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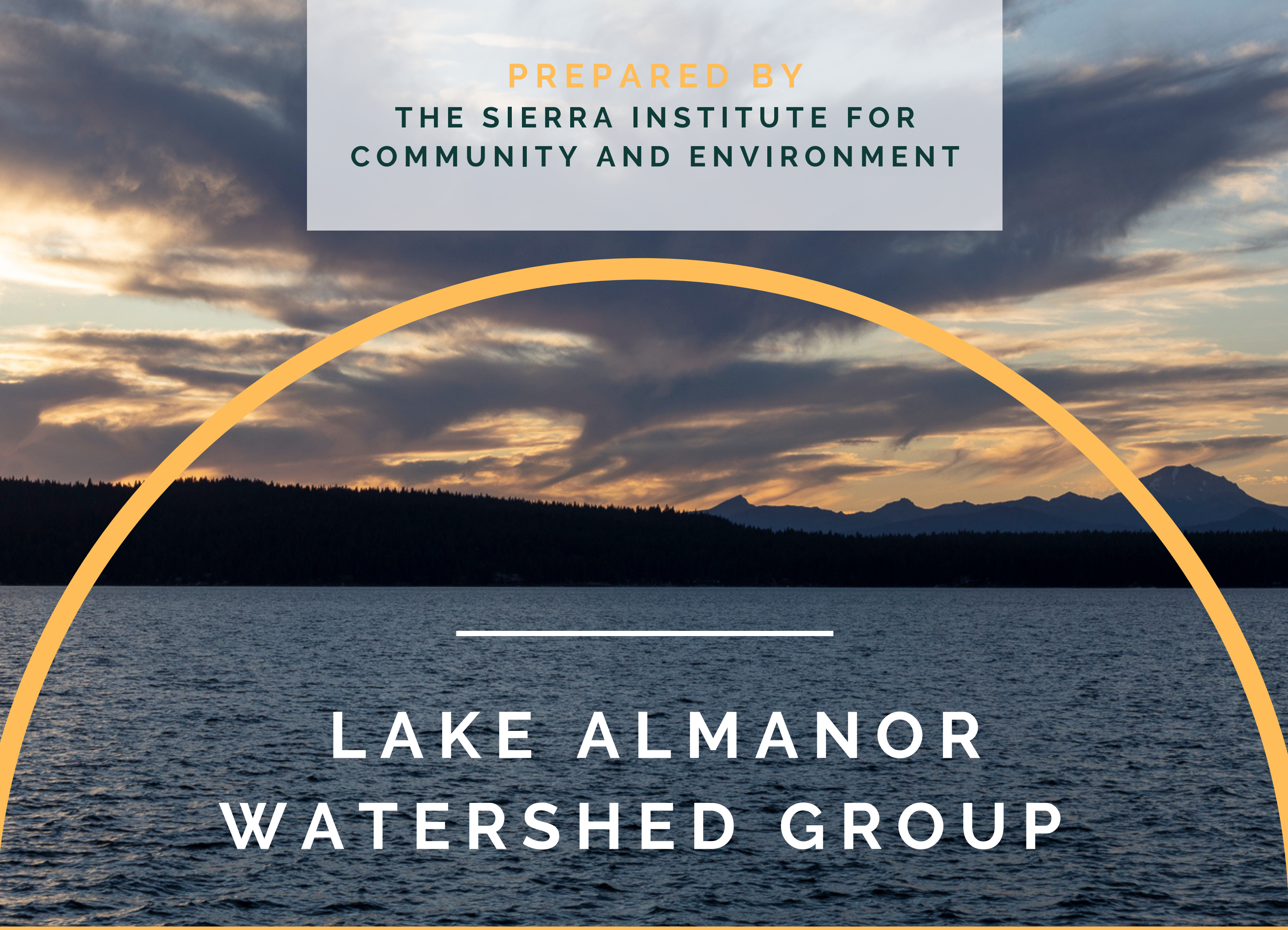


