

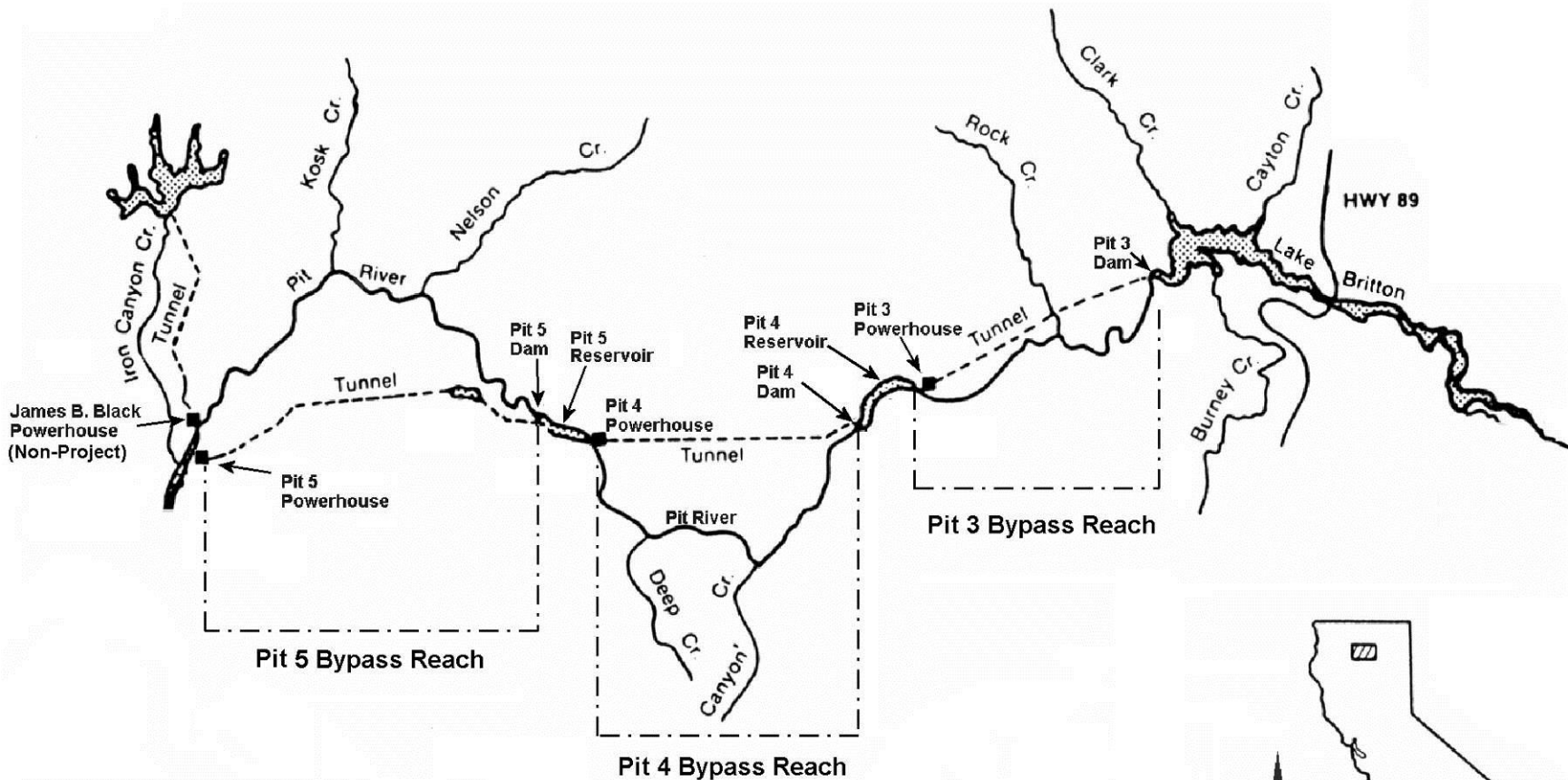
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# Lake Britton 2016 Water Quality Monitoring



