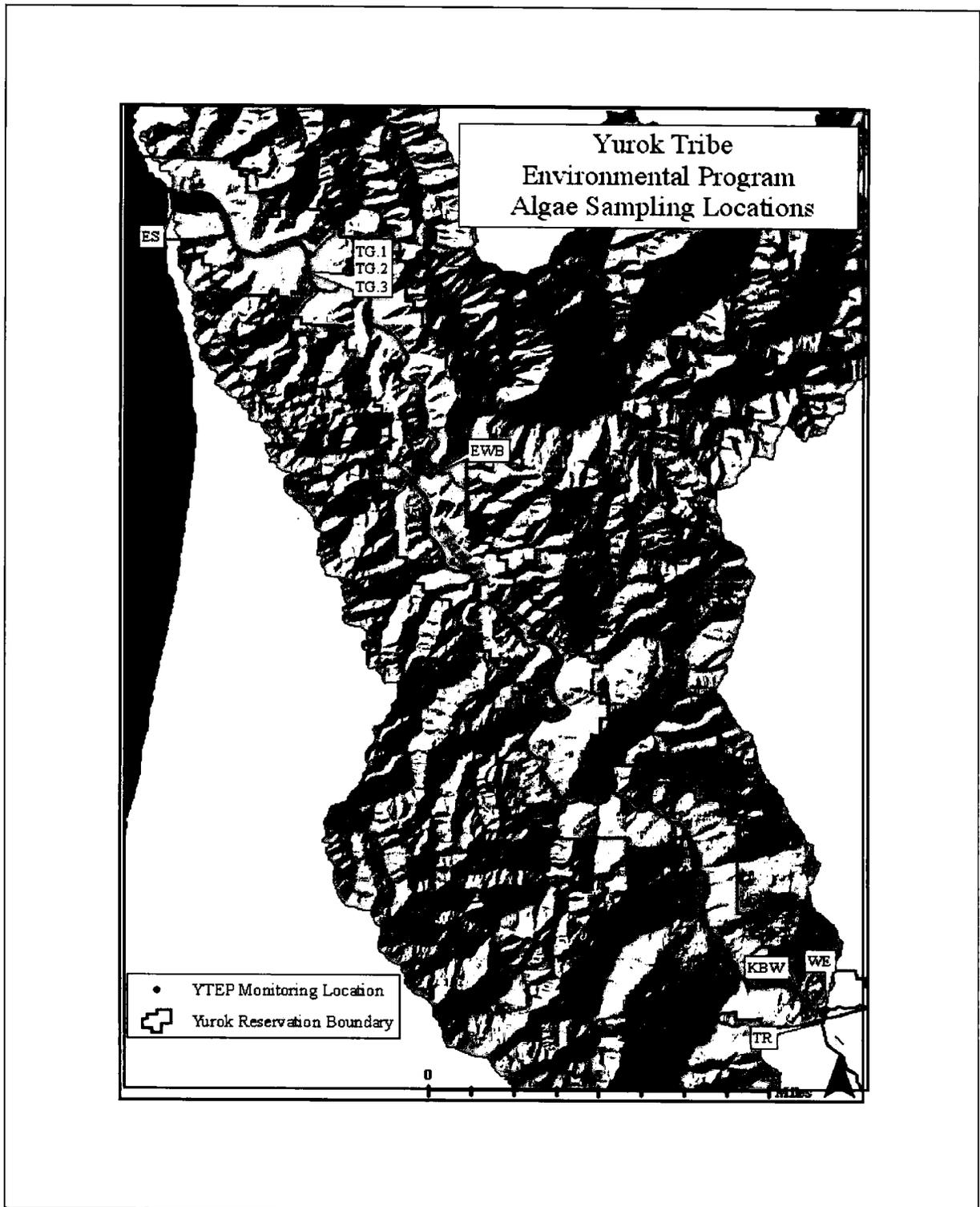


Figure 1. Map of blue-green algae monitoring locations within Yurok Reservation boundaries, Water Year 2005.



