In-Lake Holy Fire Runoff Sediment & Water Monitoring Program

Holy Fire Runoff Monitoring Program

CALIFORNIA

Firefighters gain upper hand on 22,700-acre Holy fire in Cleveland National Forest, as containment rises to 41%

1/53 A firefighter douses hot spots in the McVicker Canyon neighborhood of Lake Elsinore. (Irfan Khan / Los Angeles Times)

ADVERTISEMENT

Holy Fire chars 10,236 acres as it moves close to homes in Lake Elsinore-Corona area

By John Gregory and Rob McMillan

LAKE ELSINORE, Calif. (KABC) -- The Holy Fire exploded to more than 10,200 acres on Thursday and moved dangerously close to homes in Riverside County's Lake Elsinore-Corona area.

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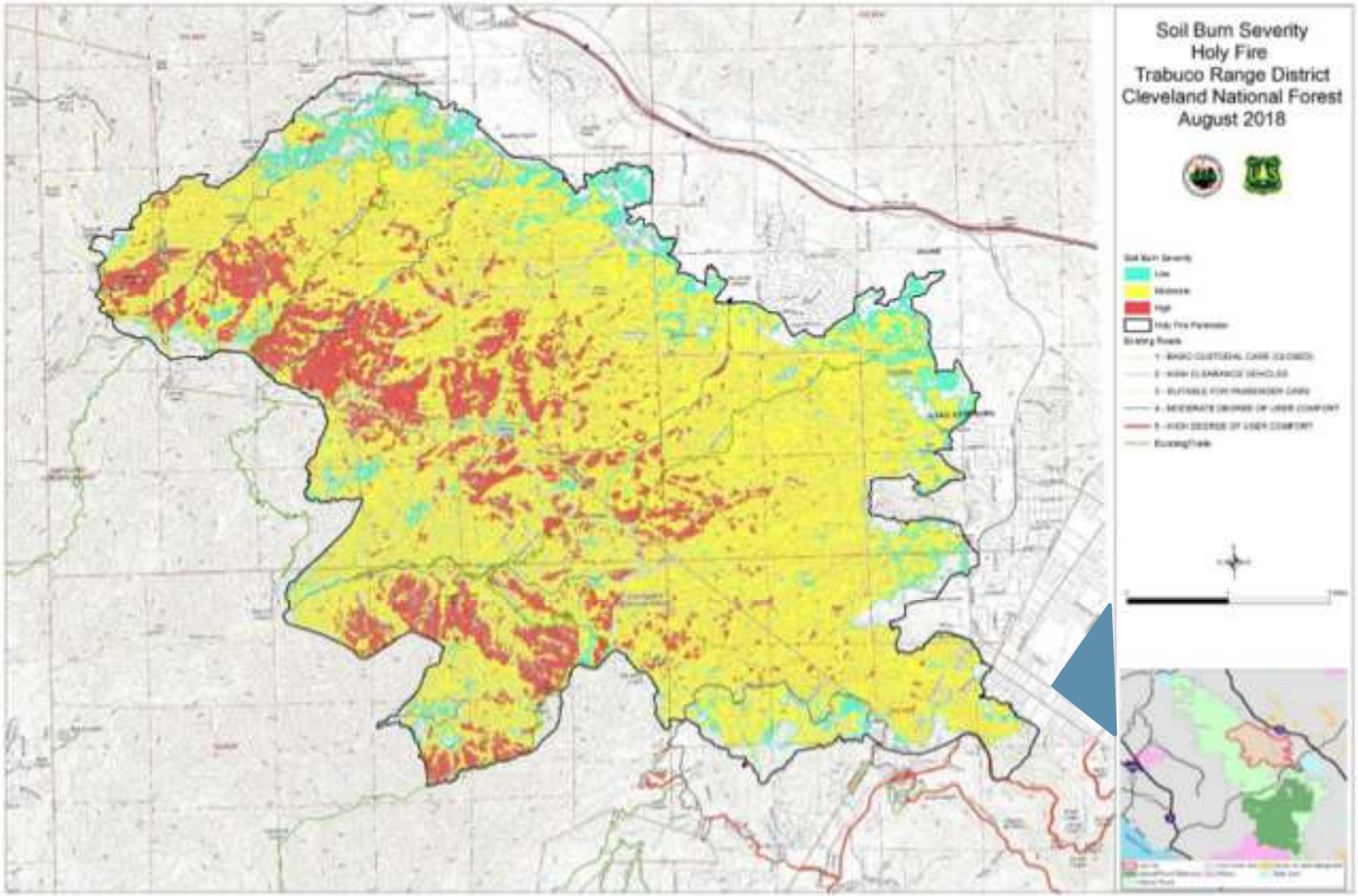

