LAKE TAHOE CLARITY TREND ANALYSIS PROJECT SUMMARY

AUGUST 2020

- Ramon Naranjo (USGS – Carson City)
- Paul Work (USGS - Sacramento)
- Alan Heyvaert (Desert Research Inst.)
- Geoff Schladow, Alicia Cortes, Lidia Tanaka, Shohei Watanabe (UC Davis)
- Şebnem Elçi (Izmir Inst. Of Tech., TR)

- *Preliminary results, pending USGS approval*

PROJECT COMPONENTS

- **Quantify Clarity Trends**
- **Assemble Relevant Datasets**
- **Hypothesis 1** – Clarity controlled by fine particles in suspension.
- **Hypothesis 2** – Winter clarity changing due to fine suspended sediment load reductions.
- **Hypothesis 3** – Changing hydrodynamic conditions are increasing thermal stability and resistance to mixing.
- **Hypothesis 4** – Summer clarity is changing due to more intense stratification.
- **Hypothesis 5** – Ecological interactions are influencing clarity trends.

DATA ROUNDUP

Secchi depths since late 1960s

Some time series much more recent:
- fine particles 2008-present
- atmospheric 2000-present
- urban loading 2014-present

Environment	Parameter	Environment	Parameter
Lake	Secchi Depth	**Streams**	Discharge
	Water Temp.		Nutrients (N, P)
	Particle Size Distribution		Suspended Sediment
	Nitrogen		Particle Size Distribution
	Phosphorus	**Atmospheric**	N, P
	Chlorophyll	**Meteorology**	Wind
	Cyclotella		Air Temperature
	Mixing Depth		Solar Radiation
	Stratification Length	**Climate**	Precipitation
	Peak Stratification		Snow Water Equivalent
	End of Stratification	**Urban**	Fine Sediment Particles
	Buoyancy Frequency		Pollution Load Credits
	Stability Index		N, P

MULTI-DECADAL CLARITY TRENDS: 1968-2019

- Long-term trend shows reduced clarity.

-17 cm/yr for annual time series.