Figure 2. Lower Estuary Surface (LES) sampling location, September 8, 2005.

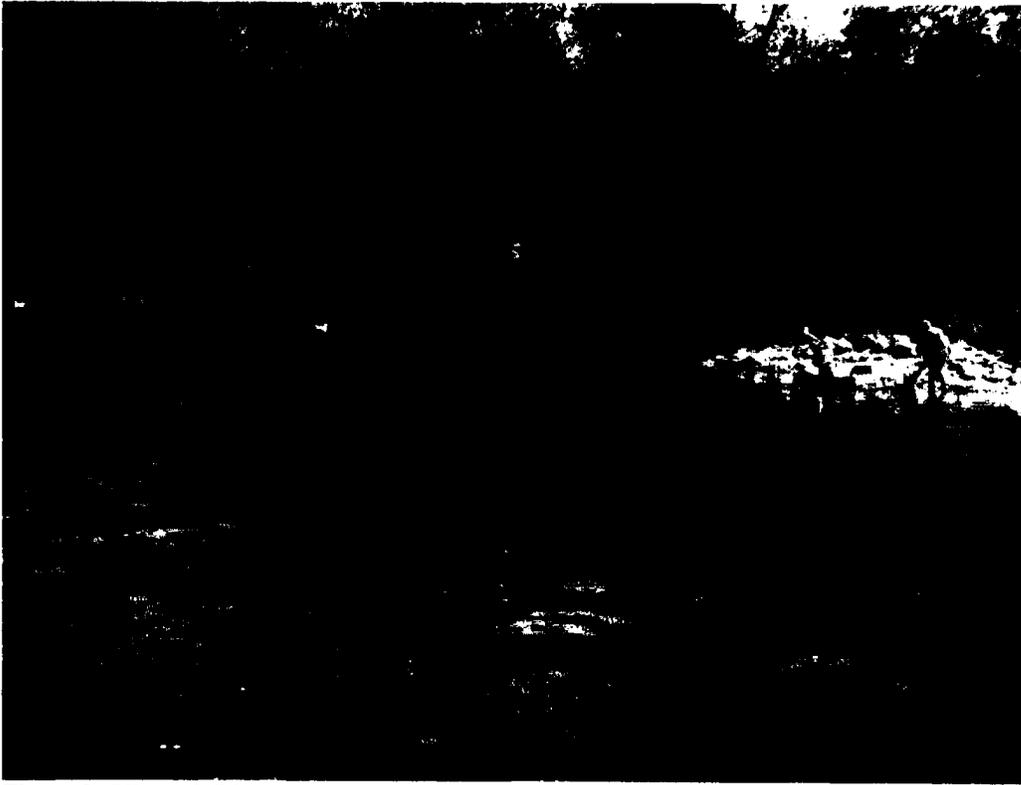


Figure 3. Klamath River at Turwar Gage (TG.2) sampling location, September 8, 2005.



Figure 4. YTEP staff Micah Gibson collects a water sample at Klamath River at Turwar Gage (TG.2)



Figure 5. Klamath River edgewater below mouth of Blue Creek (EWB) sampling location, September 8, 2005



Figure 6. Klamath River below Weitchpec (KBW) sampling location, August 30, 2005.



Figure 7. Trinity River at Weitchpec (TR) sampling location, September 21, 2005.



Figure 8. Klamath River at Weitchpec (WE) sampling location, August 30, 2005.

IV. Results:

Table 1. *Microcystis aeruginosa* and microcystin sample results for water samples collected within Yurok Reservation boundaries Water Year 2005.