 Photos courtesy of Alta Environmental

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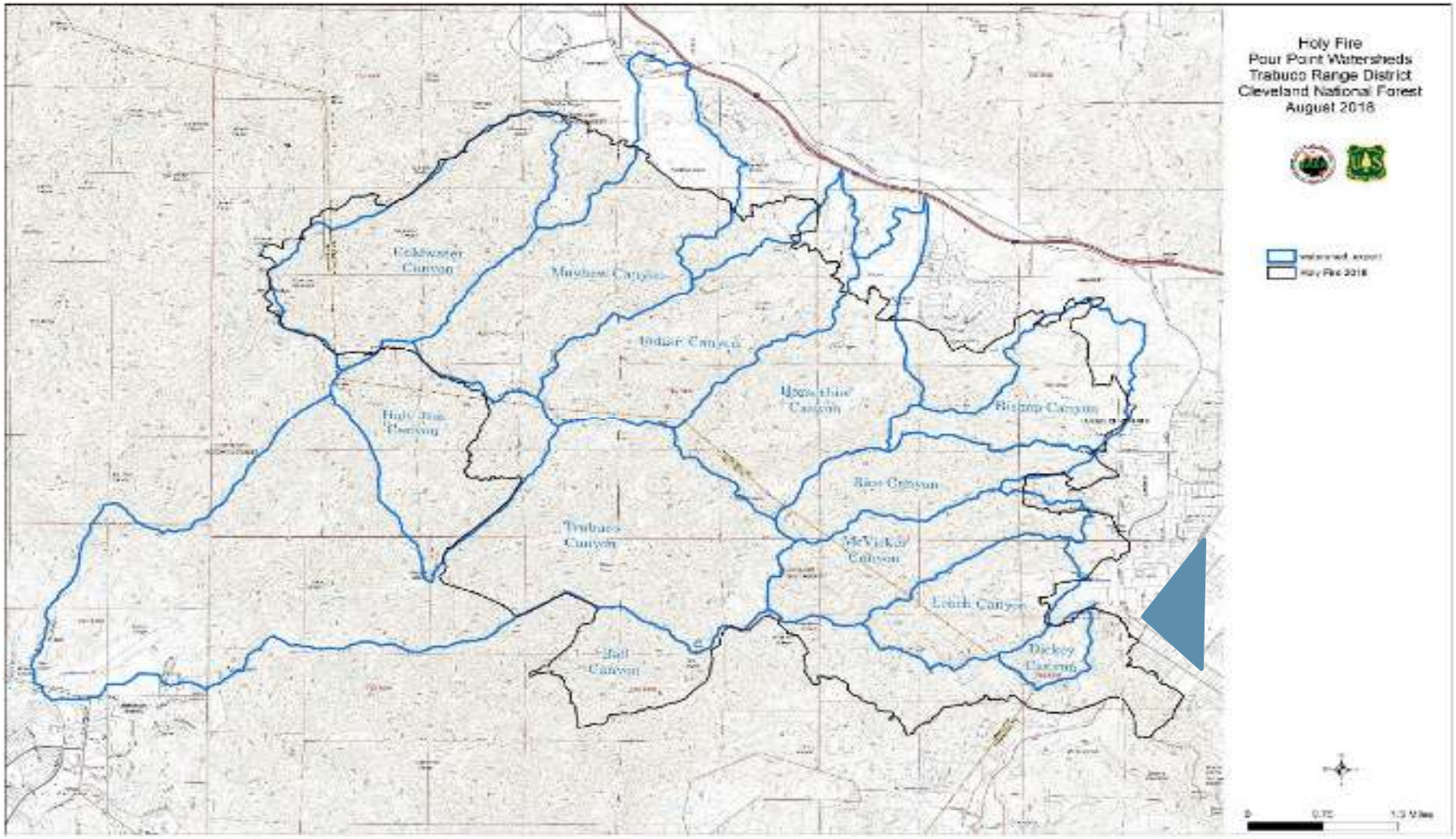
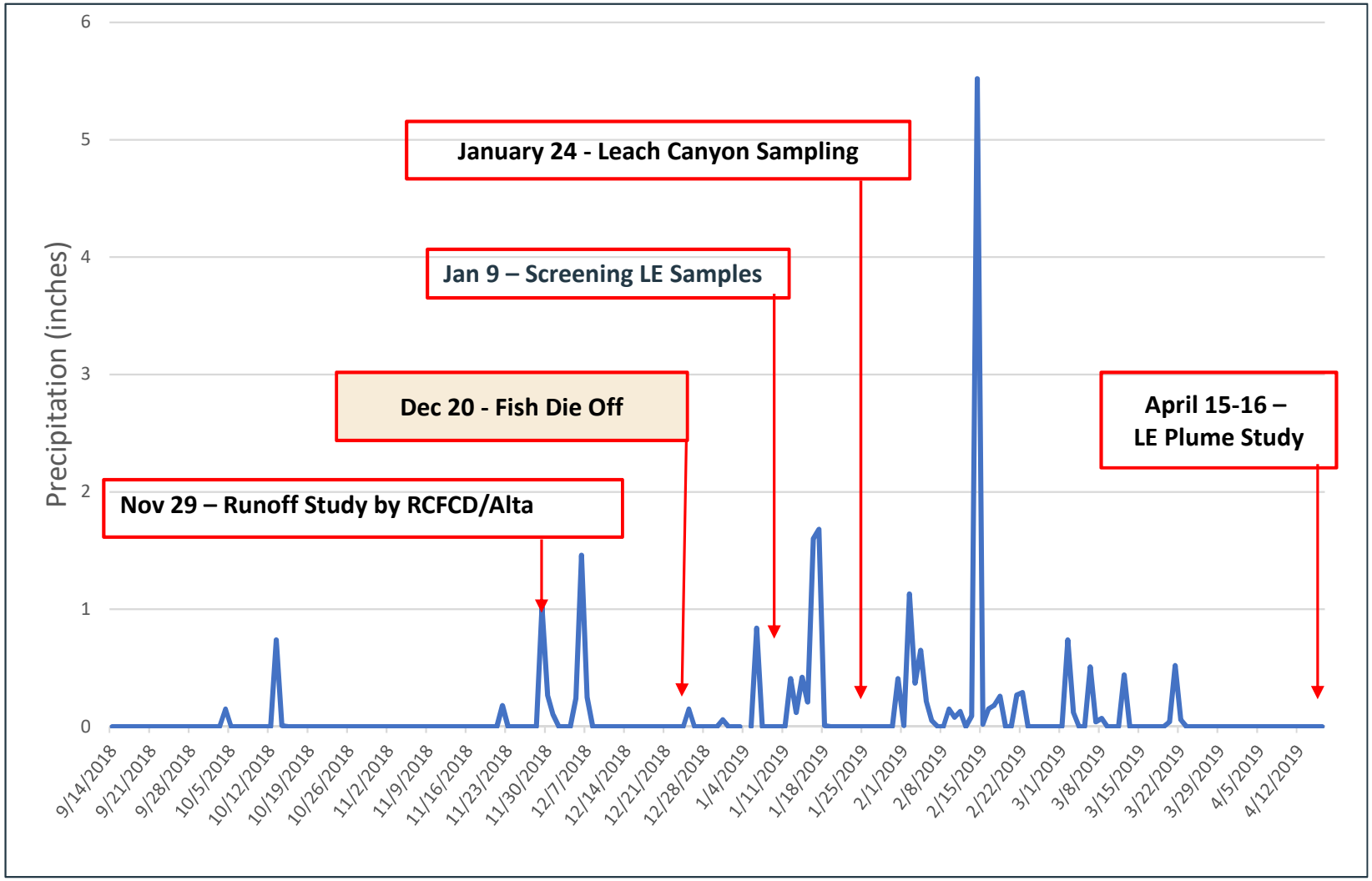


 Photos courtesy of Alta Environmental

Lake Elsinore Sampling and Fish Die off Relative to Rainfall Patterns Between Sept 2018 and April 2019



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https://youtu.be/PUsGqmUN7-U?t=2

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Lake Elsinore Fish Die-off

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- Around December 25 lake staff observed many dead carp on the lake
- Golden Algae was discussed as a possible culprit
- January 9 Wood sampled 5 points around the lake for metals, toxicity, and phytoplankton
  - Metal results were low
  - Fathead minnow acute toxicity was observed
  - Golden Algae, *Prymnesium parvum*, was observed at very high concentrations in all samples
- January 16 - Carp swimming up the EVMWD recycled water input to Lake Elsinore
- Golden Algae likely cause based on multiple lines of evidence