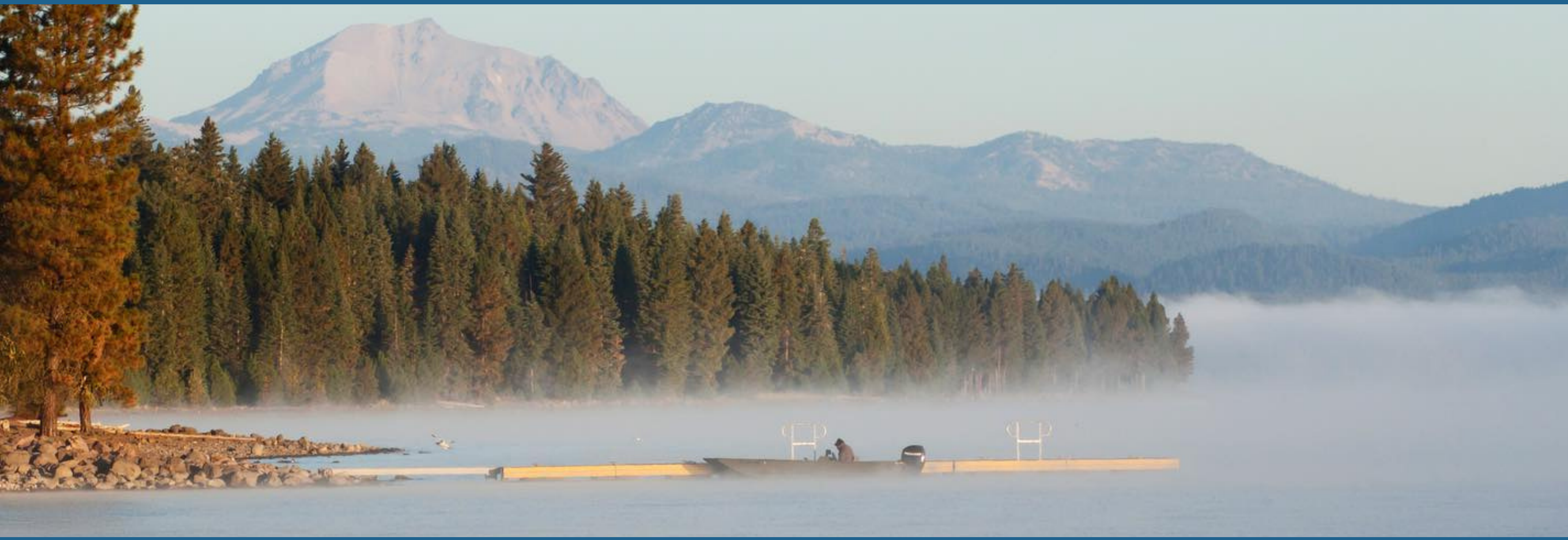
LAKE ALMANOR WATERSHED GROUP

WATER QUALITY VOLUNTEER MANUAL

JUNE 2021

Sierra Institute for Community and Environment

PREFACE:



The Lake Almanor Watershed Group (LAWG), formerly known as the Almanor Basin Watershed Group (ABWAC), was created in 2005 by the Plumas County Board of Supervisors to address water quality, land use, and critical habitat issues in the Lake Almanor Basin and make policy recommendations to the Board of Supervisors. From 2005 to 2013, ABWAC served as an official advisory body to the Plumas County Board of Supervisors. The eleven volunteer ABWAC members worked closely with existing organizations and provided recommendations to the county on a range of topics from overnight boat use on Lake Almanor to cloud-seeding. ABWAC created a Watershed Management Plan that was approved by the Plumas County Board of Supervisors in 2009 and is intended to guide all efforts by the ABWAC to protect water quality, critical habitat, and quality of life in the Lake Almanor Basin. Since 2009, ABWAC (now LAWG) raises money each year to hire an independent contractor to sample the lake. In September of 2013, the group decided to end their official relationship as an advisory body to the Plumas County Board of Supervisors. The group continues to pursue its mission to maintain and improve the health of the Lake Almanor watershed. Sierra Institute has been a part of LAWG since its origins in the early 2000s and provides watershed coordination for the group.

THE LAKE ALMANOR WATERSHED GROUP AS OF DECEMBER 2020:

Peggy Fulder, Chair	Lassen County
Bridie Johnston, Chair	Member-At-Large
Carl Felts	East Shore/Hamilton Branch
Aaron Seandel	Peninsula/North Shore
Lorena Gorbet	Maidu Community
Gina Johnston	Chico State University
Jacqui Cordova	Member-At-Large
Susan Padilla Riney	Member-At-Large
Philip Datner	Almanor Fishing Association
Charlie Plopper	Almanor Parks and Recreation District

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Section 1: Orientation

1. Introduction

Thank you for being a volunteer for the Lake Almanor Water Quality Monitoring Program. The future health of Lake Almanor depends upon your efforts of collecting water data on the lake and its tributaries. You are extremely appreciated!

This manual addresses protocol and considerations for every aspect of the sampling procedure; this is meant to help you and ensure that sampling happens in an accurate, scientific manner. Data collected from monthly samples will be entered into a database and results will be evaluated by Dr. Gina Johnston with Lake Almanor Watershed Group (LAWG). Determinations for future efforts to improve water quality in Lake Almanor will be based upon your efforts.

Lake Almanor Watershed Group hopes that you will enjoy the experience of being a water quality monitor. It's not always an easy job! Please allocate at least half a day for your sample collection if sampling lake or stream sites and the whole day if sampling both. Do not hesitate to contact the monitoring coordinator (Bella Bledsoe: 530-284-1022) if you have any needs, questions, or schedule changes.

The monitoring coordinator will contact you the week before a collection run to confirm your monitoring date and time. Please be prompt in answering back, and try to inform us of scheduling changes well in advance. Samples are meant to be collected at the same time of day from month to month. This will give us time to reschedule you or find a replacement monitor for that month.

2. Safety Considerations

One of the most critical considerations for a volunteer monitoring program is the safety of its volunteers. All volunteers will be trained in safety procedures and should carry a set of safety instructions and the phone number of their monitoring coordinator. Safety precautions can never be overemphasized.

The following are some basic safety rules:

At stream sites:

• Always monitor with at least one partner. Always let someone else know where you are, when you intend to return, and what to do if you do not come back at the appointed time.

• Have a first aid kit handy. Know any important medical conditions of team members (e.g., heart conditions or allergic reactions to bee stings). It is best if at least one team member has First Aid/CPR training.

• Listen to weather reports. Never compromise your safety if severe weather is predicted or if a storm occurs while at the site.

• Never wade in swift or high water (above knee height).

• If you drive, park in a safe location. Be sure your car doesn't pose a hazard to other drivers and that you don't block traffic.

• Put your wallet and keys in a safe place, such as a watertight bag you keep in a pouch strapped to your waist. Without proper precautions, wallet and keys might end up downstream.