Date	Site	<i>Microcystis aeruginosa</i> cells/mL	Microcystin µg/L	Sampling Crew
8/24/2005	LES	DNS	DNS	DNS
8/24/2005	TG.1	0	DNS	YTEP
8/24/2005	KBW	391	DNS	YTEP
8/24/2005	TR	0	DNS	YTEP
8/24/2005	WE	1,628	DNS	YTEP
9/1/2005	LES	4,393	DNS	YTEP
9/1/2005	TG.1	11,745	DNS	YTEP
9/1/2005	KBW	DNS	DNS	YTEP
9/1/2005	TR	DNS	DNS	DNS
9/1/2005	WE	44,543	3.53	USFWS
9/8/2005	LES	12,297	0.96	YTEP
9/8/2005	TG.1	12,819	2	YTEP
9/8/2005	TG.2	22,390	2.53	YTEP
9/8/2005	TG.3	29,807	2.62	YTEP
9/8/2005	EWB	5,704	1.99	YTEP
9/8/2005	KBW	DNS	DNS	DNS
9/8/2005	TR	0	BDL	USFWS
9/8/2005	WE	29,413	6.25	USFWS
9/12/2005	LES	26,058	2.24	YTEP
9/12/2005	TG.1	18,989	0.79	YTEP
9/12/2005	KBW	DNS	DNS	DNS
9/12/2005	TR	0	BDL	USFWS
9/12/2005	WE	24,285	BDL	USFWS
9/21/2005	LES	DNS	DNS	YTEP
9/21/2005	TG.1	1,804	0.2	YTEP
9/21/2005	KBW	1,296	0.58	YTEP
9/21/2005	TR	0	BDL	YTEP
9/21/2005	WE	3,235	BDL	YTEP
9/28/2005	LES	DNS	DNS	DNS
9/28/2005	TG.1	0	BDL	YTEP
9/28/2005	KBW	DNS	DNS	DNS
9/28/2005	TR	DNS	DNS	DNS
9/28/2005	WE	0	BDL	USFWS

LES=Lower Estuary Surface

TG.1=Klamath River at Turwar Gage-Right Bank (LDS)

TG.2=Klamath River at Turwar Gage-Center of River Channel

TG.3=Klamath River at Turwar Gage-Left Bank (LDS)

EWB=Edgewater downstream of mouth of Blue Creek

KBW=Klamath River below Weitchpec

TR=Trinity River at Weitchpec

WE=Klamath River at Weitchpec

DNS= Did not sample for this parameter

YTEP=Yurok Tribe Environmental Program

USFWS=US Fish and Wildlife Service

BDL=below detection limit (0.147µg/L)