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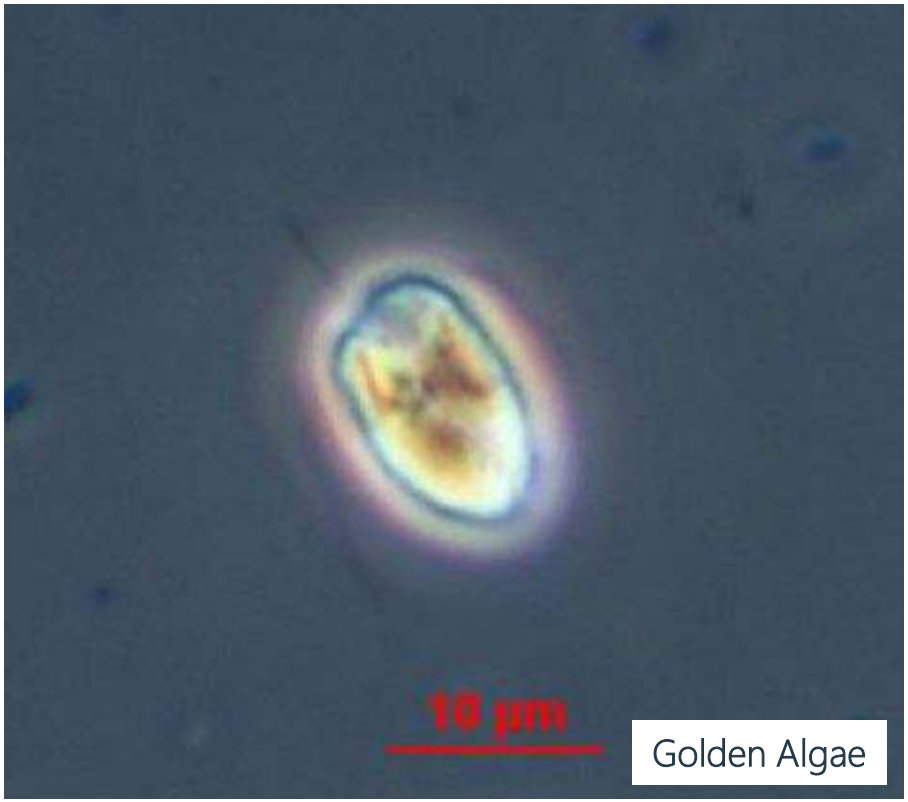

Golden Algae

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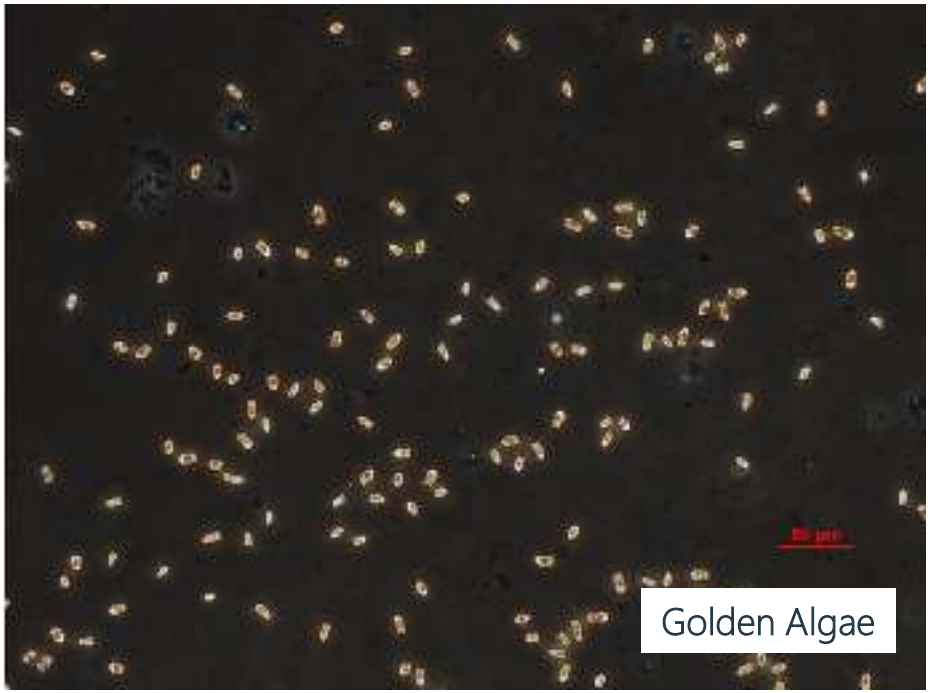

Golden Algae

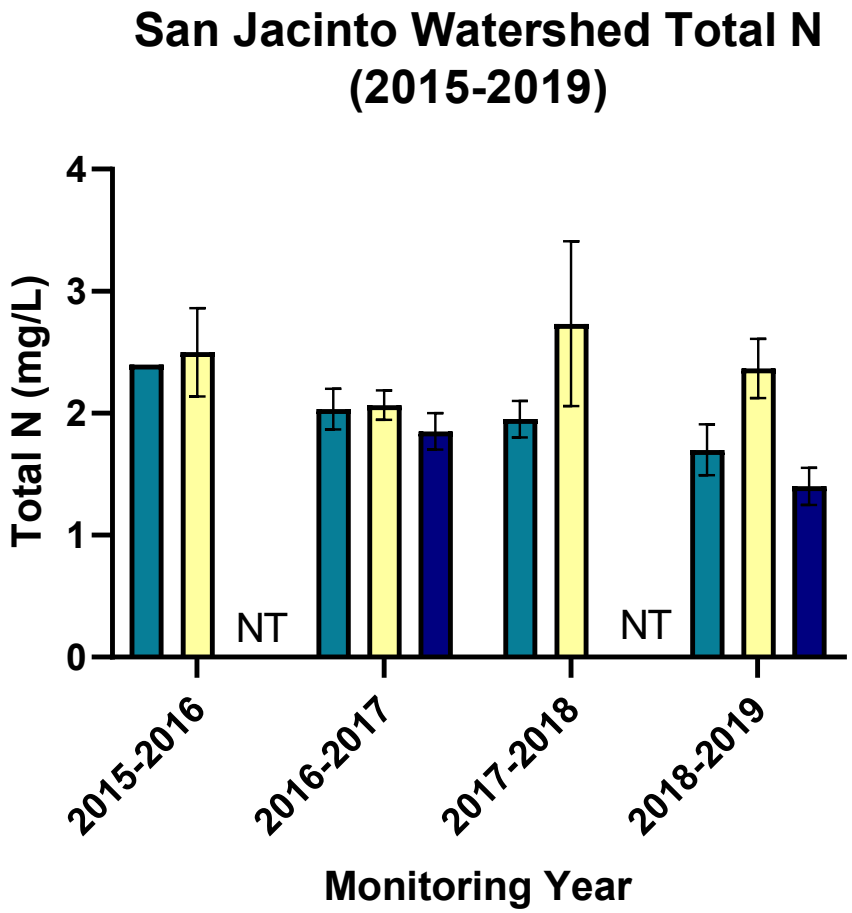
January 24 Leach Canyon Channel Sampling

- TNTP offset monitoring and Leach Canyon Channel sampling
- Overall less dead carp observed on the lake
- Four sample types collected
  - Algal sample from mid-lake for phytoplankton ID
  - Sediment from the new delta formed by the Holy Fire runoff: chemistry and toxicity
  - Two water samples on and near the sediment delta: chemistry
- Very few carp observed in EVMWD recycled water channel