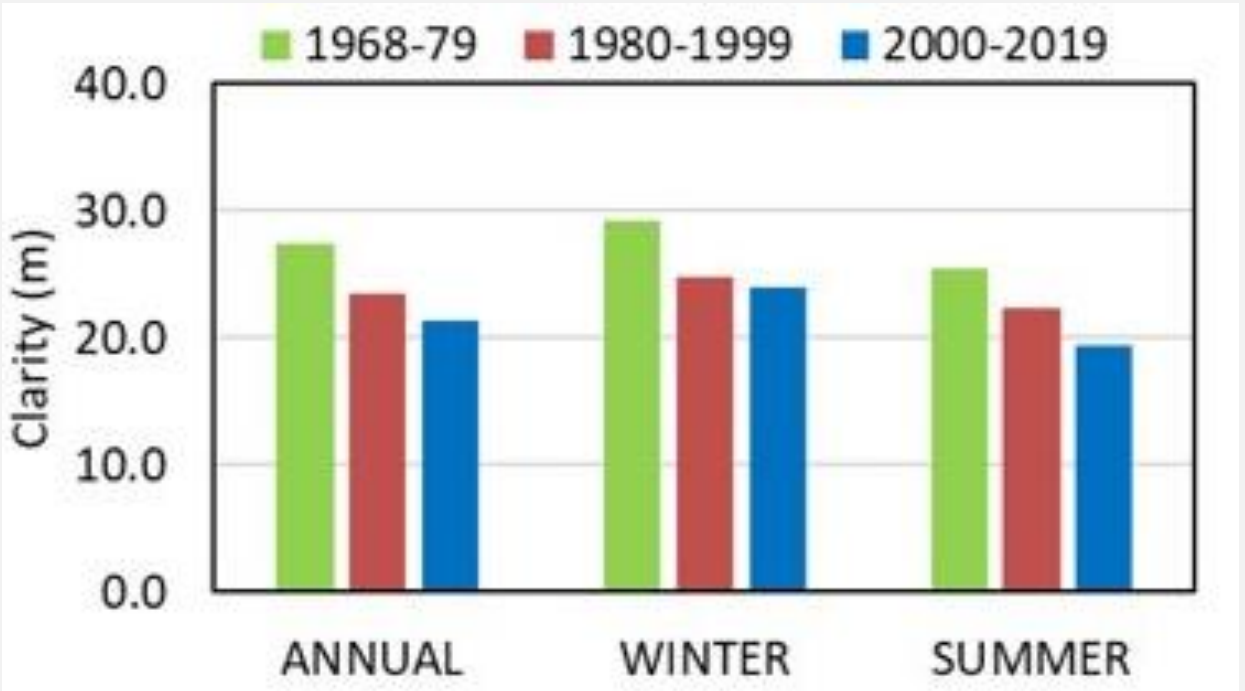
- 1980-1999 and 2000-2019

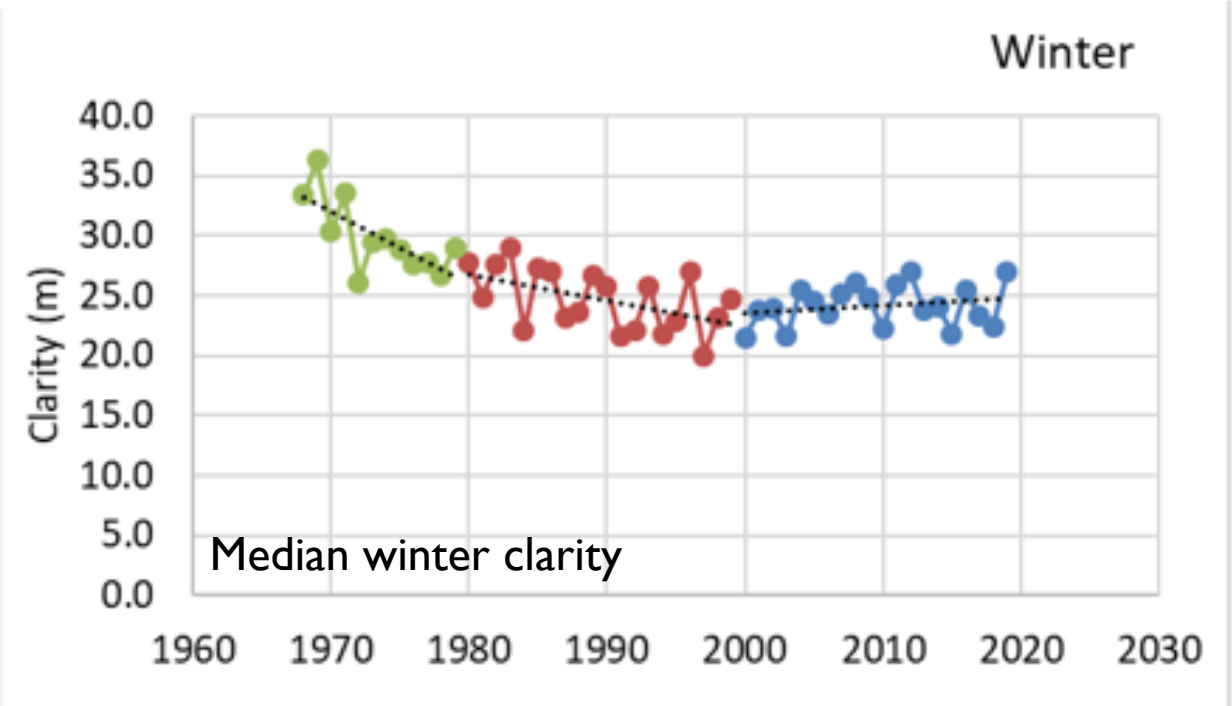
Winter went from negative trend to no trend.

Summer trend still negative.