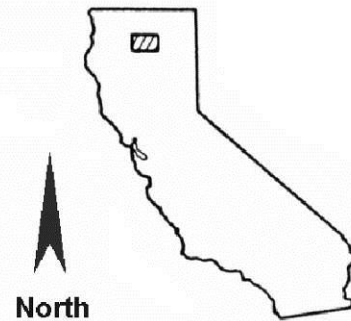
September 2016

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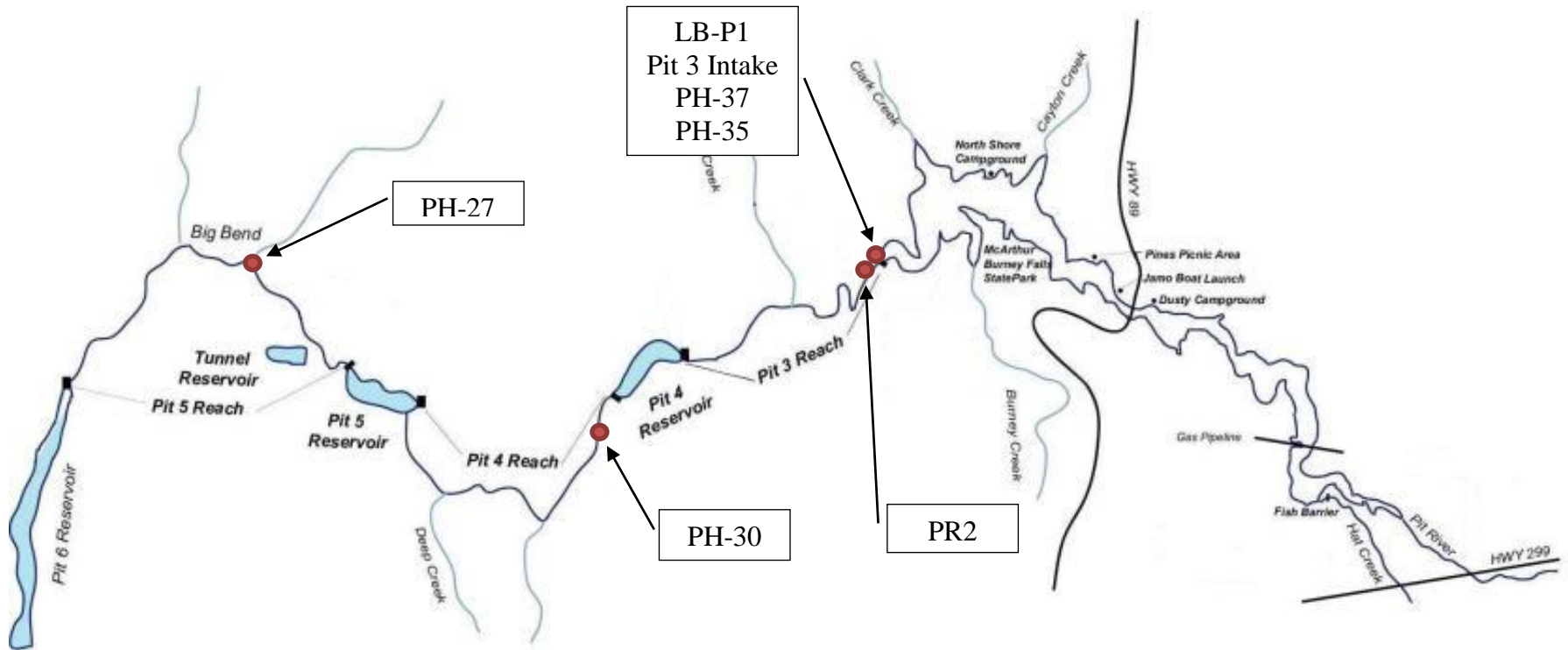


0 5 10

SCALE: kilometers



# Monitoring Network



# Lake Britton Monitoring Objectives

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- Characterize the effects of the new license flow regime on summer water quality (DO and water temperature) in Lake Britton.
  - Monthly synoptic water quality monitored in Lake Britton (1 profile station near dam).
    - June 15<sup>th</sup>, July 12<sup>th</sup>, August 9<sup>th</sup>, September 14<sup>th</sup>
  - Install seasonal meteorology station at Pit 3 Intake.
- Perform visual assessment for the presence/absence of algal blooms in Lake Britton.
  - Conduct monthly visual assessments and photo documentation.