January 24 Leach Canyon Channel Sampling

- Decreased densities of Golden Algae (12th most abundant) mid-lake
- Water from Holy Fire Delta
  - Not toxic (Minnow 100% survival)
  - Nutrients
    - TN = 14 mg/L
    - TP = 7.4 mg/L
  - PAHs – ND
  - Metals (ug/L)
    - Arsenic 87 (T), 3.4 (D)
    - Cadmium 28 (T), ND (D)
    - Copper 520 (T), 1.7 (D)
    - Lead 190 (T), ND (D)
    - Zinc 2300 (T), ND (D)

Relative Watershed Stormwater Concentrations



SJR at Goetz Rd
Salt Creek
Canyon Lake Spillway

Post-Fire Storm Event on 11/29/18 = 58 and 33 mg/L in McVicker's and Horsetheif Canyons

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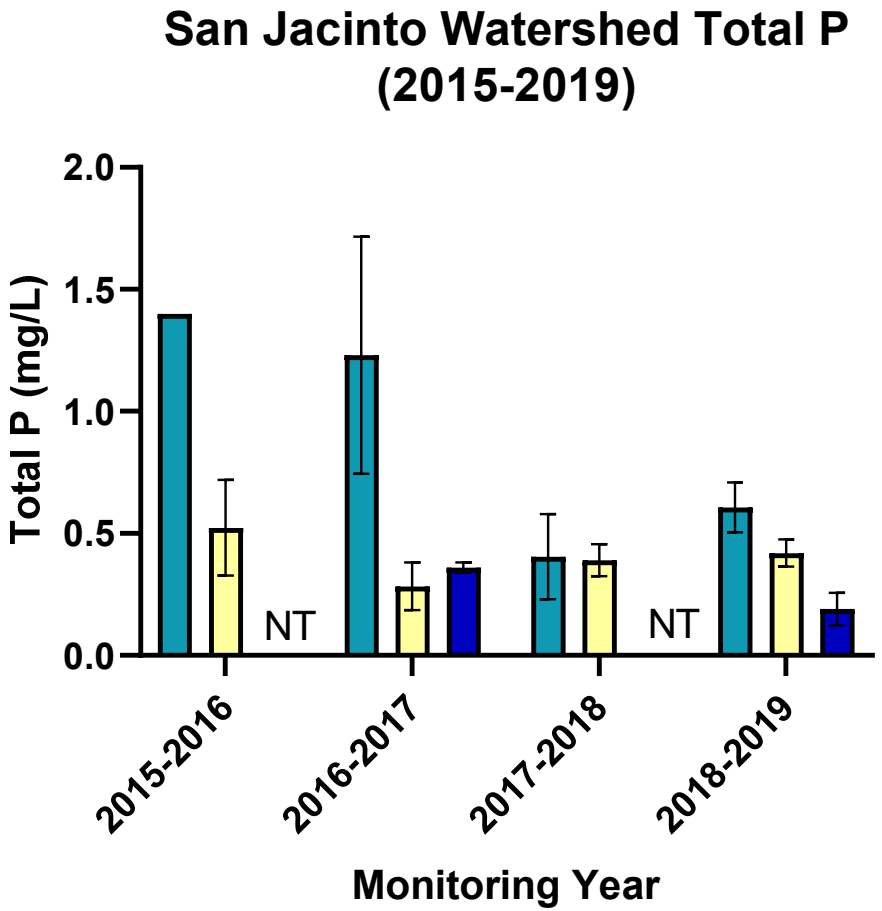


SJR at Goetz Rd
Salt Creek
Canyon Lake Spillway

Post-Fire Storm Event on 11/29/18 = 7.3 and 16 mg/L in McVicker's and Horsetheif Canyons

January 24 Leach Canyon Channel Sampling

- Sediment from Holy Fire Delta
  - Not toxic to (Hyalella 91% survival)
  - Grain size = 93% silt/clay
  - Metals (mg/kg)
    - Arsenic 18.3
    - Cadmium 1.33
    - Copper 54.9
    - Lead 11.6
    - Zinc 180
    - Mercury ND
  - PAHs – Naphthalene 20 ug/kg
  - Total Nitrogen – 1400 mg/kg
  - Total Phosphorus – 39 mg/kg

Holy Fire Sediment Plume Monitoring

- Scope of work provided by Wood for plume monitoring related to the Holy Fire
- SA Regional Board and City of Lake Elsinore worked together on CAA application for additional funding
- TMDL and TNTP Offset monitoring in place to monitor lake impacts