• Never cross private property without the permission of the landowner. If LAWG directions lead you to private property, verify with LAWG that permission has been granted.

• Watch for irate dogs, farm animals, wildlife (particularly snakes), and insects such as ticks, hornets, and wasps. Know what to do if you get bitten or stung. Advise your partners if you are allergic, and carry a sting kit with you to the field.

• Watch for poison oak and other types of vegetation that can cause rashes and irritation.

• Never drink the water in a stream. Assume it is unsafe to drink, and bring your own water from home. After monitoring, wash your hands with antibacterial soap before eating.

• Do not walk on unstable stream banks. Disturbing these banks can accelerate erosion and might prove dangerous if a bank collapses. Disturb streamside vegetation as little as possible.

• Be very careful when walking in the stream itself. Rocky-bottom streams can be very slippery and can contain deep pools; muddy-bottom streams might also prove treacherous in areas where mud, silt, or sand have accumulated in sinkholes. If you must cross the stream, use a walking stick to steady yourself and to probe for deep water or muck. Your partner(s) should wait on dry land ready to assist you if you fall. Do not attempt to cross streams that are swift and above the knee in depth.

• If you are sampling from a bridge, be wary of passing traffic. Never lean over bridge rails unless you are firmly anchored to the ground or the bridge with good hand/foot holds.

• If at any time you feel uncomfortable about the condition of the stream or your surroundings, stop monitoring and leave the site at once. Your safety is more important than the data.

Boat Specific Safety Considerations:

- Know the rules. Before launching your boat, learn the nautical "rules of the road" by taking a boater safety class. They are a large part of boating safety, especially when meeting, crossing, or overtaking another boat. Learn the meaning of buoys and other water markers. Maintain a safe speed and keep a watchful eye on the waters for smooth sailing. Check the U.S. Coast Guard Boating Safety Resource Center for approved boating courses.

- Protect against propeller strikes. Make sure all passengers are accounted for before starting the engine, and wear your emergency cut-off switch at all times. When people are in the water, ask one person to propeller-watch. Consider additional propeller-safety devices, such as guards or sensors.

- Dress for the water temperature, not the air temperature. Hunters and fishermen boating during colder-weather months should remember that cold water can kill — always wear life jackets while boating.

- If you can't swim, take lessons. Even a few rudimentary lessons could someday mean the difference between living and drowning.

- If your boat capsizes, stay with it. Not only will it provide flotation assistance, but it's easier for rescuers to spot.

- Always wear the right-sized U.S. Coast Guard-approved life jacket. Wear it, don't stow it. Tucked-away life jackets are useless in an accident. In 2018, 77% of fatal boating accident victims drowned. Of those drowning victims, 84% were not wearing a life jacket.

- Be aware of carbon monoxide. All internal combustion engines produce carbon monoxide, an odorless, colorless, and poisonous gas. Poor cabin ventilation, blocked exhaust outlets, and faulty equipment can contribute to the problem, but carbon monoxide emissions can affect the boat's swim platform and other areas near the engine.

- Don’t boat under the influence (BUI). The use of alcohol is involved in about 19% of all recreational boating fatalities, according to the U.S. Coast Guard.

- Leave a float plan. If you're going to be on the water for a couple hours, make sure someone on land knows where you're going and when you plan to return.

- Appoint an assistant skipper. Don't be the only person on your boat who knows how to operate the vessel and where the safety and first aid equipment is stored.

• Check the weather. Consult local forecasts before heading out, especially windy conditions. Reschedule if windy.

• Have communication options. Bring a mobile phone sealed in a water resistant bag, but don't rely on it completely.

• Use a kill switch lanyard. On power boats and personal watercraft, this simple tether between you and the ignition key shuts the engine off if you fall overboard or lose your balance while driving, reducing the potential for harm to you or others in the water.

Some items you may want to bring with you when monitoring:

1. Whistle 2. Compass 3. Utility knife 4. Zip lock bags to keep extra clothes dry 5. Advil 6. Flashlight or headlamp 7. Batteries 8. Miniature sewing kit Boat Specific: ● Radio equipment ● Charts of the local area and a compass ● Anchor and extra line	9. Hand warmers 10. Emergency survival blanket 11. Waterproof matches 12. Sunscreen and sunglasses 13. Insect repellent 14. Extra clothes 15. Food 16. Water ● Tool kit for repairs ● Paddles ● Bailer or bilge pump ● Fire extinguishers

Section 2: Water Monitoring Parameters

1.Water Temperature

Water temperature is the measure of the average kinetic energy of water molecules. It is measured on a linear scale of degrees Celsius or degrees Fahrenheit. The formula for conversion between Fahrenheit and Celsius is: (°F - 32) x 5/9 = °C. Lake Almanor Watershed Group tracks all data in Celsius so be sure to take or convert your measurements to Celsius before recording the data.

Importance of Water Temperature

Temperature is one of the most important water quality parameters. Aquatic organisms from microbes to fish are dependent on certain temperature ranges for their optimal health. Optimal temperatures for fish depend on the species: some survive best in colder water, whereas others prefer warmer water. If water temperatures are outside this optimal range for a prolonged period of time, organisms become stressed and can die. Temperature affects the oxygen content of the water (oxygen levels become lower as temperature increases); the rate of photosynthesis by aquatic plants; the metabolic rates of aquatic organisms; and the sensitivity of organisms to toxic wastes, parasites, and diseases.

