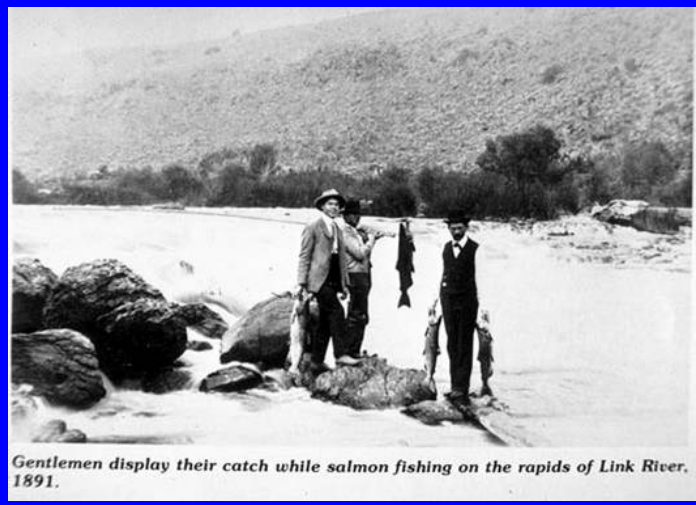
Accumulation of Microcystin in Tissues of Fish and Shellfish of the Klamath River



Gentlemen display their catch while salmon fishing on the rapids of Link River, 1891.

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Klamath River

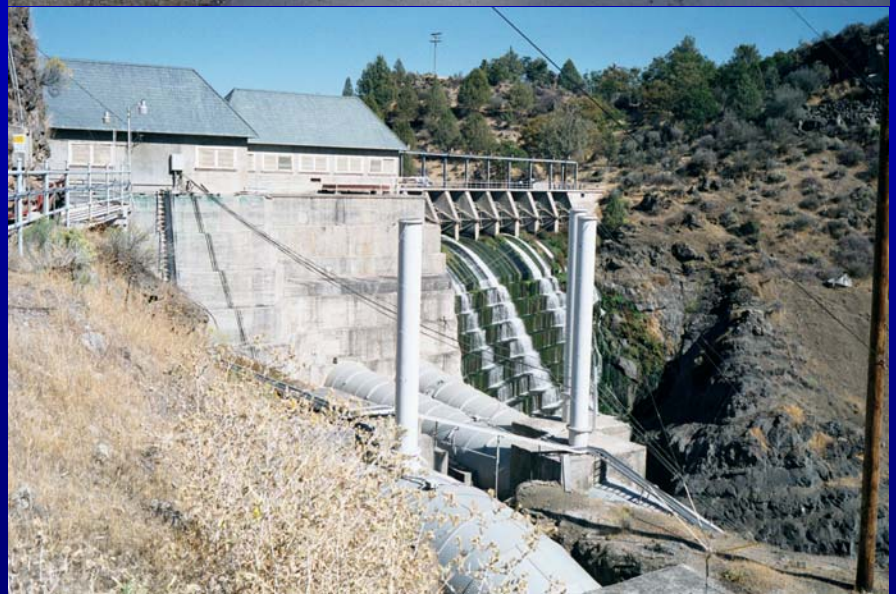
- The Klamath River in California is listed as an impaired water body on the Clean Water Act section 303(d) list for sediment, microcystin toxin, temperature, nutrients and dissolved oxygen.
- The US Environmental Protection Agency added the Klamath River segment including Iron Gate and Copco Reservoirs as impaired for microcystin toxin in May 2008.

