2021 Oregon Lakes Association Online Seminar Series

AGENDA

Session 1: CyanoHAB monitoring and detection, chaired by *Dan Sobota*
Wednesday, November 3rd, 2:30-5:00 pm

- Bernadel Garstecki, Portland State University. Modeling Cyanotoxin Production, Fate and Transport in Surface Waterbodies.
- Tom Warmuth, BioSafe Systems. Use of peroxyacetic acid (PAA)/hydrogen peroxide in freshwater cyanobacterial control – case study of lab scale trials and treatments in relation to use in field sites.
- Lindsay Collart, Oregon State University (2020 OLA Scholarship recipient). Proof of concept: use of volatile organic compounds to predict toxic HAB trajectories and species composition in Upper Klamath watershed, OR.
- Chippie Kislik, UC Berkely. Detecting Algal Blooms in Small Reservoirs of Northern California using Sentinel-2 Imagery in Google Earth Engine.
- Daniel J. Sobota, Oregon DEQ. Three years of comparing satellite imagery with field data on cyanobacteria blooms in lakes and reservoirs of the Upper Deschutes River Basin.
- Alyssa Payne and Kelly Fry, Clark County Public Health. Utilizing CyAN for improved detection of harmful algal blooms.
- Amalia Handler, USEPA. Satellites predict lakes at risk from cyanobacteria and microcystin toxins.

OLA Business Meeting
Wednesday, November 10th, 2:00-2:30 pm

Session 2: Lake physiology and management, *chaired by Desiree Tullos*
Wednesday, November 10th, 2:30-5:00 pm

- Theo Dreher, Oregon State University. Toxic *Dolichospermum* cyanobacteria in Oregon lakes.
- Emi Fergus, USEPA. Natural and anthropogenic controls on lake water-level decline and evaporation-to-inflow ratio in the conterminous US.
- Desiree Tullos, Oregon State University. Evaluation of mixing mechanisms in the control of cyanobacterial blooms.
- Scott Wells, Portland State University. Water Quality Modeling in Lakes and Reservoirs. How Good Should Your Model Be?
- Edgar Rudberg, Ph.D., CD3, General Benefit Corporation. Online Boater Led Check-In/Check-Out Alternative to In-Person Inspections. A COVID-19 Response Pilot.

Session 3: Our beautiful lakes: past and present, chaired by *Ron Larson*
Wednesday, December 1st, 3:00-5:00 pm

- Jamila Baig, University of Oregon (2021 OLA Scholarship recipient). A multiproxy approach to reconstruct paleotemperature, vegetation change, fire history, and lake productivity in the Pacific Northwest, Gold Lake, Willamette National Forest, OR.
- Casie Smith, USGS. A progression of understanding of the turbid, shallow Malheur Lake: Restoration implications.
- Ron Larson, Oregon Lakes Association. Effects of climate change on Lake Abert: Initial results based primarily on ground-acquired data.

- Dorothy Hall. Earth System Science Interdisciplinary Center/University of Maryland and Cryospheric Sciences Laboratory, NASA/Goddard Space Flight Center. Effects of climate change on Great Basin playa lakes in Oregon: Initial results using mostly satellite data.
- Judy Sims. We just bought a lake. Now what?

ABSTRACTS

Session 1: CyanoHAB monitoring and detection, chaired by *Dan Sobota*

Wednesday, November 3rd, 2:30-5:00 pm

1.1 Modeling Cyanotoxin Production, Fate and Transport in Surface Waterbodies. ***Bernadel Garstecki*** *and Scott Wells, Portland State University****.*** *Student presentation*. Cyanobacteria exist throughout the world and are frequently associated with forming toxic blooms. The toxins produced by cyanobacteria, cyanotoxins, are harmful to both humans and animals. Rising temperatures due to global climate change, increased nutrient loading, and other anthropogenic impacts on waterbodies are expected to increase the prevalence of cyanobacteria. Modeling the production and movement of these toxins is an important step in limiting exposure to them and evaluating management strategies to mitigate their impact. The research provided here offers an overview of some of the environmental factors and cyanobacteria species that are associated with toxin production, and the research also presents preliminary models for the transport and fate of cyanotoxins. The models were first tested using published data from laboratory experiments, and then the models were incorporated into the two-dimensional (longitudinal and vertical) hydrodynamic and water quality model CE-QUAL-W2. The functionality of the CE-QUAL-W2 toxin models were tested using a model of Henry Hagg Lake (Oregon). The preliminary models were able to capture similar dynamics as the published data from the laboratory experiments, but the toxin data available at Henry Hagg Lake was minimal so it was difficult to compare the model results to the field data using the CE-QUAL-W2 model. However, the models were able match predicted results for various test scenarios using Henry Hagg Lake. Further applications of the toxin models to other waterbodies with more consistent toxin data will help verify the accuracy of the preliminary models. In addition, further research of the environmental factors that affect toxin production is necessary to incorporate variable rates of toxin dynamics. The preliminary models should provide a framework to develop more specific models through continued research of cyanotoxins.