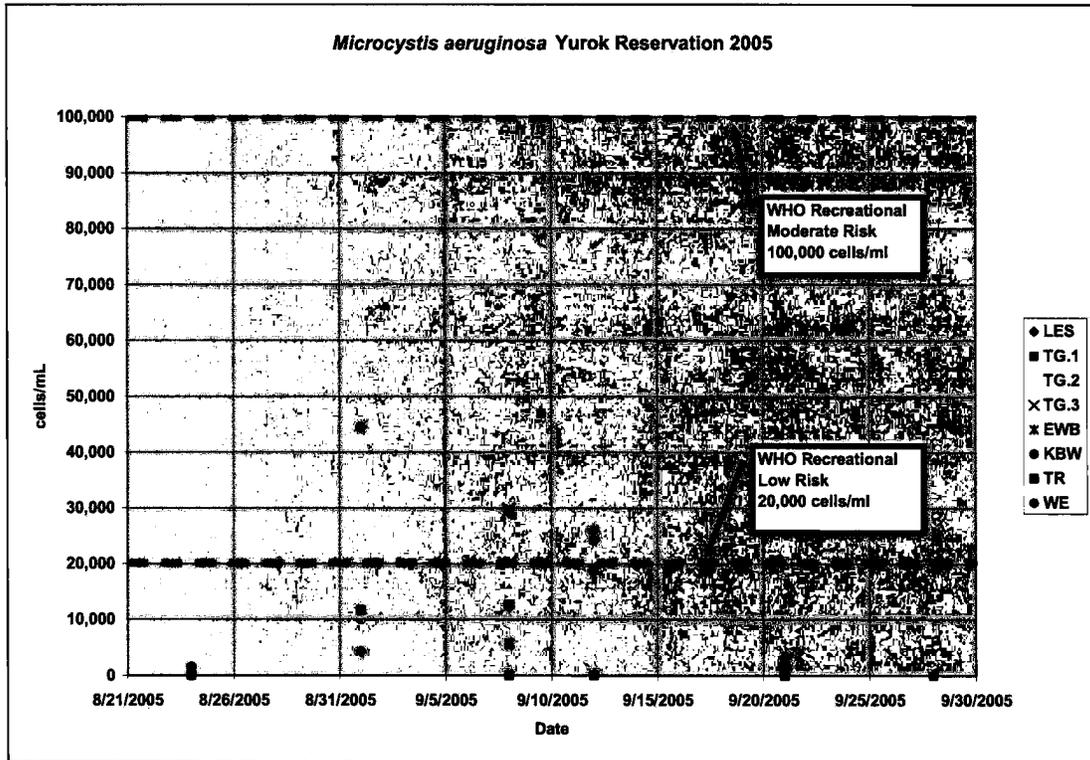


Figure 9. *Microcystis aeruginosa* results for water samples collected within Yurok Reservation boundaries, Water Year 2005.

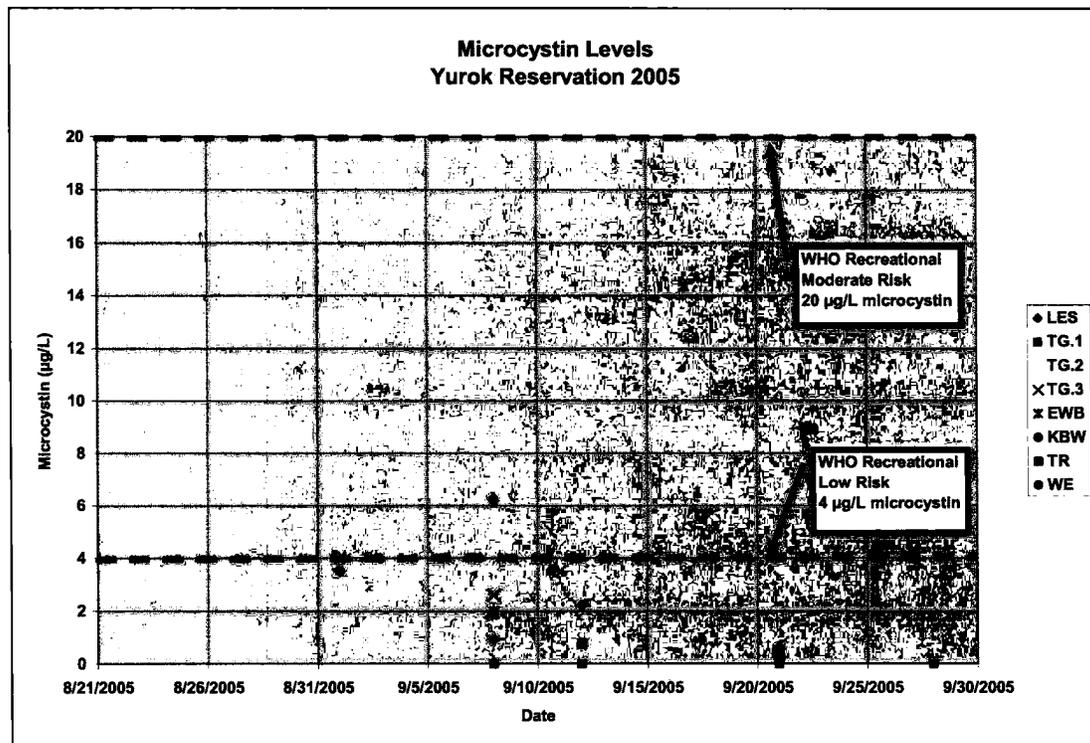


Figure 10. Microcystin results for water samples collected within Yurok Reservation boundaries, Water Year 2005.

Table 2. Microcystin results for fish tissue samples collected within Yurok Reservation boundaries, Water Year 2005.