- 2000-2019

Summer months July and August display strongest trends



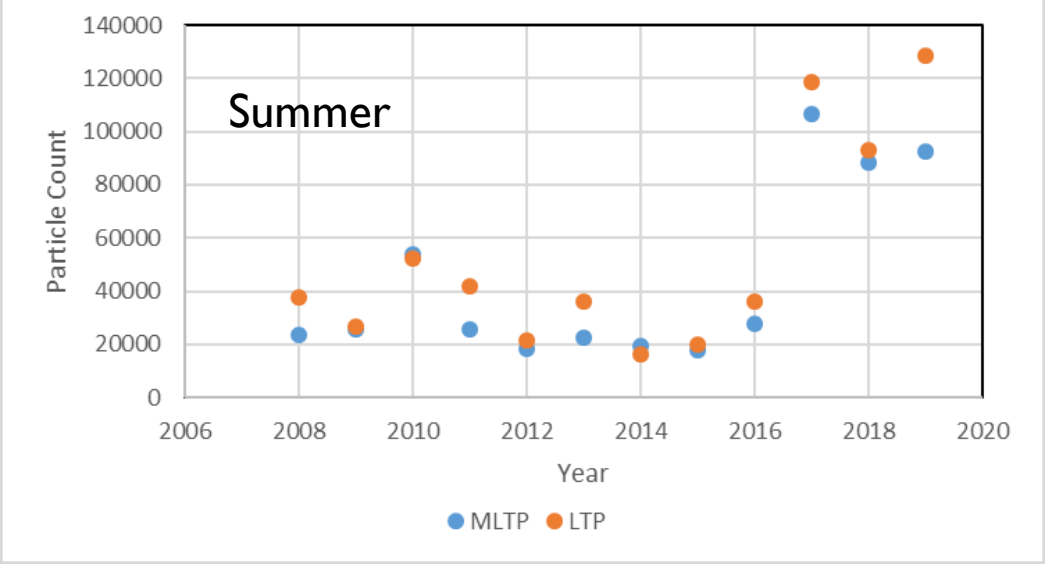


HYP. 1, 2: INFLUENCE OF FINE PARTICLES IN SUSPENSION

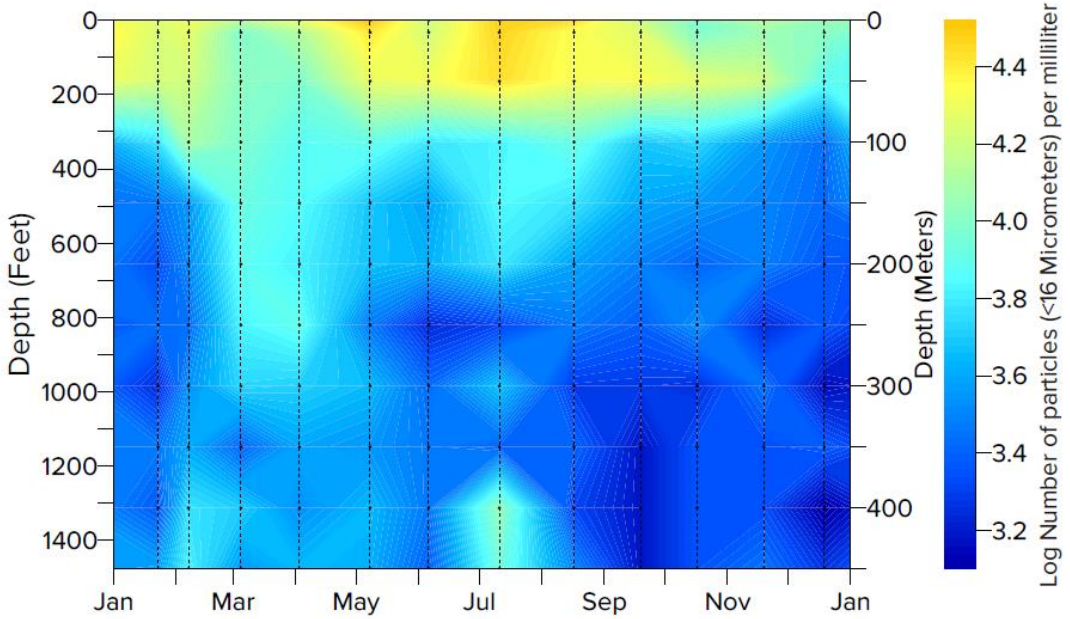
Fine Particles: 2008-2019

0.5 – 20 μm, 0-50 m depth range

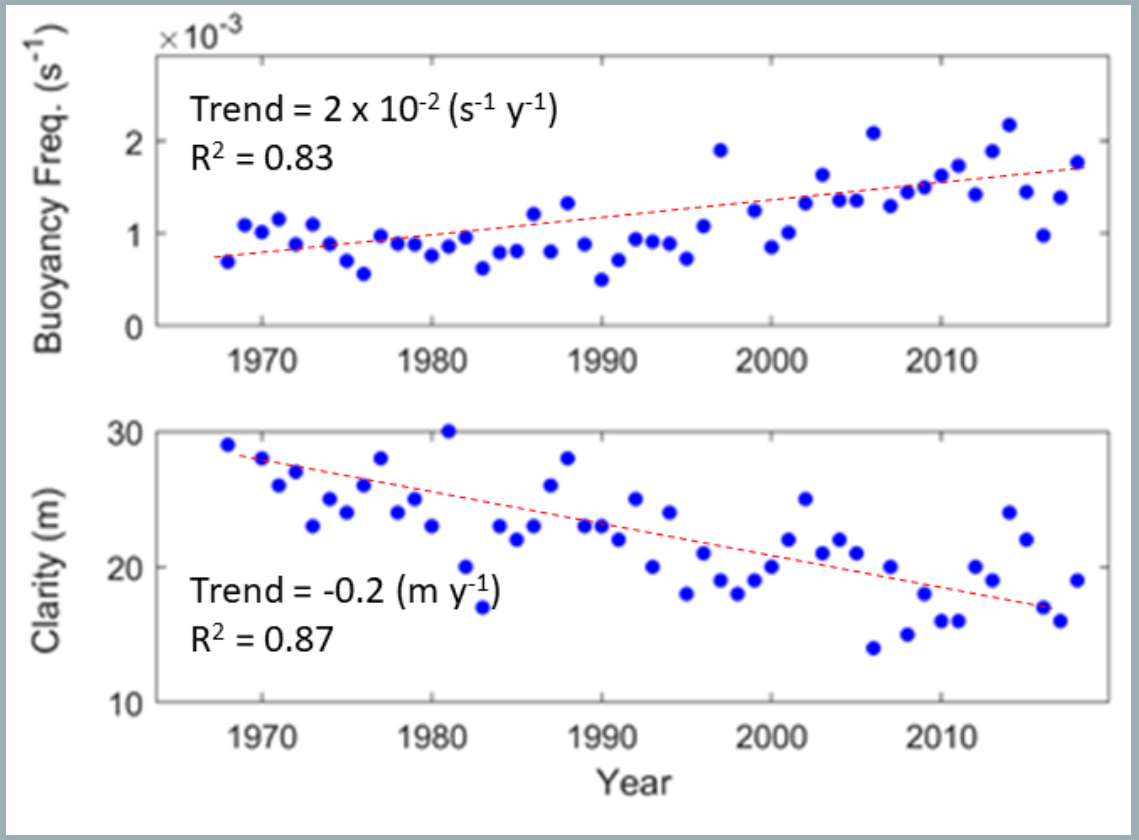
Includes sediment and other particles



- Large increase in 2016-17, both in lake and in streams
- Clarity negatively correlated with particle abundance (1-5 μm).
- Size and type of particle is important.
- Insufficient field data to assess stream loading or trends in urban loading.



HYP. 3, 4: CHANGING HYDRODYNAMICS AND STRATIFICATION



- Summer clarity correlated with date of onset of stratification, duration of stratification, and buoyancy frequency
- Lake stratification is commencing earlier in the year and extending a month longer than 50 yrs ago
- Date of maximum mixing is occurring progressively earlier in the year. Often now occurs in winter
- Stronger, longer-duration stratification appears to influence suspended particle behavior and biological activity to collectively reduce summer clarity

HYP 5: ECOLOGICAL CHANGES IMPACTING CLARITY

- Potential effect of *Mysis* shrimp introduction on *Daphnia, Bosmina*, and fine particles within the lake
- Motivated in part by a 6-year study of *Mysis* disappearance and return in Emerald Bay
- *Mysis* predation ➡ *Bosmina* (filter feeding) ➡ Fine particle (and *Cyclotella* abundance*)* ➡ clarity change

PROJECT TIMELINE

- 1/16/20: Work order signed; group had first meeting
  Biweekly meetings since then.
- Jan-May 2020: Data assemblage, analysis and assessment
- 3/31/20: Delivered report outline for review comments
- 4/17/20: Mid-project meeting with agency leads
- 5/6/20: Briefing with agency reps
- 6/15/20 Draft documents distributed for Council review
- June-August 2020: edit to address review comments
- 8/6/20: Delivered two-page summary of report
- Final Report. Project end date September 30, 2020