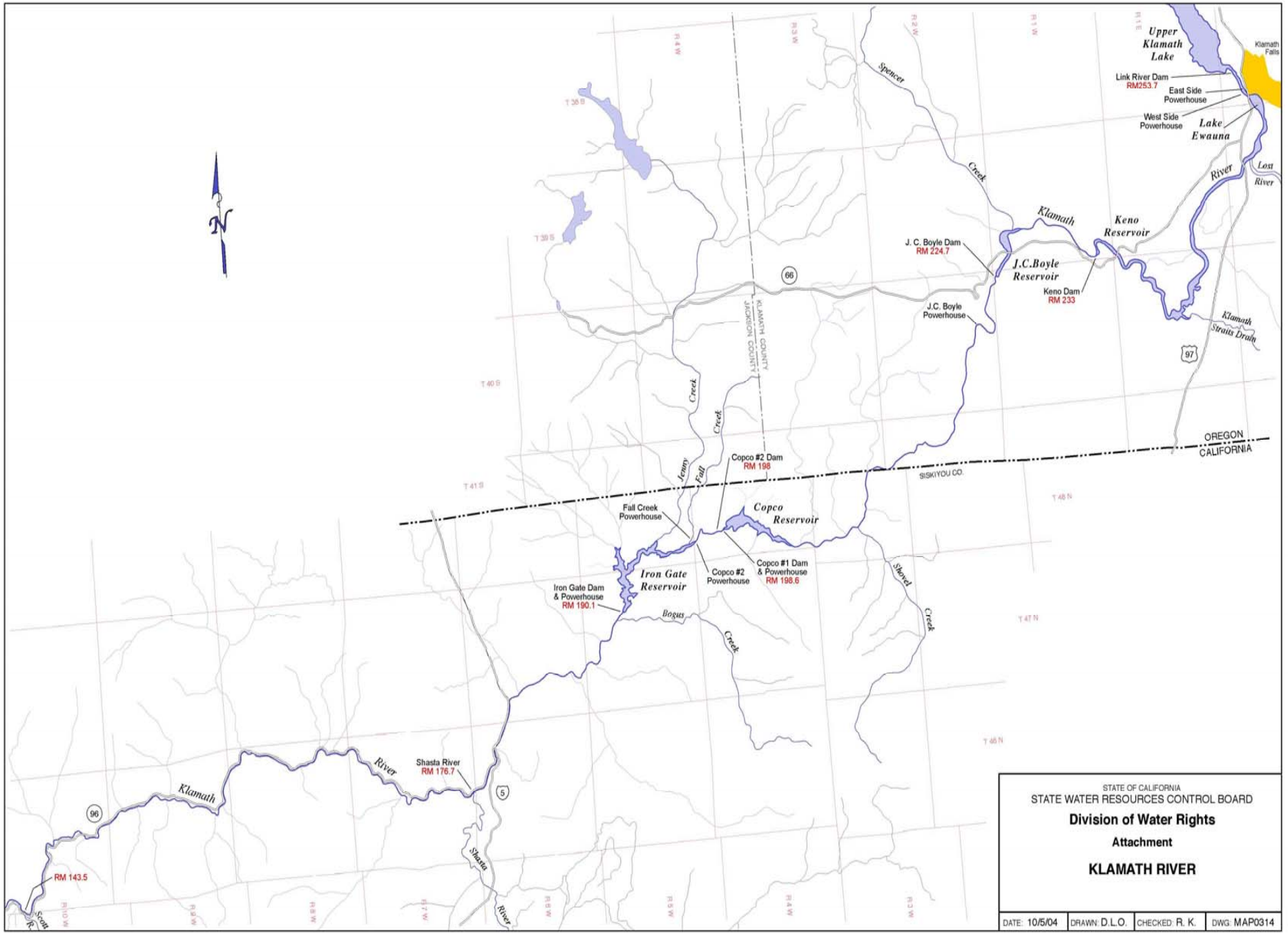
Regulatory Issues

- The North Coast Regional Water Quality Control Board (NCRWQCB) is in the process of developing a Total Maximum Daily Load (TMDL) for the Klamath River.
- PacifiCorp is in the process of relicensing the Klamath Hydroelectric Project. Will required water quality certification (CWA section 401) from the State Water Resources Control Board.
- Settlement???

Klamath River

- Large blooms of the cyanobacteria Microcystis aueruginosa occur in Iron Gate and Copco Reservoirs
- The cyanotoxin microcystin is found in very high concentrations in the reservoirs
- Microcystis and microcystin is passed downstream to the Klamath River below Iron Gate Dam
- Impacts to aquatic species is unknown





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STATE WATER RESOURCES CONTROL BOARD

Division of Water Rights

Attachment

KLAMATH RIVER

DATE: 10/5/04	DRAWN: D.L.O.	CHECKED: R. K.	DWG: MAP0314

2007

Photo from Thomas B. Dunklin, August 26, 2007

Photos from Thomas B. Dunklin,

August 26, 2007

Microcystin

- High levels of microcystins can produce chronic and lethal health effects in humans and animals. Microcystins are the most commonly detected cyanotoxin across the globe
- The mechanism of toxicity of microcystins is the inhibition of protein phosphatases, which can cause internal hemorrhaging of the liver.
- Exposure to microcystins has the potential to cause acute and chronic injury, depending on the dose and duration of exposure.