Seasonal Temperature Changes In Lake Almanor

Lakes that are deep enough undergo a pattern of thermal changes throughout the year. The description below is what happens in Lake Almanor. Other lakes are different depending on climate.

Winter

Lake Almanor usually doesn't freeze over, except in isolated pockets. During the winter, the lake is usually isothermal, meaning all of the water is at the same temperature. This is because the water mixes freely from top to bottom as winds blow across the surface during these colder and stormier months. Dissolved oxygen is at its highest concentration throughout the lake during this period because cold water can hold more gases in solution than warm water.

Spring

As spring progresses, solar insolation (rays) warms up the top of the lake during the day. After that, the daily sun penetration starts heating up several meters of water at the top of the lake, usually the top 3- 4 meters. The upper warm water floats on top of the colder, denser water below. Mixing by wind is not strong enough to push this warmer, less dense water, all the way to the bottom. By the end of spring, the lake becomes separated into thermal layers. The upper warm layer that is mixed by the wind is called the epilimnion. The middle layer where temperature decreases with depth is called the metalimnion. The top of the metalimnion, where temperature decrease is greater than one degree per meter, is called the thermocline. In Lake Almanor this is usually between 10-14 meters depth. Its depth depends on how strong the wind is and how deep sunlight can penetrate into the water. Below the metalimnion is the hypolimnion, which is the coldest and densest layer of water. It is isolated from the surface and its oxygen content will decrease because of the decomposition of organic material that falls from the layers above.

Summer

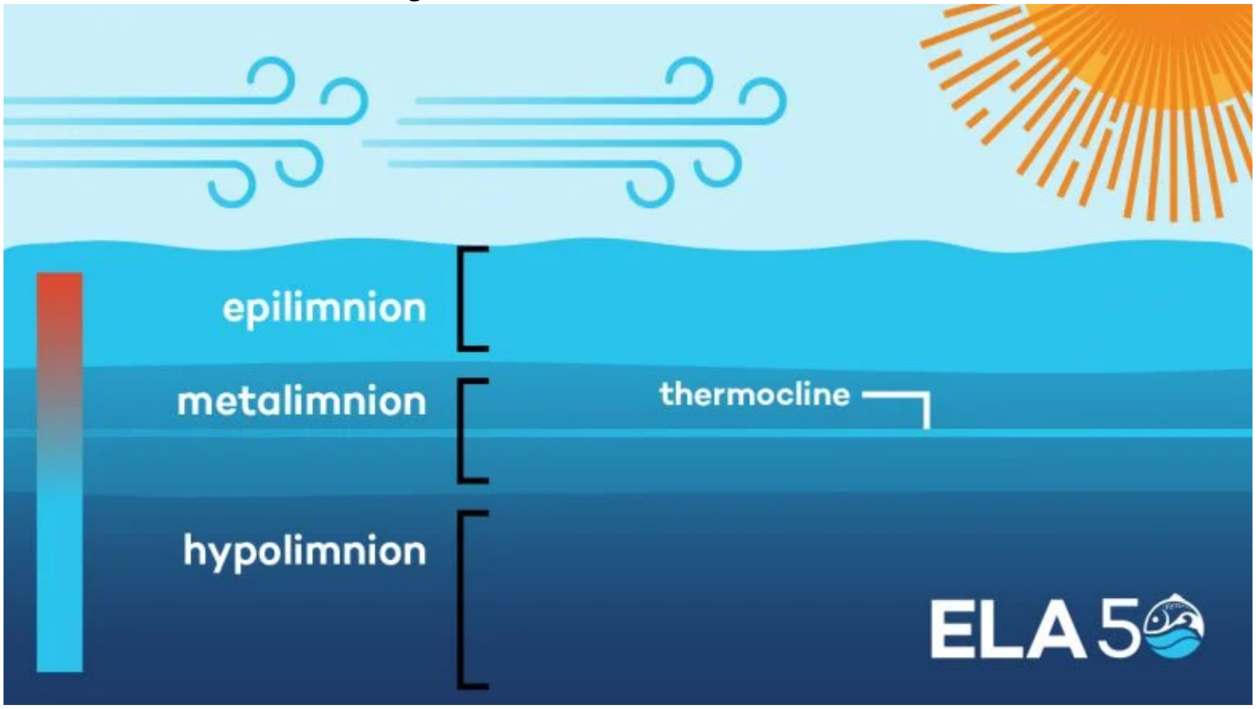
Once the thermal stratification gets established, it will persist for the entire summer. Most of the algal growth occurs in the epilimnion, where the algae produce oxygen. As algae and other aquatic organisms die, their organic material drops to the hypolimnion. The epilimnion is well oxygenated by the wind and photosynthesis, and is warm. The hypolimnion is cool but gets depleted of oxygen. By the end of summer, the best habitat for cold water fish species is essentially gone. Water near the surface is too warm and the deep cool water has no oxygen. There may be a narrow band in the metalimnion that suits their needs.

Fall

As fall approaches, days are shorter, and there is not enough sunlight to make up for the heat loss at the surface from evaporation and radiation. The night air is cooler, causing further cooling of the surface of the lake. Eventually the top several meters of the lake are cooler and denser than the water below, and the lake becomes "top heavy". This denser water sinks and mixes until all water in the lake cools to the same temperature. Just as in the winter, the slightest wind can mix the entire lake again from top to bottom. All of the nutrients released by decomposition in the hypolimnion get mixed into the surface waters. This can often trigger a rapid growth of phytoplankton or a “bloom”.