 Photo courtesy of Alta Environmental

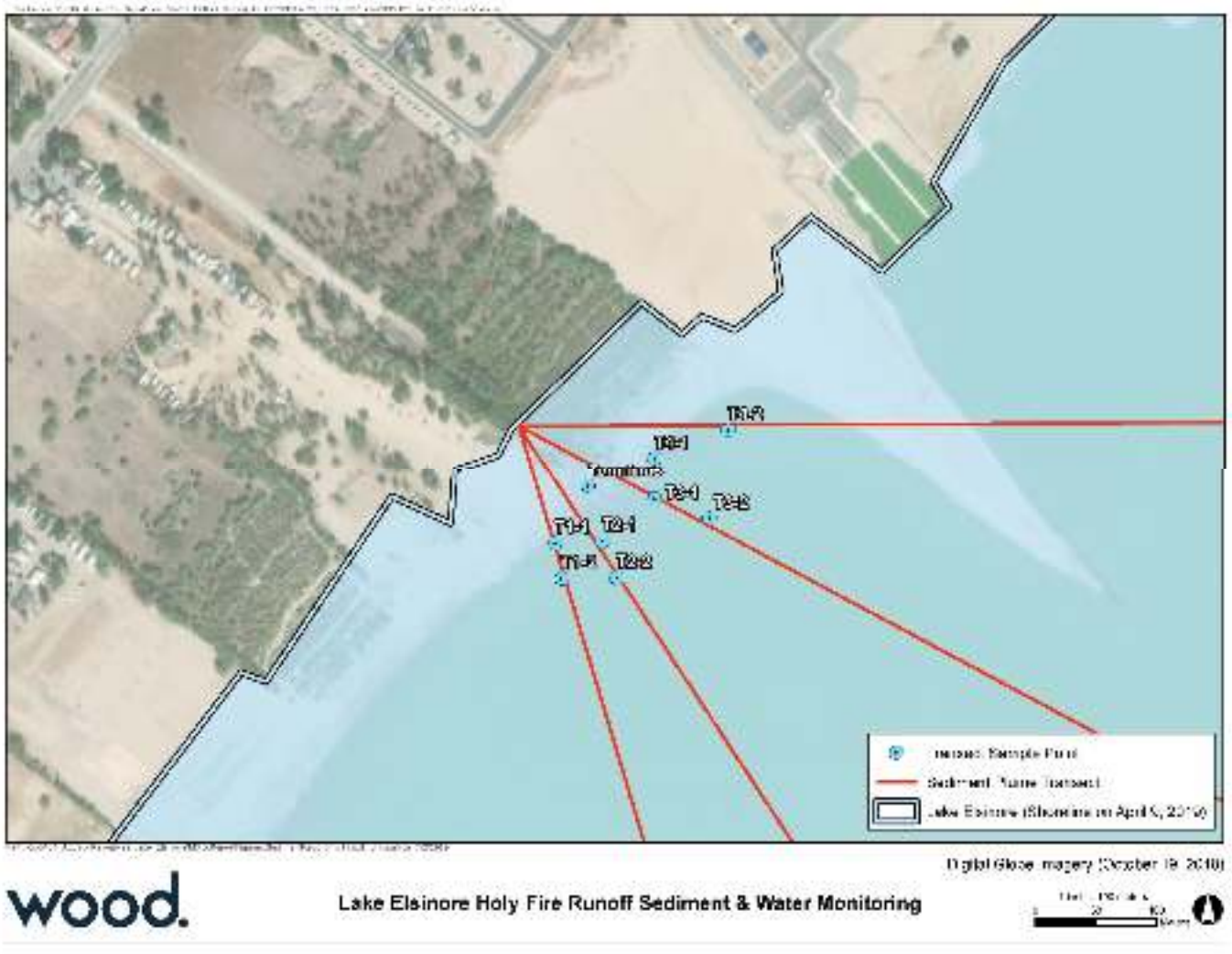
Holy Fire Sediment Plume Monitoring

- Day 1- Delineate lateral extent of delta with transects radiating from the mouth of Leach Canyon Channel (April 15, 2019)
  - 4-5 cores collected along each transect
- Day 2 – Analytical samples collected in three areas (April 16, 2019)
  - Sediment Delta Footprint (3 samples)
  - Beach area just east of Leach Canyon Channel (1 sample)
  - Mid-lake (TMDL Station LE02; 1 sample)
- Five sample types collected
  - Water quality profiles
  - Water samples – chemistry & toxicity
  - Sediment samples – chemistry & toxicity
  - Phytoplankton taxonomy
  - Cyanotoxins

Holy Fire Sediment Plume Monitoring - Analytes Measured

Water Analytes
Phytoplankton Speciation and Enumeration
Cyanotoxins
Chlorophyll-a
Total Suspended & Dissolved Solids (TSS & TDS)
Total & Dissolved Organic Carbon (TOC & DOC)
Major ions
Nutrient Suite
Total and Dissolved Metals
7-day Chronic Fathead Minnow Survival/Growth Toxicity
4-day Acute *Ceriodaphia dubia* Survival Toxicity
Sediment Analytes
% Solids
Total Organic Carbon
Grain size
Nutrient Suite
Polycyclic Aromatic Hydrocarbons (PAHs)
Total Petroleum Hydrocarbons (TPH) Diesel & Oil
Total Metals
10-day Chronic *Hyalella azteca* Survival/Growth Toxicity

Day 1 - Holy Fire Plume Delineation



Day 1 - Holy Fire Plume Delineation

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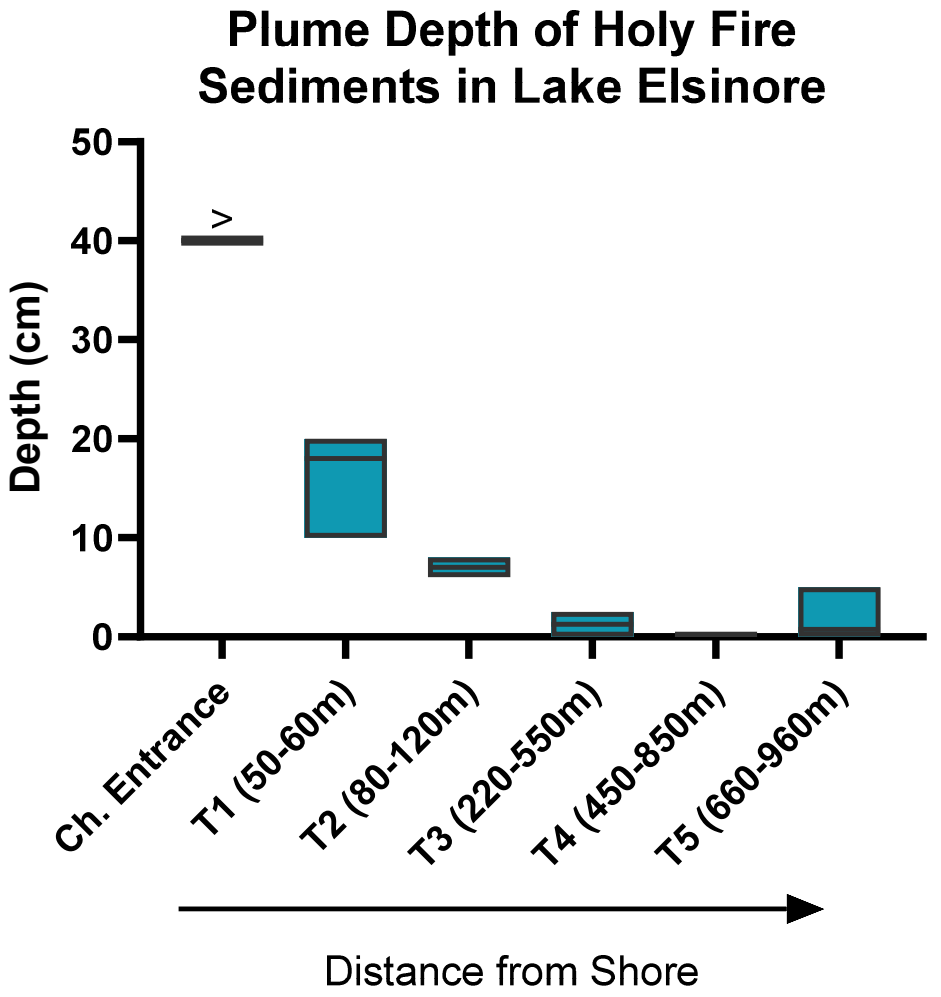
Channel Mouth

Mid-Lake LE02

Day 1 - Holy Fire Plume Delineation

- Fire runoff sediment depth greatest at mouth >40cm
- Decrease with distance from mouth
- Majority of runoff sediment within 550m of channel mouth
- Likely that some fine material influenced much of Lake Elsinore