Cooperative Agreement

- In 2007 the State Water Board received funding through a Water Quality Cooperative Agreement from the USEPA for the analysis of fish tissue and water from the Klamath River for the presence of the microcystin.
- The State Water Board entered into a contract with the California Department of Fish and Game Water Pollution Control Lab (WPCL) to collect fish and analyze samples for microcystins.

Study Objectives

- Perform a screening level analysis of microcystin accumulation in a range of aquatic species.
- Provide microcystin levels in yellow perch to the Office of Environmental Health Hazard Assessment (OEHHA) that could be used to develop public fish tissue consumption advisory.
- Provide support for other studies by analyzing water samples for microcystin.

Yellow Perch

- Yellow perch are the most abundant species in Iron Gate and Copco Reservoirs, and are a popular sport fish. The California Department of Fish and Game (DFG) does not impose catch limits for yellow perch and catches of 50-100 yellow perch per day are not uncommon.

Freshwater Mussels

- Freshwater mussels (or clams) were a part of the traditional diet of tribal people on the Klamath River (Norgaard 2004). Anecdotal information indicates some tribal members may still collect and consume mussels from the Klamath River. River otters, raccoons, and other species also rely on mussels as a food source.

Why Mussels?

- Mussels are very sensitive to environmental changes and may be indicators of degradation. Freshwater mussels are very long-lived species, and *Margaritifera falcata* (western pearlshells) can live for over a century. Almost three-quarters of all 297 native freshwater mussel species in North America are imperiled and almost 35 are extinct. Mussels are one of the most endangered groups of animals on Earth, yet little is known about their life history, and habitat needs.

Bloom Period Samples

- 6 Yearling Chinook Salmon – IG Hatchery
- 4 Gonidea angulata – Klamath River
- 13 Gonidea angulata (composite) – Klamath River
- 18 Yellow Perch (18 tissue, 3 liver composites) – Iron Gate Reservoir
- 18 Yellow Perch (18 tissue, 3 liver composites) – Copco Reservoir

Non-Bloom Period Samples

- Does depuration occur?
- 15 mussels – Klamath River
- 8 Yellow Perch Copco
  (8 tissue, 1 liver composite)
- 8 Yellow Perch Copco
  (8 tissue, 1 liver composite)

Results - Yearling Chinook Salmon

Lab #	Date Collected	Tissue Type	Total Microcystin (ng/g)
L-463-07-01	8/13/2007	Fish Liver	301
L-463-07-01	8/13/2007	Fish Stomach	ND
L-463-07-01	8/13/2007	Fish Fillet	ND

Results - Mussels

Lab #	Date Collected	Species	Total Microcystin (ng/g)
L-405-07-1	7/11/2007	Gonidea angulata	2,803.1
L-405-07-2	7/11/2007	Gonidea angulata	412.54
L-405-07-2Dup	7/11/2007	Gonidea angulata	383.35
L-405-07-3A	7/11/2007	Gonidea angulata	889.8
L-405-07-3B	7/11/2007	Unknown	201.2
L-405-07-13	7/20/2007	13 Gonidea angulata	57
L-405-07-Dup	7/20/2007	13 Gonidea angulata	32.3
L-405-07-Trip	7/20/2007	13 Gonidea angulata	34.2

Results - Yellow Perch

Date Collected	Location	Tissue Type	Total Microcystin (ng/g)
9/6-7/2007	**Iron Gate**	Fillet	ND - 229.23
9/6-7/2007	Copco	Fillet	ND - 422

L-524-07-37	9/6-8/2007	Iron Gate Reservoir	IG Liver Composite	ND
L-524-07-38	9/6-8/2007		IG Liver Composite	50.1
L-524-07-39	9/6-8/2007		IG Liver Composite	70.6
L-524-07-40	9/6-8/2007	Copco Reservoir	CP Liver Composite	177.7
L-524-07-41	9/6-8/2007		CP Liver Composite	473.2
L-524-07-42	9/6-8/2007		CP Liver Composite	228.48

Results - Non-Bloom Period

- All non-bloom period samples (November Mussels, June Perch) were non-detect

Conclusions

- The data collected during this study has provided new and important information on the impact of cyanotoxins in the Klamath River.
- Shows that more information will be needed to understand the full impact of microcystin accumulation in mussels and fish, and the impact to wildlife (river otters, raccoons, etc.) and humans from consuming these species.

Conclusions

- Data has been generated that can be used in regulatory processes, and to inform and protect the public and tribal members about risks of consuming fish and shellfish from the Klamath River.
- Given a high likelihood that yellow perch and mussels sampled in the spring of 2008 were representative of the populations sampled in 2007 the data indicate that depuration had occurred.