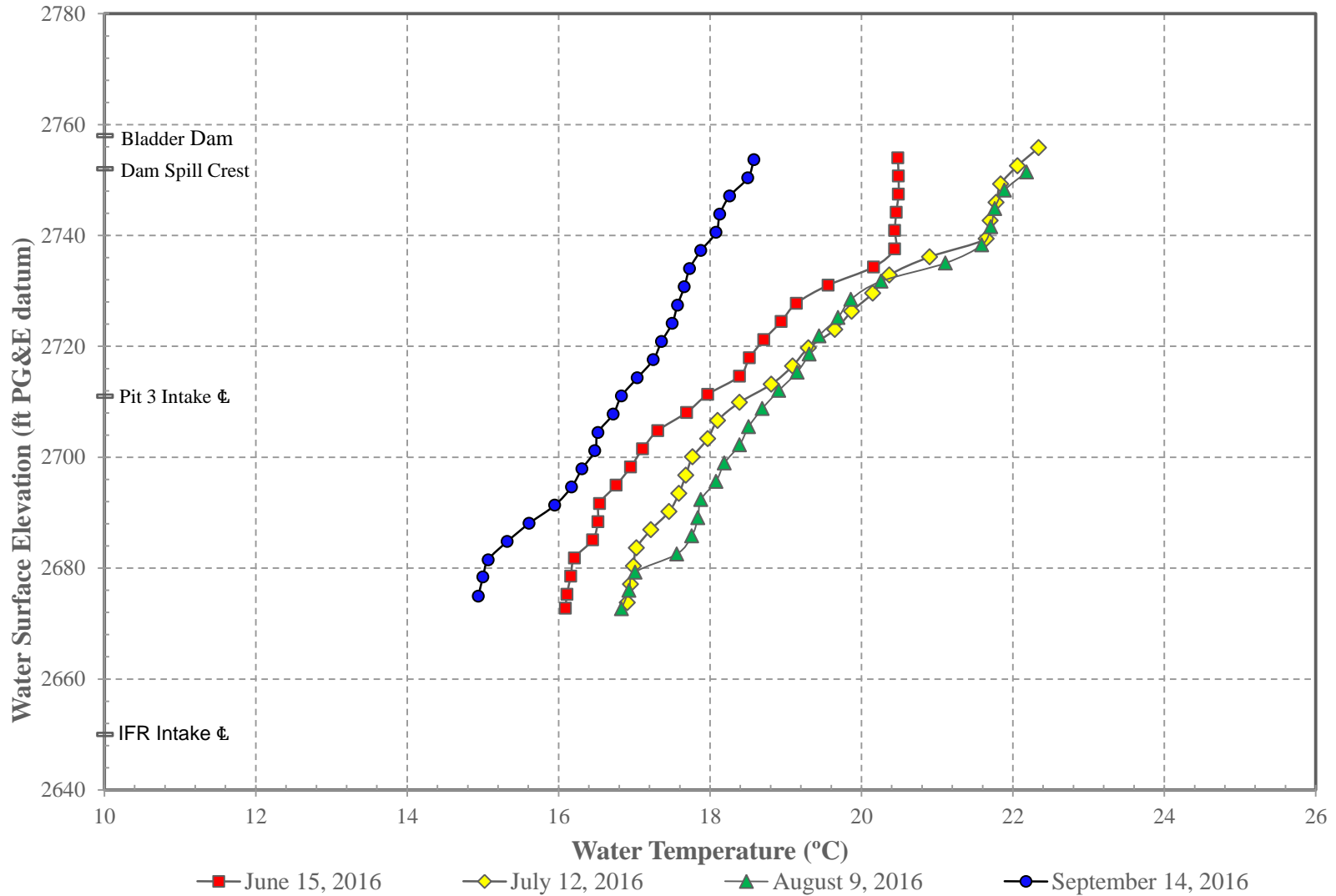
# Regional Hydrology

Water Year	Watershed Runoff				Precipitation <sup>4</sup>	
	DWR Runoff Index <sup>1</sup>	Sac. River Basin WY Type <sup>1</sup>	Flow Into Lake Britton <sup>2</sup>	Pit River WY Type <sup>3</sup>	Hat Creek PH No.1	Pit 5 PH
2016	7.0	Blw Norm	1,629	Blw Norm	14.7 p	62.6 p
2015	4.0	C Dry	1,102	C Dry	15.6	41.0
2014	4.0	C Dry	1,094	C Dry	17.3	75.6
2013	5.8	Dry	1,318	Dry	5.9 p	25.2
2012	6.9	Blw Norm	1,260	C Dry	19.9	86.9
2011	10.0	Wet	1,984	Wet	16.5 p	62.5
2010	6.9	Blw Norm	1,271	C Dry	18.9	99.2
2009	5.5	Dry	1,338	Dry	14.5	68.5
2008	5.4	C Dry	1,456	Blw Norm	13.6	57.2
2007	6.2	Dry	1,367	Dry	13.1	52.7
2006	13.0	Wet	2,646	Wet	14.2	93.7
2005	7.4	Blw Norm	1,686	Abv Norm	23.6	96.1
2004	7.7	Blw Norm	1,599	Blw Norm	18.4	72.0
2003	8.0	Abv Norm	1,656	Abv Norm	20.2	67.6
2002	6.5	Dry	1,524	Blw Norm	13.8	74.8
2001	5.9	Dry	1,482	Blw Norm	14.6	72.8
2000	9.2	Wet	1,911	Abv Norm	17.7	84.4
Average	--	--	1813		18.3	75.9
Maximum	--	--	2,914-1998 WY		34.2	138.8
Minimum	--	--	1,094-2014 WY		7.0	25.2
Data Years	--	--	41		70	64