Day 2 – Analytical Sample Collection

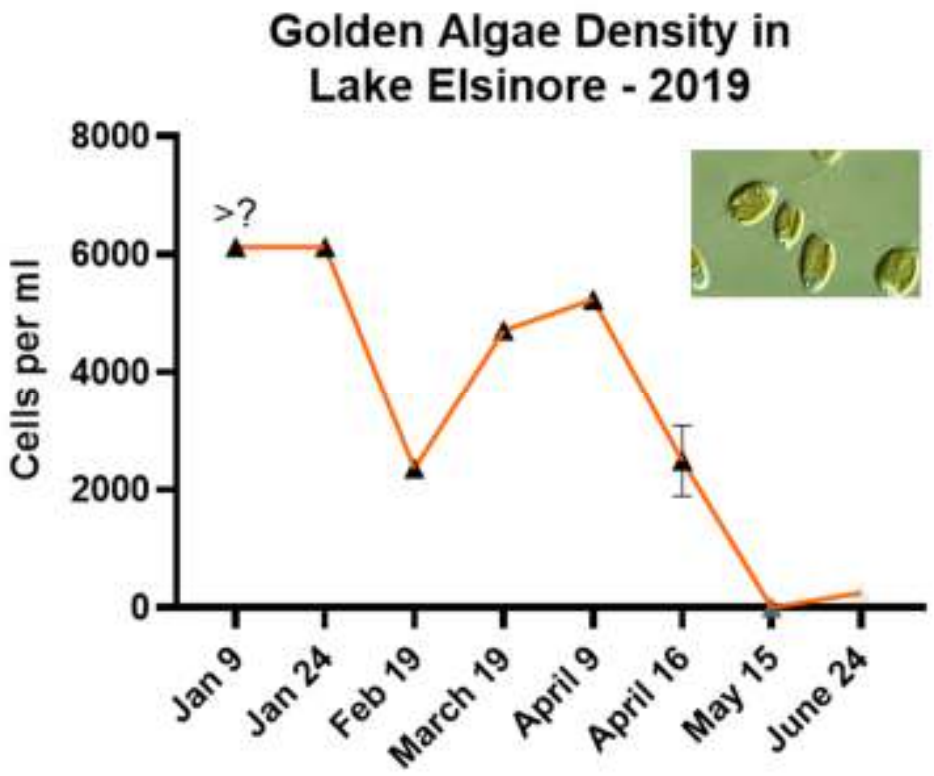
Day 2 – Water Quality Profiles

- No real difference in WQ profiles, except DO

Site	Water Depth (m)	Time	Measure	Surface	1 m	2 m	3 m	4 m	5 m	6 m	7 m	Water Column Mean	Secchi Depth (m)
Plume-1	2.0	0740	Temp (°C)	18.2	18.2	18.2	--	--	--	--	--	18.2	0.40
			Sp. Cond (µS/cm)	3339	3342	3341	--	--	--	--	--	3341	
			pH	9.13	9.14	9.15	--	--	--	--	--	9.14	
			DO (mg/L)	9.4	9.4	9.4	--	--	--	--	--	9.4	
Plume-2	5.0	0915	Temp (°C)	18.5	18.5	18.5	18.5	18.4	18.3	--	--	18.5	0.35
			Sp. Cond (µS/cm)	3342	3343	3344	3344	3344	3344	--	--	3344	
			pH	9.15	9.13	9.13	9.13	9.13	9.13	--	--	9.13	
			DO (mg/L)	8.6	8.5	8.3	8.1	8.1	8.1	--	--	8.3	
Plume-3	5.4	1130	Temp (°C)	18.8	18.8	18.8	18.8	18.7	18.6	--	--	18.8	0.40
			Sp. Cond (µS/cm)	3345	3345	3345	3345	3345	3345	--	--	3345	
			pH	9.12	9.13	9.12	9.12	9.12	9.12	--	--	9.12	
			DO (mg/L)	9.0	8.8	8.6	8.4	8.2	8.1	--	--	8.5	
LE02	7.2	1310	Temp (°C)	19.0	19.0	19.0	19.0	19.0	18.9	18.9	18.7	18.9	0.40
			Sp. Cond (µS/cm)	3345	3346	3345	3346	3346	3346	3346	3345	3346	
			pH	9.13	9.13	9.13	9.13	9.12	9.12	9.11	9.09	9.12	
			DO (mg/L)	8.8	8.8	8.7	8.6	8.4	8.3	8.0	7.2	8.3	
Beach	0.6	1500	Temp (°C)	19.7	--	--	--	--	--	--	--	19.7	0.15
			Sp. Cond (µS/cm)	3322	--	--	--	--	--	--	--	3322	
			pH	9.15	--	--	--	--	--	--	--	9.15	
			DO (mg/L)	12.3	--	--	--	--	--	--	--	12.3	

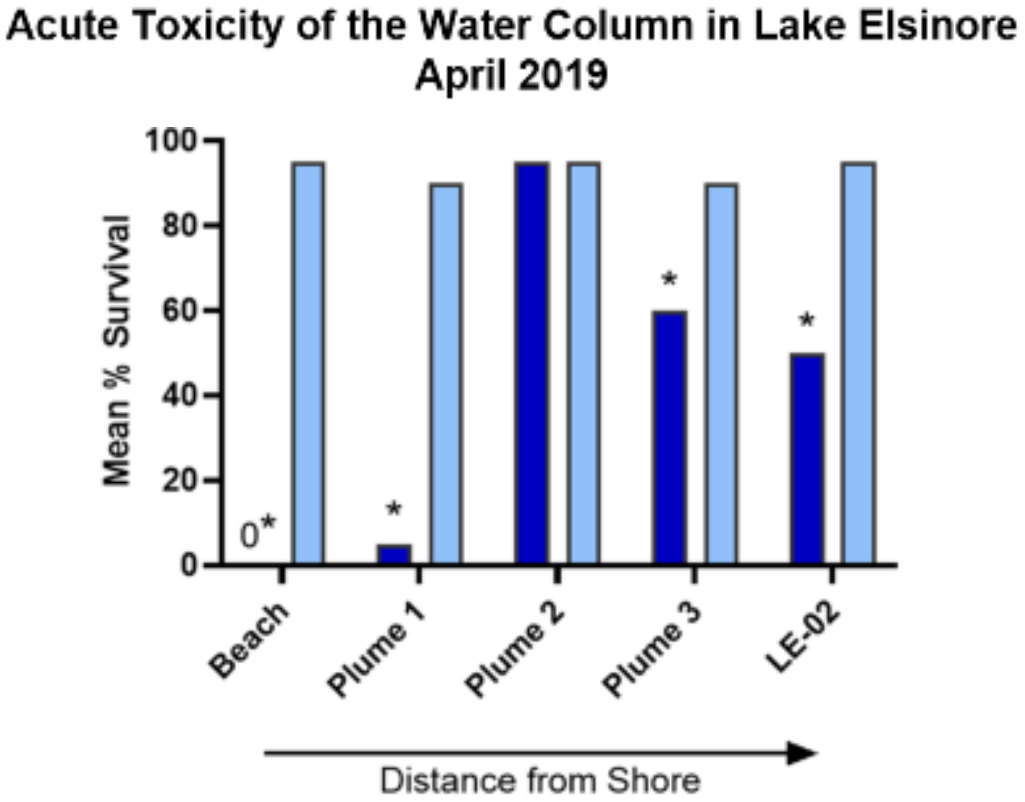
Day 2 – Phytoplankton Trends

- Taxonomic composition of phytoplankton among the three stations monitored did not vary substantially
- Cyanobacteria were 98% of cells at all stations
- Cyanotoxins low at all stations (<2 ug/L Microcystin). Others non-detect.
- Golden Algae density similar across sites, and low relative to prior densities during fish kill
- Paper by K.D. Hambright (Univ of Oklahoma) suggests fish kills occur at densities 20k-50k cells/ml
- But that much lower densities could prove harmful to herbivorous zooplankton