The lake will continue to mix throughout the winter. As the water gets colder, algal growth slows. In colder climates, lakes will develop a layer of ice at the surface which stops the circulation until ice melts in the spring.

Diagram of Lake Stratification and Zones



Factors Affecting Water Temperatures

Natural Factors

- Sunlight energy such as seasonal and daily changes, effects of shade (cover), and air temperature
- Wind speed at water surface and number of windy days
- Stream flow
- Depth of water
- Inflow of groundwater which is usually colder than creek water
- Inflow of surface water including a drainage ditch or another creek
- Color and turbidity of water (suspended sediment absorbs heat)

Human Factors

- Removal of riparian vegetation
- Soil erosion, filling in deep pools that were once cold, dark refugia for fish
- Stormwater runoff from hot impervious surfaces
- Alterations to stream morphology, substrate, and flow
- Cooling water discharges from power plants
- Water diversion or storage resulting in decreased flows
- Water originating from surface or bottom of reservoir

2.Dissolved Oxygen (DO)

The amount of oxygen dissolved in water is measured in milligrams per liter(mg/L) or parts per million (ppm).

Importance of Dissolved Oxygen (DO)

The creek system both produces and consumes oxygen. It gains oxygen from the atmosphere and from plants as a result of photosynthesis. Running water, because of its churning, dissolves more oxygen than still water, such as that of a reservoir behind a dam. Most aquatic organisms need oxygen to survive and grow. Some species such as trout and stoneflies require high levels of DO, while other species such as catfish, worms, and dragonflies do not. The following may happen if there is not enough oxygen in the water—death of adults and juveniles; reduction in growth; failure of fish eggs/insect larvae to survive; change in species present; and/or growth of toxic or smothering bacteria, fungi, or algae.

Factors Affecting Dissolved Oxygen Levels in Water

Pollution

If organic material (e.g. algae) or waste (e.g. septic leaks) is present in water, bacteria quickly move in to decompose the material. As the bacteria respire and feed on the decaying material, they use up oxygen and generate CO2 in the water. Large algae blooms (caused by events like people dumping lawn clippings or leaves, or fertilizer runoff) can create near-zero oxygen conditions in creeks.

Temperature

As temperature increases, less oxygen can be dissolved in water. When water holds all the DO it can at a given temperature, it is said to be 100 percent saturated with oxygen. Water can be supersaturated with oxygen under certain conditions (e.g. below large dams where discharging flows are very turbulent). The following table shows the concentration of dissolved oxygen that is equivalent to the 100 percent saturation for the noted temperature (and normal barometric pressure). 100 percent saturation levels will be lower at Lake Almanor for any given temperature, as it is at approximately 4500ft of elevation. For fresh water only.

Dissolved Oxygen 100% Saturation at Sea Level✦

Temperature (Degrees Celsius)	Dissolved Oxygen (mg/L)	Temperature (Degrees Celsius)	Dissolved Oxygen (mg/L)
0	14.6	16	9.9
1	14.2	17	9.7
2	13.8	18	9.6
3	13.5	19	9.3
4	13.1	20	9.1
5	12.8	21	8.9
6	12.5	22	8.7
7	12.1	23	8.6
8	11.8	24	8.4
9	11.6	25	8.3
10	11.3	26	8.1

11	11.0	27	8.0
12	10.8	28	7.8
13	10.5	29	7.7
14	10.3	30	7.6
15	10.1	31	7.5

Sources of Dissolved Oxygen (DO)

Oxygen is added to water by:

Re-aeration

Oxygen from air is dissolved in water at its surface, mostly through turbulence. Examples of this include water tumbling over rocks (rapids, riffles, curves in the waterway) and wave action.

Photosynthesis (during daylight)

Plants produce oxygen when they photosynthesize. DO is generally highest in the late afternoon, and lowest in the early morning hours before sunrise.

Consumption of Dissolved Oxygen (DO)

Dissolved oxygen is used in two major ways—both of which contribute to the Biological Oxygen Demand (BOD) of the creek system.

Respiration

- Aquatic organisms breathe and use oxygen.
- Large amounts of oxygen are consumed by algae and aquatic plants at night (when large masses of plants are present).
- Large amounts of oxygen are consumed by decomposing bacteria (when there are large amounts of dead material to be decomposed, there will be significant numbers of bacteria).

Substances

Examples of substances that break down and use oxygen in the process are generally biodegradable and include dead organic matter, algae, sewage/feedlot waste, yard clippings/yard waste, oil/grease, and fertilizer runoff.

Causes of Low Dissolved Oxygen (DO) Levels

- Increases in water temperature
- Algal blooms
- Human waste
- Animal waste (especially from feedlots/dairy farms)
- Depletion near the bottom of reservoirs by bacteria
- Altitude—water holds less oxygen at higher altitudes
- Salinity—dissolved oxygen decreases, as salinity increases
- Mineral content--dissolved oxygen decreases, as the mineral content and concentration of the water increases

3.pH

pH is a term used to indicate the alkalinity or acidity of a substance as ranked on a scale from 1.0 to 14.0. Acidity increases as the pH gets lower. The pH scale measures the logarithmic concentration of hydrogen (H+) and hydroxide (OH-) ions, which make up water (H+ + OH- = H2O). When both types of ions are in equal concentration, the pH is 7.0 or neutral. Below 7.0, the water is acidic (there are more hydrogen ions than hydroxide ions). When the pH is above 7.0, the water is alkaline, or basic (there are more hydroxide ions than hydrogen ions). Since the scale is logarithmic, a drop in the pH by 1.0 unit is equivalent to a 10-fold increase in acidity. So, a water sample with a pH of 5.0 is 10 times as acidic as one with a pH of 6.0, and a pH of 4.0 is 100 times as acidic as a pH of 6.0.