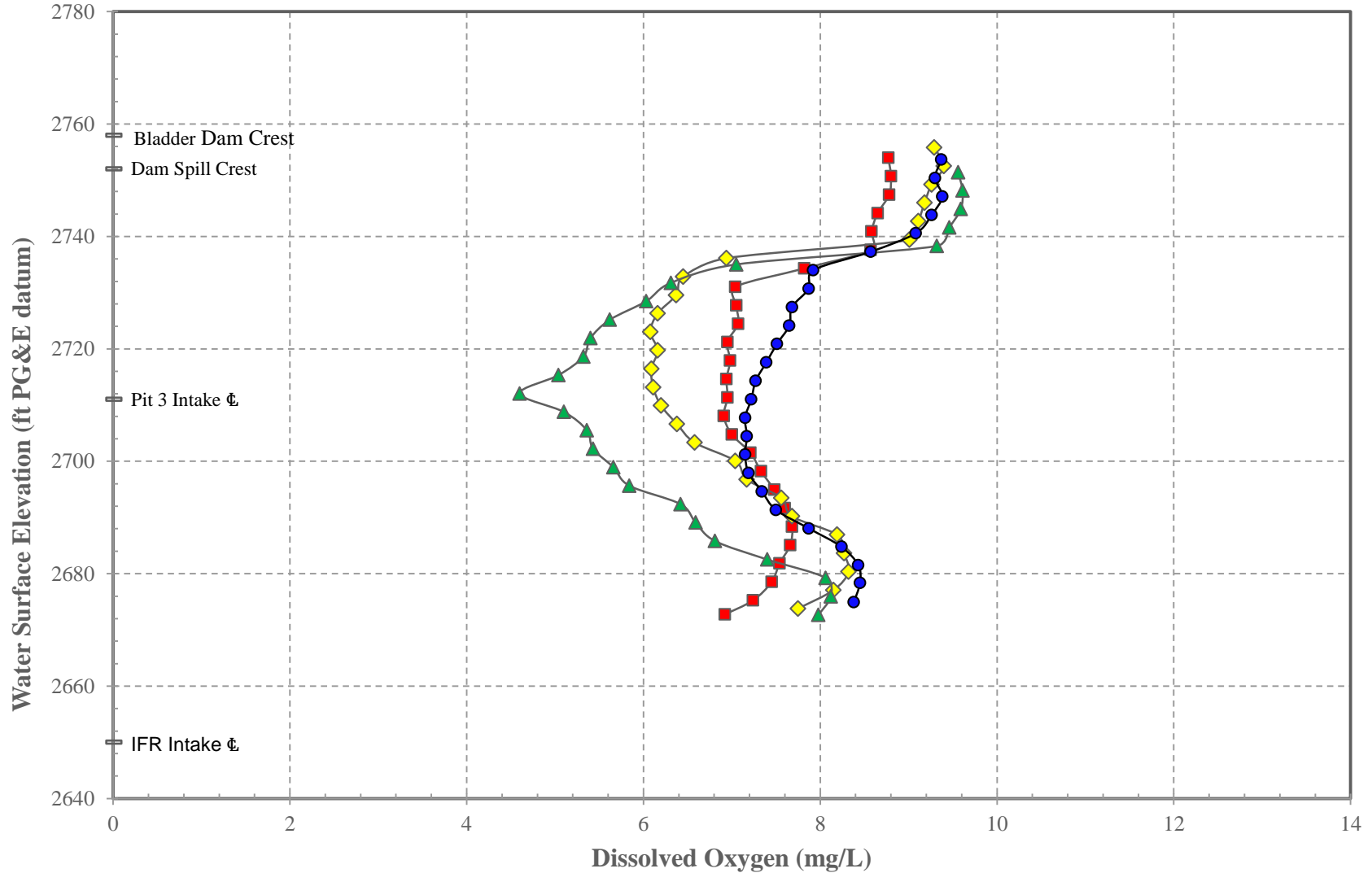
# Project Area Meteorology

Year	Mean Monthly Air Temperature - Hat 1 Powerhouse											
	June			July			August			September		
	Mean (°C)	Exceedance (%)	Class	Mean (°C)	Exceedance (%)	Class	Mean (°C)	Exceedance (%)	Class	Mean (°C)	Exceedance (%)	Class
2015	20.4	1%	Hot	20.7	51%	Norm	20.1	39%	Norm	16.8	43%	Norm
2014	18.3	24%	Abv Norm	23.2	2%	Hot	20.3	30%	Norm	17.0	34%	Norm
2013	18.3	23%	Abv Norm	21.8	26%	Abv Norm	19.0	77%	Blw Norm	15.4	75%	Blw Norm
2012	16.2	80%	Blw Norm	19.9	77%	Blw Norm	21.1	15%	Abv Norm	17.6	14%	Abv Norm
2011	15.5	93%	Cold	19.7	79%	Blw Norm	19.6	52%	Norm	18.7	4%	Hot
2010	15.2	97%	Cold	20.7	50%	Norm	18.8	78%	Blw Norm	15.4	77%	Blw Norm
2009	16.7	63%	Norm	20.6	55%	Norm	19.0	73%	Blw Norm	17.5	25%	Abv Norm
2008	16.4	71%	Blw Norm	20.8	48%	Norm	20.6	26%	Abv Norm	16.4	53%	Norm
2007	17.6	43%	Norm	19.4	87%	Blw Norm	19.2	66%	Norm	14.3	90%	Cold
2006	18.8	16%	Abv Norm	21.5	29%	Abv Norm	18.4	88%	Blw Norm	15.5	72%	Blw Norm
2005	14.0	100%	Cold	21.8	28%	Abv Norm	19.8	46%	Norm	13.2	100%	Cold
2004	17.9	34%	Norm	20.8	46%	Norm	19.4	59%	Norm	15.1	80%	Blw Norm
2003	19.0	13%	Abv Norm	21.9	19%	Abv Norm	18.7	80%	Blw Norm	17.3	28%	Abv Norm
2002	17.8	38%	Norm	21.8	26%	Abv Norm	19.0	74%	Blw Norm	16.3	57%	Norm
2001	16.9	57%	Norm	20.4	62%	Norm	19.5	56%	Norm	16.4	55%	Norm
2000	18.5	21%	Abv Norm	18.8	92%	Cold	19.3	62%	Norm	15.1	79%	Blw Norm
Mean	17.3			20.7			19.7			16.3		
Maximum	21.0			23.5			21.8			19.9		
Minimum	14.0			17.6			16.5			13.2		
Data Years	89			92			90			92		