1.2. Use of peroxyacetic acid (PAA)/hydrogen peroxide in freshwater cyanobacterial control – case study of lab scale trials and treatments in relation to use in field sites. ***Tom Warmuth***, *BioSafe Systems.* Peroxide based algaecide have been shown effective in selective treatments for cyanobacteria. Lab scale trails of liquid Peroxyacetic acid (PAA)/hydrogen peroxide and solid SCP (sodium carbonate peroxyhydrate) on Microcystis aeruginosa give direction on developing effective dosing in field applications for cyanobacterial harmful algal blooms (cHAB). Monitoring prior to treatment the bloom density and distribution provide guidance for effective timing and method/technique of application adjusting for cell density at depth with algaecide concentration.

1.3. Proof of concept: use of volatile organic compounds to predict toxic HAB trajectories and species composition in Upper Klamath watershed, OR. ***Lindsay Collart*** *(2020 OLA Scholarship recipient), Duo Jiang, and Kimberly Halsey, Oregon State University. Student presentation*. Toxic freshwater cyanobacterial harmful algal blooms (HABs) occur annually during the summer months in the eutrophic Upper Klamath River Watershed, OR. Agency Lake (AL) and Upper Klamath Lake (UKL) exhibit successional blooms consisting of several cyanobacterial genera. These toxic HABs degrade the ecology, potability, and recreation opportunities of these freshwater systems. The interactions between toxic HABs and volatile organic compounds (VOCs) have not previously been studied even though VOCs are considered to be a fundamental component of microbial phenotypes. We explored relationships between microcystin concentrations, VOCs, environmental variables, and the microbial community in UKL and AL during 2018 and 2019. A total of 327 m/z values representing different VOCs were measured in 35 samples. The machine learning regularization method, LASSO, selected 20 VOC m/z values that significantly improved upon a multiple linear regression model composed solely of rapidly accessible environmental variables, such as temperature and pH, to predict toxin concentration. The new LASSO model yielded a remarkably high predictive ability (r2>0.9). The success of this proof-of-concept study points to VOCs as leading chemical indicators of toxic events and suggests VOC monitoring is a relatively inexpensive and rapid approach to protecting public health while limiting the economic impacts of waterway closures. Finally, we are using LASSO and other regression techniques to reveal relationships between VOCs the microbial community, and the environment.

1.4. Detecting Algal Blooms in Small Reservoirs of Northern California using Sentinel-2 Imagery in Google Earth Engine. ***Chippie Kislik*** *and Maggi Kelly, UC Berkeley, UC ANR. Student presentation*. Algal bloom events have caused ecological damage and public health concerns in aquatic environments throughout the world. Satellite imagery has proven to be an effective tool to monitor floating algal blooms in coastal and inland environments, helping water quality managers and researchers understand the spatial and temporal extents of potentially toxic blooms. However, many satellite missions provide imagery at coarse resolutions that cannot account for the spatial heterogeneity of bloom dynamics. Sentinel-2 MultiSpectral Imager data have effectively detected chlorophyll-a, a proxy for algal biomass, in large bodies of water, but few studies have shown the applicability in small (<10 km^2) reservoirs. This study provides validation for the use of Sentinel-2 imagery in algal bloom detection in small, freshwater reservoirs in northern California, USA. Here we analyzed four spectral algorithms, the Normalized Difference Chlorophyll Index (NDCI), the Normalized Difference Vegetation Index (NDVI), B8B4A, and B3B2, to retrieve chlorophyll-a data for algal blooms. We assessed algorithm performance using linear regressions with monthly in situ samples that were collected at three sites within the reservoirs. Algorithms that leveraged the red-edge and near-infrared wavelengths accurately identified chlorophyll-a, and NDCI was the most successful spectral algorithm across all sites. Although chlorophyll-a is a proxy for algal biomass and does not necessarily indicate the toxicity of a bloom, NDVI and B4B8A identified strong relationships between chlorophyll-a and microcystin toxins. Upcoming dam removals in the Klamath River Basin are expected to alter the intensity and frequency of algal blooms in these reservoirs. Sentinel-2 imagery provides a useful tool to understand and mitigate ecological changes not only in this system but also in other freshwater reservoirs, lakes, and rivers that experience high disturbance events. We demonstrate that Sentinel-2 imagery can help capture greater spatial heterogeneity of algal bloom dynamics than typical in situ sampling.