Importance of pH

pH affects many chemical and biological processes in the water. For example, different organisms flourish within different ranges of pH. The largest variety of aquatic animals prefers a range of 6.5-8.0. pH outside this range reduces the diversity in the stream because it stresses the physiological systems of most organisms and can reduce reproduction. Low pH can also allow toxic elements and compounds to become mobile and “available” for uptake by aquatic plants and animals. This can produce conditions that are toxic to aquatic life, particularly to sensitive species like rainbow trout. Changes in acidity can be caused by atmospheric deposition (acid rain), surrounding rock, and certain wastewater discharges.

Factors Affecting pH

Input of basic or acidic substances (human-made or natural) . pH can change because of external inputs. You might measure a difference in pH along a stream due to:

- Changes in tree types surrounding the water, for example conifer needles are acidic and maple leaves are basic

- Changes in adjacent soils or rock types and erosion events
- Changes in the stream bottom material, for example the difference between gravel, silt, and bedrock
- Large changes in temperature affecting the CO_2/O_2 (carbonic acid) cycle in the water
- Changes in human activity affecting the stream

Other Factors

- In freshwater, increasing temperature decreases pH.
- Waters with high algal growth can show a diurnal change in pH. When algae grow and reproduce they use carbon dioxide. This reduction causes the pH to increase. Therefore, if conditions are favorable for algal growth (sunlight, warm temperatures), the water will be more alkaline. Maximum pH usually occurs in late afternoon, pH will decline at night. Because algal growth is restricted to light penetrating zones, pH can vary with depth in lakes, estuaries, bays, and ocean water.
- High levels of bacterial activity in sediments can cause associated water to become acidic.
- Human-made inputs that reduce pH include acid rain (from automobiles or industrial sources) and acid mine drainage. Nutrients can indirectly affect pH by stimulating algal growth.

4.Electrical Conductivity or Total Dissolved Salts

Electrical Conductivity is the ability of water to conduct an electrical current. Dissolved ions in the water are conductors. The major positively charged ions are sodium (Na^+) calcium (Ca^{2+}), potassium (K^+) and magnesium (Mg^{2+}). The major negatively charged ions are chloride (Cl^-), sulfate (SO_4^{-2}), carbonate (CO_3^{-2}), and bicarbonate (HCO_3^-). Nitrates (NO_3^-) and phosphates (PO_4^{-3}) are minor contributors to conductivity, although very important biologically.

Salinity is a measure of the amount of salts or ions in the water. Because dissolved ions increase salinity as well as conductivity, the two values are related. The salts in seawater are primarily sodium chloride ($NaCl$). However, other saline waters, such as Mono Lake, owe their high salinity to a combination of dissolved ions including sodium, chloride, carbonate, and sulfate.

Importance of Conductivity

Conductivity can affect the quality of water used for irrigation or drinking. Most aquatic biota tolerate a range of conductivity. However, the ionic composition of the water can be critical. For example, cladocerans (water fleas) are far more sensitive to potassium chloride than sodium chloride at the same concentration. Conductivity will vary with water sources such as ground water, water drained from agricultural fields, municipal wastewater, and rainfall. Therefore, conductivity can indicate groundwater seepage or a sewage leak.

What Affects Conductivity of Water

• Soil and rocks release ions into the waters that flow through or over them. The geology of a certain area will determine the amount and type of ions.
• Salinity and conductivity of coastal rivers is influenced by tides. Sea spray can carry salts into the air that then fall back into the rivers with rainfall.
• De-icing salt used on roads and driveways can easily end up in nearby streams and affect salinity until diluted by large volumes of low salinity water.
• Flow of rivers into estuaries can greatly affect salinity as well as the location of the estuarine mixing zone. This is very important to the survival of estuarine organisms.
• Fresh water lost by evaporation will increase the conductivity and salinity of the waterbody. Warm weather can increase ocean salinity.
• As temperature increases, conductivity increases. Salinity is the amount of salt actually present in the water; therefore, it is not dependent on temperature.

5.Turbidity

Turbidity is a measure of water clarity and how much the material suspended in the water decreases the passage of light through the water. Suspended materials include soil particles (clay, silt, and sand), algae, plankton, microbes, and other substances. These materials are typically in the size range of 0.004 mm (clay) to 1.0 mm (sand). Turbidity can affect the color of the water. Higher turbidity increases water temperatures because suspended particles absorb more heat. This, in turn, reduces the concentration of dissolved oxygen (DO) because warm water holds less DO than cold. Higher turbidity also reduces the amount of light penetrating the water, which reduces photosynthesis and the production of DO. Suspended materials can clog fish gills, reducing the resistance to disease in fish, lowering growth rates, and affecting egg and larval development. As particles settle, they can blanket the stream bottom, especially in slower waters, and smother fish eggs and benthic macroinvertebrates.

Why Measure for Turbidity

Turbidity can be useful as an indicator of the effects of runoff from construction, agricultural practices, logging activity, discharges, and other sources. Turbidity often increases sharply during a rainfall, especially in developed watersheds, with large areas of impervious surfaces. The flow of storm water runoff from impervious surfaces rapidly increases stream velocity, which increases the erosion rates of stream banks and channels. Turbidity can also rise sharply during dry weather if earth-disturbing activities are occurring in or near a creek without erosion control practices in place.