Day 2 – Toxicity

- Water Column
  - Acutely toxic to *C. dubia* in multiple samples, but removed by filtering *(96-hr test)*
  - Survival effects to fathead minnows at only the Beach site (7-day test)
  - Slight effect on fish growth at 4 of the 5 sampling locations
- Sediments
  - No survival effects to *H. azteca* (10-day test)
  - Slight effect on growth of *H. azteca* at only the Beach sampling location



Day 2 – Water Column Chemistry (detections only)

Analyte	Plume-1	Plume-2	Plume-3	Beach	LE02	WQO (mg/L)	CTR (ug/L)
Conventional Constituents (mg/L)							
Calcium	34	37	36	38	34	-	-
Potassium	33	35	33	34	33	-	-
Magnesium	55	59	56	58	56	-	-
Sodium	540	580	550	560	560	-	-
Chloride	710	710	710	710	710	-	-
Sulfate	380	380	380	380	380	-	-
Total Kjeldahl Nitrogen	3.8	4.2	4.1	4.3	9.5	-	-
Total Nitrogen	3.8	4.2	4.1	4.3	9.5	-	-
Total Dissolved Solids	2000	2000	2000	2000	2000	2000	-
Total Suspended Solids	38	28	24	50	30	-	-
Total Phosphorus	0.26	0.25	0.25	0.30	0.25	-	-
Ortho Phosphate Phosphorus	0.044	0.041	0.018	0.048	0.048	-	-
Total Organic Carbon	27	25	23	25	25	-	-
Dissolved Organic Carbon	21	21	21	20	20	-	-
Ammonia-Nitrogen	<.044	<.044	0.086	<.044	<.044	-	-
Chlorophyll a (µg/L)	90	105	83	91	89	-	-

Day 2 – Water Column Chemistry (detections only)

Analyte	Plume-1	Plume-2	Plume-3	Beach	LE02	WQO (mg/L)	CTR (ug/L)
Total Metals (ug/L)							
Arsenic	19.7	15.3	17.5	18.7	18.8	-	-
Copper	2.2	1.6	1.9	2.6	1.9	-	-
Lead	1.2	<1	<1	<1	<1	-	-
Nickel	1.6	1.5	1.6	1.8	1.6	-	-
Selenium	1.9	4.0	3.3	2.9	2.3	-	-
Zinc	<5	<5	6.6	5.5	5.2	-	-
Dissolved Metals (ug/L)							
Arsenic	14.2	16.0	17.4	19.3	20.2	-	150
Chromium	<1	<1	1.0	<1	<1	-	180
Copper	1.2	1.4	1.8	1.8	1.7	-	90
Nickel	1.5	1.6	1.6	1.5	1.5	-	52
Selenium	4.7	4.3	4.5	3.3	3.1	-	5
Zinc	<5	<5	22.3	<5	<5	-	120

Day 2 – Sediment Chemistry (detections only)

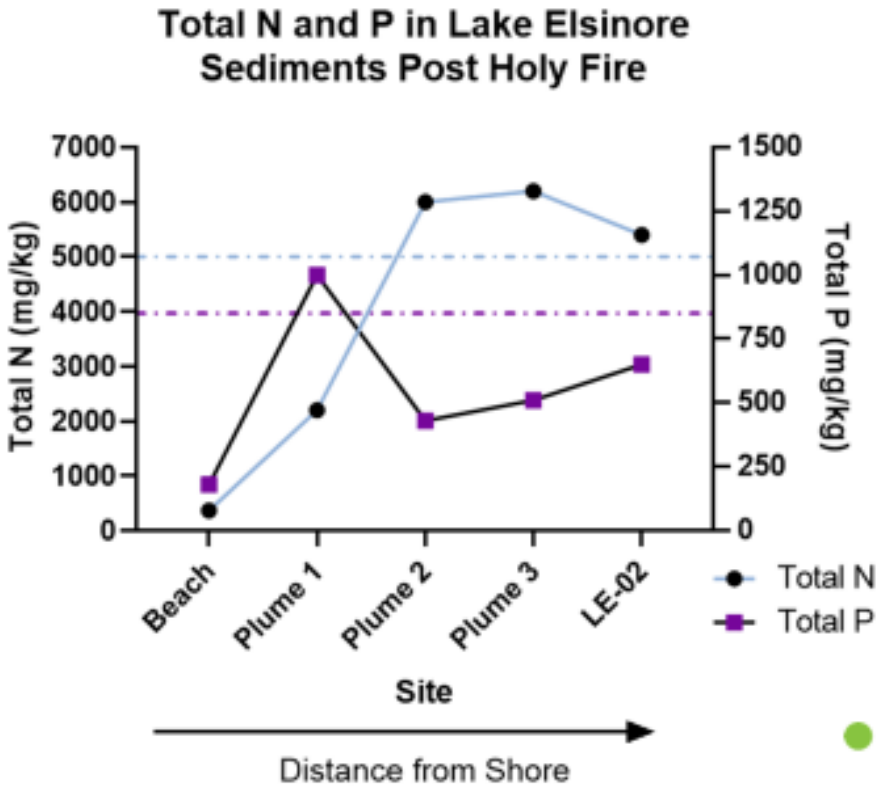
Analyte	Plume-1	Plume-2	Plume-3	Beach	LE02	Units	TEL (mg/kg)	PEL (mg/kg)
Organic Constituents								
2,6-Dimethylnaphthalene	ND	ND	0.49	ND	ND	mg/kg	-	-
Naphthalene	0.045*	ND	ND	ND	ND	mg/kg	0.0346	0.391
Ammonia (as N)	2.6	6.8	20	0.37	71	mg/kg	-	-
Carbon, Total Organic	2.3	2.8	3.2	0.38	6.2	%	-	-
TPH as Diesel	ND	ND	ND	13	ND	mg/kg	-	-
TPH as Motor Oil	ND	ND	ND	62	ND	mg/kg	-	-
Total Metals								
Arsenic	13.6*	5.13	17.7**	2.31	9.32*	mg/kg	5.9	17.0
Cadmium	1.19*	0.397	1.32*	ND	ND	mg/kg	0.60	3.5
Chromium	53.5*	19.5	65.9*	8.71	29.8	mg/kg	37.3	90
Copper	39.9*	14.9	57.4*	4.78	37.6*	mg/kg	35.7	197
Lead	13.3	4.43	19.2	2.62	19.2	mg/kg	35.0	91.3
Nickel	20.8*	7.90	29.9*	3.58	17.4	mg/kg	18.0	36.0
Selenium	0.953	ND	1.18	ND	4.82	mg/kg	-	-
Silver	0.273	0.279	0.374	ND	ND	mg/kg	-	-
Zinc	141*	49.5	193*	29.3	132*	mg/kg	123	315