# Lake Britton Water Temperature Profiles



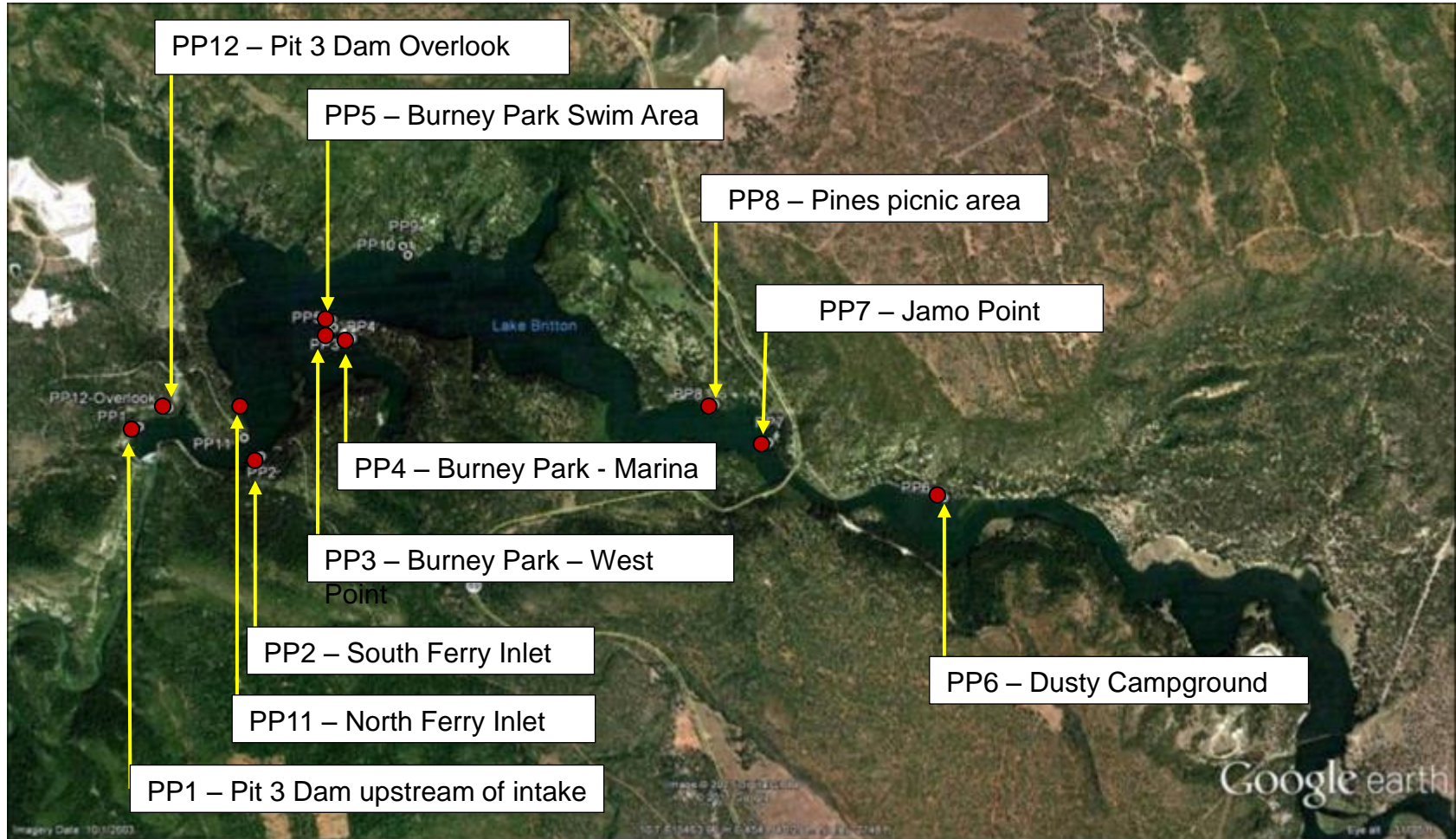
# Lake Britton Dissolved Oxygen Profiles





# Lake Britton Algae Monitoring – Stations

- Monthly observations made at 10 locations around Lake Britton.



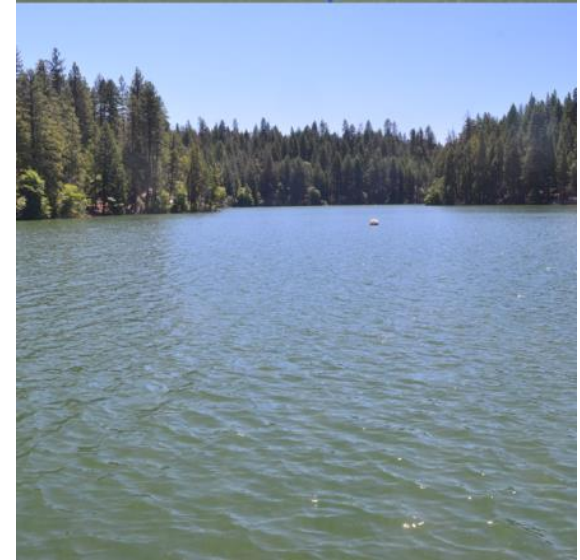
# Lake Britton Algae Monitoring – Visual Assessment

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- Moderate cyanobacteria concentration in July 2016.
  - Some accumulation in quiet cover areas (e.g., State Park Marina, Jamo Boat Ramp).
- Abundance low in August, no film/scum.
- Factors possibly influencing algae production:
  - Water year with moderate inflow (reduced residence time).
  - Cooler meteorology.
  - Moderate turbidity during spring run-off (limited light penetration to sediments).

# State Park—Marina Dock (July 14, 2016)

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# State Park Swim Beach (July 14, 2016)