Date	Site	Tissue Type	Species	Microcystin µg/g	Sampling Crew
9/13/2005	KBW	Liver	Chinook salmon	BDL	YTFP
9/14/2005	KBW	Filet	Chinook salmon	BDL	YTFP
9/14/2005	KBW	Liver	Chinook salmon	BDL	YTFP
9/14/2005	KBW	Filet	Chinook salmon	BDL	YTFP
9/14/2005	KBW	Liver	Chinook salmon	BDL	YTFP
9/30/2005	IG	Male Liver	Chinook salmon	BDL	CDF&G
9/30/2005	IG	Male filet	Chinook salmon	BDL	CDF&G
9/30/2005	IG	Female Liver	Chinook salmon	BDL	CDF&G
9/30/2005	IG	Female Filet	Chinook salmon	BDL	CDF&G
10/03/205	WE	Adult Liver	Steelhead	Trace	YTFP
10/03/205	WE	Adult Filet	Steelhead	BDL	YTFP
10/03/205	WE	1/2 pounder Liver	Steelhead	0.54	YTFP
10/03/205	WE	1/2 pounder Filet	Steelhead	BDL	YTFP
KBW=Klamath River Below Weitchpec			CDF&G=California Dept. of Fish and Game		
WE=Klamath River at Weitchpec			BDL=Below Detection Limit (0.147 µg/L)		
IG=Klamath River Iron Gate Hatchery			Trace=(0.17 µg/L)		
YTFP=Yurok Tribe Fisheries Program					

V. Discussion:

The presence of the *Microcystis aeruginosa* bloom was documented in the Klamath River within the Yurok Reservation boundaries beginning on August 24, 2005 and extended until approximately September 21, 2005. *Microcystis aeruginosa* were first documented in samples collected on the Klamath River at Weitchpec (WE) and Klamath River below Weitchpec (KBW) on August 24, 2005 during a routine nutrient grab sampling event. *Microcystis aeruginosa* and microcystin were present in water samples collected from September 1 to September 21st. On September 28th water samples collected at the Klamath River at Turwar Gage (TG.1) and at the WE site did not contain *Microcystis aeruginosa* or microcystin.

The lowest cell density of *Microcystis aeruginosa*, 391 cells/ml, was detected in the water sample that was collected at the KBW site on August 24, 2005. The highest cell density of *Microcystis aeruginosa*, 44,543 cells/ml, was detected in the water sample that was collected at the WE site on September 1, 2005. The phytoplankton results indicate that the most common group of phytoplankton present during the summer months in 2005 were diatoms, green algae and cryptophytes. With the exception of *Oscillatoria sp.* identified at low levels in the WE sample collected on September 28, 2005, *Microcystis aeruginosa* was the only blue-green algae species found in the Klamath River samples within the Yurok Reservation boundaries.

The lowest detected microcystin level, 0.2 µg/L, was detected in the water sample that was collected at the TG.1 site on September 21, 2005. The highest microcystin level, 6.25 µg/L, was detected in the water sample that was collected at the WE site on September 8, 2005.

All salmon tissue samples (livers and filets) collected within this study did not contain detectable levels of microcystin. Two steelhead filets were also sampled and did not contain detectable levels of microcystin. However, two steelhead liver samples, collected on October 3, 2005 did contain measurable levels of microcystin.

Although sample size is limited, low to trace quantities of microcystin in steelhead livers in the Lower Klamath River indicate that these fish were exposed to toxin levels in the river environment, and indicate the potential for toxin uptake to occur. Steelhead residing in the Klamath River at the time of sampling would have increased exposure time relative to salmon (Kann 2006).

These results indicate that the blue-green algae bloom was a relatively short event on the Lower Klamath River, peaking sometime in the early to middle part of September. The timing is of significance because of the presence of adult salmon and steelhead migrating upstream during this time period. This is also a time of increased cultural and recreational use of the Klamath River by both Yurok Tribal Members and sport fisherman.

Literature Cited

Kann, J. 2006. *Microcystis aeruginosa* Occurrence in the Klamath River System of Southern Oregon and Northern California, Technical Memorandum prepared for the Yurok Tribe Environmental and Fisheries Program, February 3, 2006.