* Exceeds TEL; ** Exceeds PEL

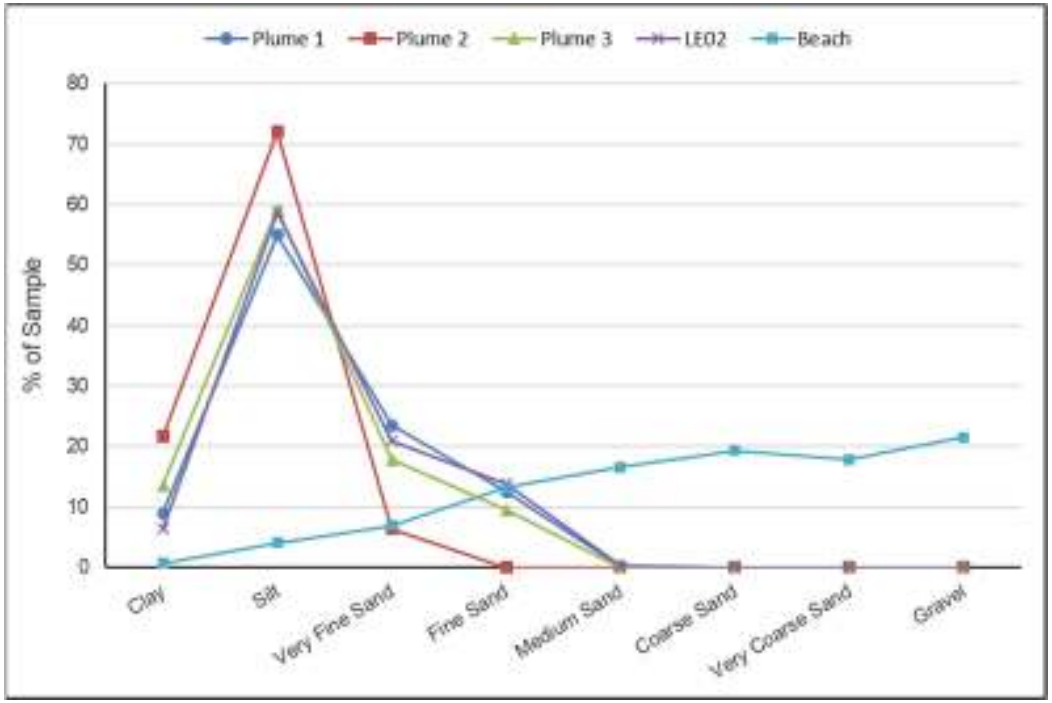
Day 2 – Sediment Chemistry

Analyte	Plume-1	Plume-2	Plume-3	Beach	LE02	Units	TEL (mg/kg)	PEL (mg/kg)
Conventional Constituents								
Total Solids	53.8	45.3	27.4	76.7	10.3	%	-	-
Total Phosphorus	1000	430	510	180	650	mg/kg	-	-
Total Kjeldahl Nitrogen	2200	5900	6100	370	5400	mg/kg	-	-
Total Nitrogen	2200	6000	6200	370	5400	mg/kg	-	-

Dotted horizontal lines represent median LE sediment concentrations reported in the CNRP in studies by Anderson et al.



Day 2 – Sediment Grain Size



Grain Size (% of Sample)	Plume 1	Plume 2	Plume 3	LE02	Beach
Clay	8.9	21.6	13.5	6.3	0.68
Silt	55.0	72.0	59.2	58.7	4.0
Very Fine Sand	23.5	6.3	17.8	20.9	6.9
Fine Sand	12.5	0	9.5	13.8	13.2
Medium Sand	0.15	0	0	0.21	16.6
Coarse Sand	0	0	0	0	19.3
Very Coarse Sand	0	0	0	0	17.8
Gravel	0	0	0	0	21.5

Conclusions

- Sediment plume related to the fire runoff extends approximately 550m from mouth of Leach Canyon Channel
- Phytoplankton identification/enumeration, and water and sediment chemistry showed few notable spatial trends
- Sediment chemistry
    - Six metals (Arsenic, Cadmium, Chromium, Copper, Nickel, and Zinc) and one PAH (Naphthalene) exceeded respective threshold effect (TEL) values
    - One metal (Arsenic) exceeded a probable effect (PEL) value
    - No clear and consistent spatial pattern for metals was observed
    - TN and TP show an opposite spatial pattern of deposition

Conclusions (Cont.)

- Water Column Toxicity
  - Acute toxicity to *Ceriodaphnia* was greatest at stations closest to Leach Canyon Channel. *Filtration removed toxicity.
  - Fathead minnow survival effect observed only at the Beach station
  - Fathead minnow growth impacted at 4 of 5 stations
- Sediment Toxicity
  - No survival toxicity
  - Reduced growth observed at Beach station only
- Water and sediment quality in areas influenced by fire sediment deposition found no indication that select physical characteristics and chemicals of potential concern would have been directly responsible for the fish die off
- Whether sediment deposition from the Holy Fire specifically triggered the Golden Algae bloom is unknown
- Increased sediment Total P at the mouth of the Leach Canyon Channel related to background concentrations may indicate a Holy Fire runoff source which could have a future impact on water quality

End

Lake Elsinore Fisheries Management Program Update

Lake Elsinore Fisheries Management Update

- Have been working through updates to the Work Plan/QAPP
- Most significant updates to the tissue samples for PCBs and DDTs
    - Added in additional PCB congeners and aroclors
- First zooplankton and phytoplankton samples collected July 26th

Lake Elsinore Fisheries Management Sampling Schedule

Sampling Method	# of Stations	Schedule of Sampling	Tentative Dates	Comments
Plankton Tows	3	Tri-annual	July, October, February	Vertical Tows
Beach Seine (¼" mesh)	3	Event 1 (Late Summer) Event 2 (3-4 Weeks After Event 1) Event 3 (3-4 Weeks After Event 2)	Event 1 – Week of Sept 2-6 Event 2 – Week of Sept 23-27 Event 3 – Week of Oct 14-18	Tagging During Events 1&2 only
Tag and Recapture (3000 tags)	3	Late Summer/Early Fall	Concurrent with Beach Seine Events	Recapture During Beach Seining Events 2 & 3
Otter Trawl (16 ft headrope)	3	Late Summer/Early Fall	Week of Oct 7-11	After Beach Seine Event 1&2
Purse Seine (230 ft long, 20 ft deep)	3	Late Summer/Early Fall	Week of Oct 7-11	After Beach Seine Event 1&2