Regular monitoring of turbidity can help detect trends that might indicate increasing erosion in developing watersheds. However, turbidity is closely related to stream flow and velocity and should be correlated with these factors. Comparisons of the change in turbidity over time, therefore, should be made at the same point at the same flow.

Turbidity is not a measurement of the amount of suspended solids present or the rate of sedimentation of a stream since it measures only the amount of light that is scattered by suspended particles. Measurement of total solids is a more direct measure of the amount of material suspended and dissolved in water.

Sources of Turbidity

- Soil erosion
- Waste discharge
- Urban runoff
- Eroding stream banks and wave action in lakes
- Large numbers of bottom feeders (such as carp), which stir up bottom sediments
- Excessive algal growth (e.g. phytoplankton)

6. Secchi Depth (Water Transparency)

Transparency of water relates to the depth that light will penetrate water. The transmission of light into a body of water is extremely important since the sun is the primary source of energy for all biological phenomena. Light is necessary for photosynthesis, a process that produces oxygen and food for consumers. It is common practice for biologists to consider the depth of the euphotic zone (the upper layers of a body of water into which sufficient light penetrates to permit growth of green plants) to be 2.7 times (roughly 3 times) the limit of visibility. As light penetrates water, it becomes attenuated and altered in its spectral composition. The change that occurs is from predominantly yellow light at the surface to blue-green at depth in clear water or yellow-green in waters having a high concentration of dissolved organic material.

7. Phytoplankton and Zooplankton

What are plankton?

Plankton are microscopic organisms that form the basis of the food web in lakes (and the ocean). They have limited mobility and are subject to the currents that exist in lakes. Generally, they are divided into phytoplankton, which can photosynthesize, and zooplankton, which feed on the phytoplankton and are the food source for small fish and other carnivores.

The phytoplankton (commonly called algae) are further divided into general groups like diatoms, green algae, yellow-brown algae, and blue-green algae. (Bluegreen algae are not plants, but cyanobacteria. Technically, they are bacteria that can photosynthesize.) Each group has different requirements for its productivity in terms of temperature and nutrients. Collecting and identifying the phytoplankton provides insight into the physical and biological conditions that exist in the lake. Some species of the phytoplankton are considered "indicators" of lake conditions. For example, some species indicate water with low nutrients, while others are only present with high nutrients or warm water. Bluegreens, or cyanobacteria, usually thrive at higher temperatures. Several species also produce toxins which can be harmful to animals or children who might ingest them. Some blue-greens are not eaten by animals, so they don't contribute to the food web like other algae.

Any species of algae can grow to such proportions as to constitute a "bloom". This occurs when conditions are right for rapid growth and the population expands to the point that there are millions of organisms in a certain area of the lake. The animals that eat them are not able to keep up with this increase and most of the phytoplankton die and settle to the bottom. When organisms die, they are decomposed by bacteria that use the dissolved oxygen present in the water. During the summer when the lake is thermally stratified, the dissolved oxygen can be depleted by decomposition and other chemical reactions and there will be no dissolved oxygen available for animals that need oxygen for their metabolism. These deep oxygen-depleted zones of the lake can no longer serve as habitat for fish and other organisms until the lake mixes and oxygen is restored.

Zooplankton are generally divided into cladocerans (like Daphnia), copepods, rotifers and other animals. They are weak swimmers and are preyed upon by any filter-feeding larger animal. They eat the phytoplankton and serve to help control their populations, as well as play an important role in the food web of the lake.

Section 3: Sampling Methods and Collection Procedures

1. Measuring Water Clarity with a Secchi Disk

1. Drop the Secchi disk into the water on the shady side of the boat. Keep lowering the disk slowly until it disappears. Note the depth on the tape measure.
2. Slowly pull the disk up until you see it again. Note the depth on the cord.
3. Average the 2 depths.
4. Record the average depth on the Secchi data sheet along with the date and time of the reading

.

2. Probe Operation

Metering equipment will be calibrated by the monitoring coordinator the day before being loaned to the volunteer for sample collection. However, all volunteers will be familiar with operating procedures of all data collection equipment including calibration.

YSI Professional Plus and Quatro Pro Cable (Calibration and Taking Measurements)

Calibration

1. pH
   - 1.1. Press the Cal Key
   - 1.2. Highlight pH in the calibration menu and press <<<ENTER>>>. For pH, auto-buffer recognition will determine which buffer the sensor is in and it will allow you to calibrate up to 6 points (LAWG performs a 3 point calibration).
   - 1.3. Place the correct amount of calibration standard (enough to fully submerge probe) into a clean, dry, or pre-rinsed container (spare probe storage containers are ideal). Do this for each of the three calibration standards (pH 4, 7, and 10).
   - 1.4. Immerse the probe into the solution, making sure the sensor and thermistor are adequately immersed. Allow at least one minute for temperature to stabilize.
   - 1.5. Wait for the readings to stabilize, highlight Accept Calibration and press enter to calibrate.
   - 1.6. For pH, continue with the next point by placing the probe in a second buffer and following the on-screen instructions or press Cal to complete the calibration.