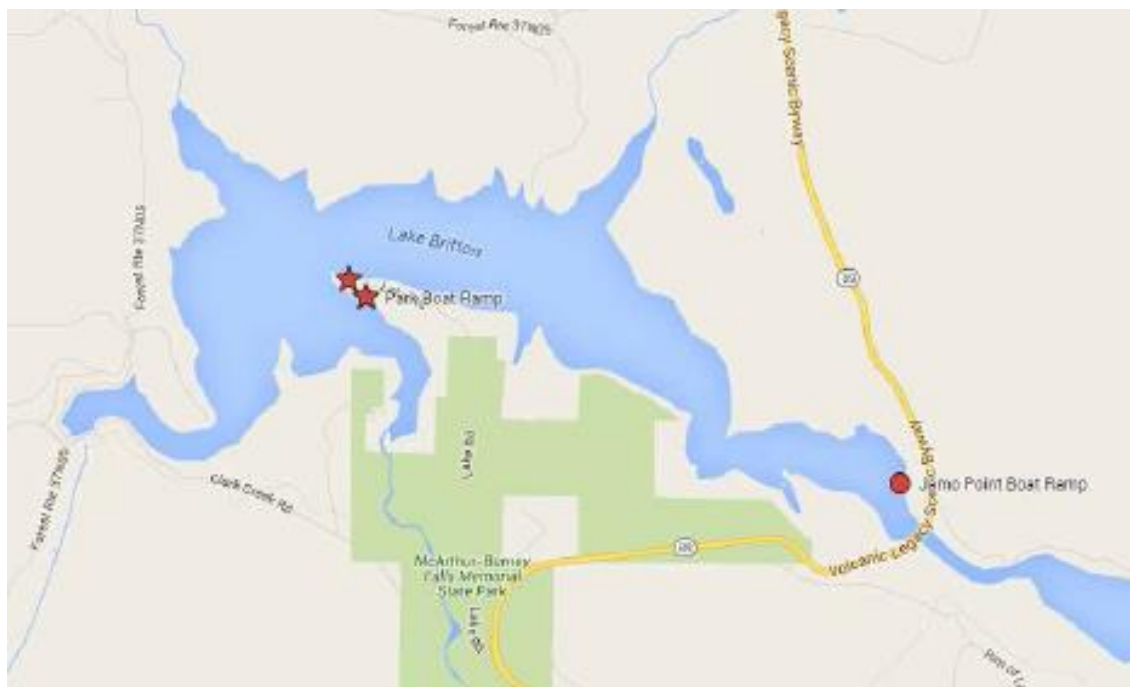


# State Park Swim Beach—August 2016

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July 18, 2016 — Lake Britton water samples from State Park Swim Beach and Burney Creek Cove Marina Boat Ramp  
Visual observations at Jamo Point Boat Ramp (no sample taken)



# Cyanotoxin Analysis Results:

Cyanobacteria genera ID'd Gloeotrichia, Aphanizomenon, and Anabaena

PG&E				<u>Anatoxin-a (ppb)</u> (Test-strips)		
<u>Project</u>	<u>Water Body</u>	<u>Location</u>	<u>GIS Coordinates</u>	<u>10-Aug-</u>		
				<u>18-Jul-16</u>	<u>16</u>	<u>15-Sep-16</u>
Pit 1	Pit 1 Forebay	Fall River Lake ADA Fishing Platform	41.008351, -121.448995		0.31	ND
Pit 345	Lake Britton	State Park Burney Creek Cove Marina Boat Launch Ramp	41.028237, -121.657314	0.41	0.33	ND
Pit 345	Lake Britton	State Park Swim Beach area	41.02902, -121.657663	0.52	0.23	ND
Pit 345	Lake Britton	Jamo Boat Launch	41.019178, -121.623481		0.31	ND
Pit 345	Lake Britton	Northshore Campground Swim Beach W	41.033608, -121.652881		<0.15	ND
Pit 345	Lake Britton					
Pit 345	Pit River	Pit5 Reach Big Bend bridge	41.020616, -121.910600	0.35	0.27	ND
	Shasta Lake	upper Pit River Arm A	40.83738, -122.02012	0.53		
	Shasta Lake	upper Pit River Arm B	40.81686, -122.05859	0.53		
	Shasta Lake	upper Pit River Arm C	40.76676, -122.12199	0.53		

				<u>Microcystins, Cylindrospermopsin (ppb)</u>		
<u>Project</u>	<u>Water Body</u>	<u>Location</u>	<u>GIS Coordinates</u>	<u>10-Aug-</u>		
				<u>18-Jul-16</u>	<u>16</u>	<u>15-Sep-16</u>
Pit 1	Pit 1 Forebay	Fall River Lake ADA Fishing Platform	41.008351, -121.448995		ND	ND
Pit 345	Lake Britton	State Park Burney Creek Cove Marina Boat Launch Ramp	41.028237, -121.657314	ND	ND	ND
Pit 345	Lake Britton	State Park Swim Beach area	41.02902, -121.657663	ND	ND	ND
Pit 345	Lake Britton	Jamo Boat Launch	41.019178, -121.623481		ND	ND
Pit 345	Lake Britton	Northshore Campground Swim Beach W	41.033608, -121.652881		ND	ND
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	Shasta Lake	upper Pit River Arm B	40.81686, -122.05859	ND		
	Shasta Lake	upper Pit River Arm C	40.76676, -122.12199	ND		

# Satellite Multi-spectral Image Analysis

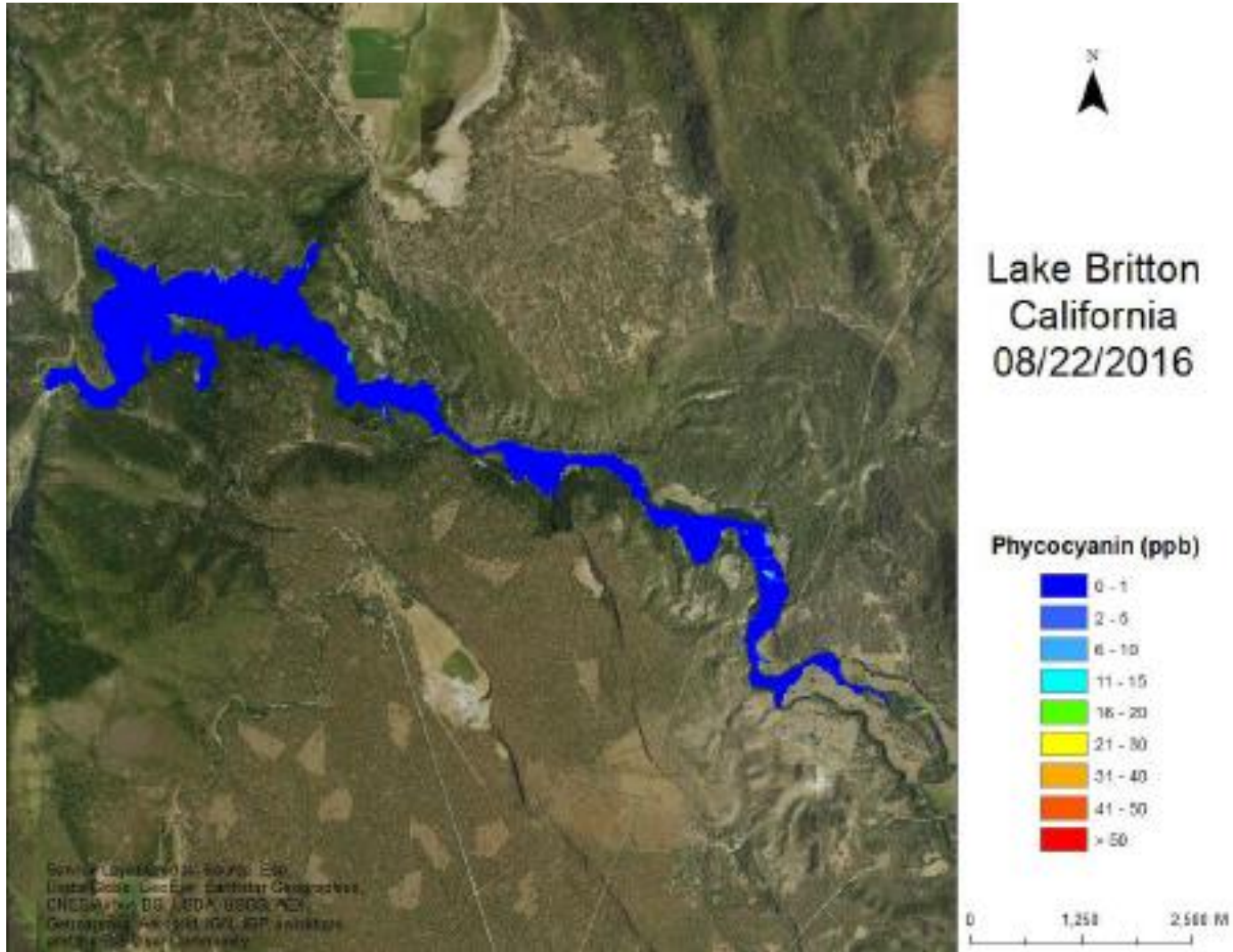
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- Satelytics (Blue Water Satellite, Inc.), Toledo OH
- Proprietary algorithm for phycocyanin concentration (primary cyanobacteria photosynthetic pigment).
- Monthly image analysis for June, July, August, and September using Landsat 7 with a pixel size of 30 square meters. Selected image date as close to physical sampling date as possible.
- Actual image used depended upon cloud cover and capture resolution.
- Conducted annually since 2012 as a supplement to ground level photo point assessment.