2. DO (Calibrate with every couple hundred feet of elevation change)
   - 2.1. Place a small amount of water (1/8 inch) in the calibration/transport cup and screw it on the probe. Disengage a thread or two to ensure atmospheric venting. Make sure the DO and temperature sensors are not immersed in the water.
   - 2.2. Turn the instrument on. Press the Cal key, highlight DO, and press enter.
   - 2.3. Highlight DO%, then press Enter.
   - 2.4. Verify that the barometric pressure and salinity displayed are accurate. Once DO and temperature are stable, highlight Accept Calibration, and press enter.

Taking Measurements

1. The instrument will be in Run mode when powered on.
2. To take readings, insert the probe into the sample. Move the probe in the sample until the readings stabilize. This releases any air bubbles and provides movement if measuring DO.
3. Once readings stabilize record 3 readings for Temperature, Dissolved Oxygen, Electrical Conductivity, and pH on the Field Data Collection Form.
4. Average these readings for a final logged reading for each parameter.

Note: One reading is taken at each stream site and depth is recorded at .15 meters. Readings at lake sites are taken at the surface (.15 meters) and at every 1 meter increment until bottom making sure the final reading is not in sediments. This can be gauged by raising the the probe up and down to identify if it is resting on bottom and is also indicated by a considerable drop in your DO reading.

3.HOBO Temperature Loggers and Application

HOBO Logger App

Use HOBOmobile to set up the logger, including selecting the logging interval, start and stop logging options, and configuring alarms. These steps provide an overview of setting up the logger. For complete details, see the *HOBOmobile User's Guide* (The Hobo mobile app can be found and downloaded from either the App Store on iOS or the Play Store on Android devices by searching for *HOBO mobile*).

Configuring Logger

1. Open HOBOmobile and tap the HOBOs icon.
2. Press the circle on the logger to wake it up. This will also bring the logger to the top of the logger list (the logger name will turn green). Note that the current sensor readings are displayed even when the logger is not logging.
3. Once connected, tap Configure.
4. Tap Logging Interval and choose how frequently the logger will record data. LAWG records temperature at 15 minute intervals starting on the hour.
5. Tap Start Logging and select when logging will begin:
    5.1. Select On Date/Time - Logging will begin at a date and time you specify. Select the Date and time and tap Done so that the logger will begin logging every 15 minutes on the hour. Tap Done in the Start Logging screen.
6. Tap Stop Logging and select the options for when logging will end.
    6.1. Select, **Never (Wrap When Full).** The logger will continue recording data indefinitely, with newest data overwriting the oldest.
    6.2. Tap Done in the Stop Logging screen.
7. Tap Logging Mode and select fixed interval logging.
8. Disable Show LED. This will help prolong battery life.
9. Enable Bluetooth Always Off. When this option is enabled, the logger will only advertise during logging when you press the circle on the logger to wake it up, thereby preserving as much battery power as possible.
10. Tap Start in the upper right corner of the Configure screen to load the settings onto the logger. Logging will begin based on the settings you selected.

Reading out and Sharing Data From Logger

Readout:

1. 1. Tap and tap Loggers at the top of the screen. Select a logger to connect to it. (If the logger is in Bluetooth power saving mode, press the button on the logger to wake it up or remove the MX2203, MX2204, and MX2501 logger from the water if it is configured with Bluetooth Off Water Detect.)
2. From the Connected screen, tap Readout. The data from the logger is offloaded to your device. A message displays when the readout is complete and a number appears on the icon indicating a new file is available for viewing.
3. Tap *Data Files* and check that the data was read out from the logger. It will be displayed in a mini-graph in the Recent Data Files list.

Share

1. Tap *Data Files* and select files to share.
   - 1.1. To share a single file, tap the mini-graph that has the data you wish to view or share and then tap at the top of the large graph.
   - 1.2. To share multiple files, tap Select at the top right corner of the Data Files screen. Tap each mini-graph you want to share or tap a group name to share all the files within that group, or tap a mix of both individual files and groups.
2. Once you have selected all the files you want, tap *Share* at the bottom left corner of the Data Files screen.
3. In the Share screen, select a data file or graph format (LAWG uses Microsoft's xlsx file format).
4. Email the files to Dr. Gina Johnston

Note that the options available for sharing depend on the apps installed on your mobile device

4.Plankton Sampling

Plankton Collection Procedure

1. Check the net for any holes, make sure that the net is securely fastened to your tow rope, and ensure that the cod end assembly is firmly screwed on.
2. Check your supplies so that you have sample bottles, preservative, labels, and a waterproof marking pen and squirt bottle. Always take extra sample bottles.
3. When you reach your station, wait until the boat is still before lowering the net. Make sure your rope is clear of anchor, propeller, or other probes.
4. Lower the net to about one meter off the bottom. You should know the total depth from your oxygen/temperature probes.
5. Begin towing the net up to the surface very slowly, about one meter every five seconds.
6. Rinse any plankton off the sides of the net by splashing water on the outside.
7. Pull the net into the boat and unscrew the cod end assembly.

8. Swirl the assembly to further concentrate the plankton until the total volume is a little less than your sample bottle volume.
9. Pour the plankton into the sample bottle.
10. Rinse remaining plankton off the sides of the assembly using the squirt bottle and add that to your sample bottle.
11. Add preservative to your sample so that the volume of preservative equals 1 percent of the total volume.
12. Tighten the lid and label your sample with the date, depth of the tow, and station location.
13. Store samples in the dark, preferably refrigerated.
14. Rinse your net in lake water without the cod end assembly to ensure that it is clean for the next station. Then replace the assembly securely.
15. When you are finished sampling, rinse the net in tap water and hang to dry.

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