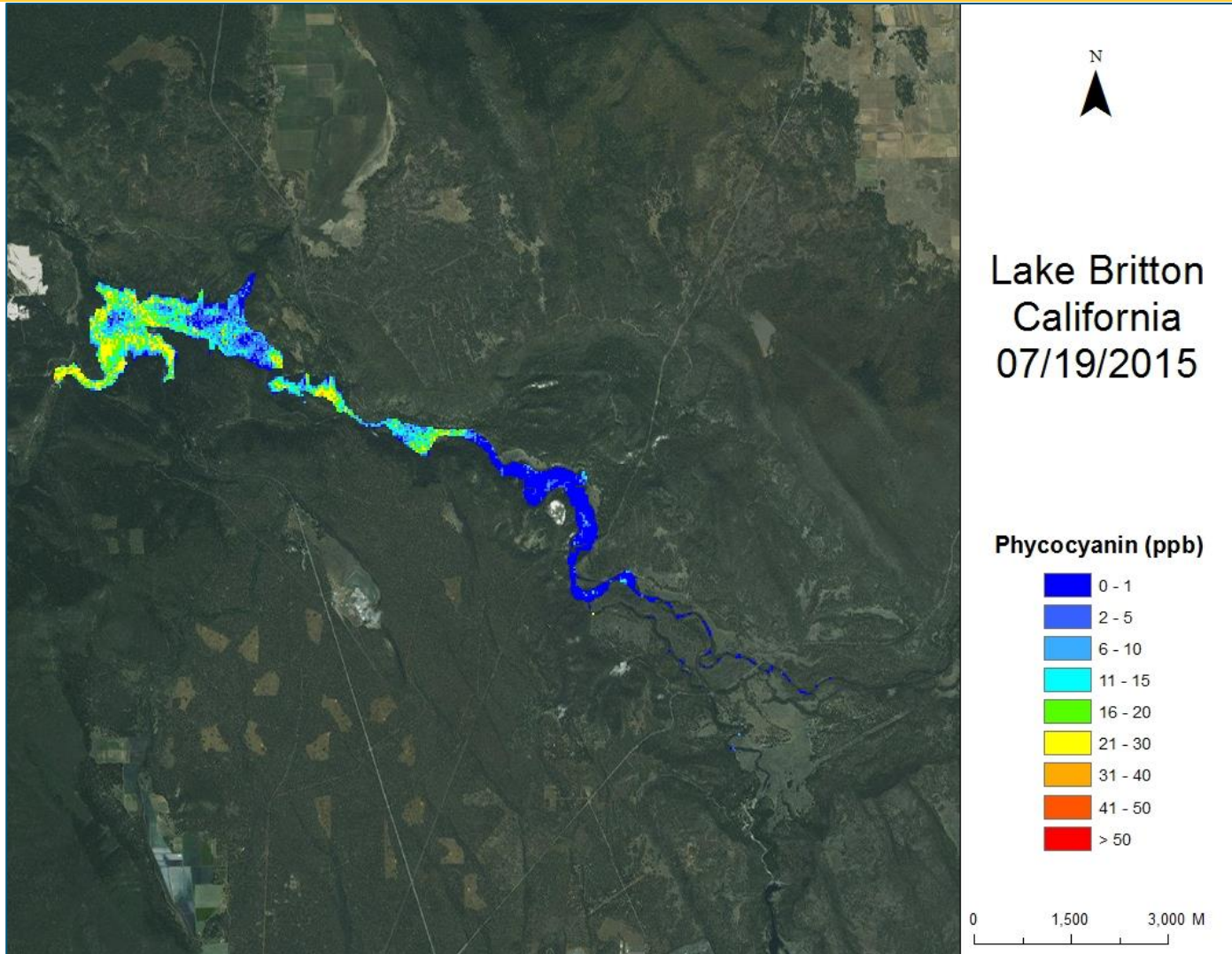




# Lake Britton Algae Monitoring – 2016 Remote sensing

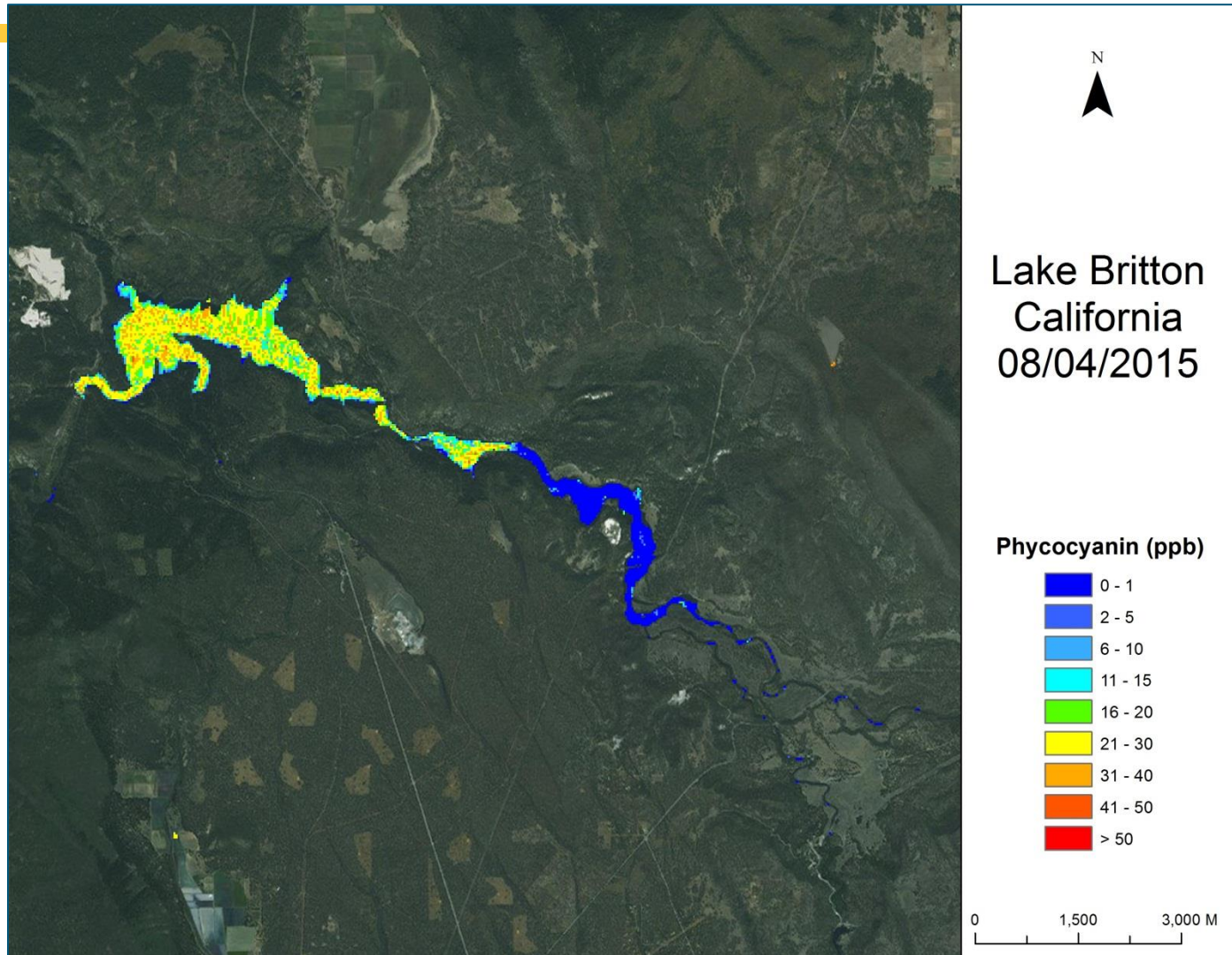


# Lake Britton Algae Monitoring – 2015 Remote sensing





# Lake Britton Algae Monitoring – 2015 Remote sensing



# Cyanotoxin Monitoring Challenges

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- Definition of Bloom Conditions
  - Satellite Imagery provides big picture view
  - Some “blooms” can be very localized
- Trigger values for anatoxin-a
  - Maybe present with “background” levels of cyanobacteria
  - Analytical sampling costs
- Public perception of environmental health risk
  - Could be “acclimated” to postings if too conservative