1.5. Three years of comparing satellite imagery with field data on cyanobacteria blooms in lakes and reservoirs of the Upper Deschutes River Basin. ***Daniel J. Sobota[1]***, *Brian Fulfrost[2], Steve Hanson[1], Smita Mehta[1], Sam Doak[1], Lara Jansen[3], Victoria Avalos[3]. [1]Oregon Department of Environmental Quality; [2]BFA Consulting; [3]Environmental Sciences and Management Department, Portland State University.* Improving the confidence in remote detection of potentially toxin-producing cyanobacteria blooms helps lake managers allocate monitoring resources and make decisions to protect public health. Here we present results from a study comparing satellite imagery with field data describing cyanobacteria collected over three years in seven lakes and reservoirs in the Upper Deschutes River Basin (Oregon, USA). Satellite imagery from the Sentinel 3 Ocean and Land Colour Instrument (OLCI) provided estimates of cyanobacteria abundance (cells mL^{-1}) based on methods used by the US Environmental Protection Agency CyAN project. We collected in situ measurements of temperature, dissolved oxygen, chlorophyll a, phycocyanin (a pigment specific to cyanobacteria), and pH at 15-minute intervals at four lakes/reservoirs and at two week intervals at three additional waterbodies from spring/summer to early fall during 2019, 2020, and 2021. For each year, field measurements that indicated cyanobacteria blooms corresponded well with elevated cyanobacteria abundance recorded by satellites in all but one waterbody due to shallow water conditions. However, bloom toxicity did not correspond with satellite estimates well across all waterbodies, with only one (Odell Lake) showing elevated microcystin-LR concentrations during blooms (2019 and 2020). Our results suggest that satellite-derived estimates of cyanobacteria abundance can provide a useful screen tool for lake and reservoir managers to make informed decisions on additional actions. Prior knowledge of and additional sampling for a specific waterbody will still be needed to determine the specific extent, magnitude, and toxicity of a satellite-detected bloom.

1.6. Utilizing CyAN for improved detection of harmful algal blooms. ***Alyssa Payne and Kelly Fry (student)***, *County Public Health.* Clark County Public Health (CCPH) relies on notifications from the public to respond to harmful algal bloom (HAB) events at our local lakes and rivers. During a confirmed HAB event, Public Health staff monitor the bloom weekly testing for cyanotoxins to inform advisories that provide water contact recommendations for lake users. Vancouver Lake in Clark County, WA is a highly used recreational lake that has had confirmed toxic algal blooms across multiple years. This project utilized data collected through the Cyanobacteria Assessment Network (CyAN) to develop a binary regression model for predicting the presence of algal blooms at Vancouver Lake. CyAN is capable of reporting estimated cyanobacteria cell counts at any location on a lake by using specialized satellite instruments that can detect and quantify pigments unique to cyanobacteria. Using over 400 days of CyAN data and recorded observations from CCPH staff during their swim beach monitoring from May 2016 to present day, a binary regression model was developed with a p-value of less than 0.001 using the continuous variable “cyanobacteria concentration” and the binary variable “algal bloom presence”. CCCPH plans to implement this model into their HAB response protocol by establishing a threshold cell count value reported throughout the monitoring season by CyAN that would trigger staff to conduct a site visit and sample for toxicity. This model and similar statistical analysis of lakes with available CyAN and observational data could allow for earlier detection of harmful algal blooms to issue advisories protecting lake users.

1.7. Satellites predict lakes at risk from cyanobacteria and microcystin toxins. ***Amalia Handler***, *J.E. Compton, R.A. Hill, S.G. Leibowitz, and B.A. Schaeffer. US EPA.* Algal blooms caused by toxin-producing cyanobacteria are a threat to global water resources and human health. Water resource managers need tools that identify lakes at risk of toxic cyanobacteria blooms. We address this need by using satellite imagery and US-wide field surveys to model the probability of large lakes (>1.25 km2) exceeding lower and higher demonstration thresholds of microcystin toxin, cyanobacteria, and chlorophyll a. For every increase of 0.01 satellite cyanobacteria magnitude the odds of exceeding the threshold increase by 23–54%. Among the 2,192 satellite monitored lakes, those identified with high probability of exceeding the lower and higher thresholds included ⩽335 and ⩽70 lakes, respectively. Our approach represents a critical advancement in using satellite imagery to aid field bloom monitoring and identify management priorities.

OLA Business Meeting

Wednesday, November 10th, 2:00-2:30 pm

Presentation of OLA's financial status, summary of the last year's activities, thanking outgoing board members and electing a new slate of board members and officers.

Session 2: Lake physiology and management, *chaired by Desiree Tullos*

Wednesday, November 10th, 2:30-5:00 pm

2.1. Toxic Dolichospermum cyanobacteria in Oregon lakes. ***Theo Dreher***[1]*, Amanda Foss*[2]*, Ryan Mueller*[1]*, Ed Davis*[1]*.* [1]*Oregon State University,* [2]*GreenWater Laboratories.* Through genome sequencing of harmful algal blooms occurring in recent years in Oregon lakes, we have identified *Dolichospermum* strains that produce 7-epi-cylindrospermopsin in Detroit Reservoir and microcystins in Detroit Reservoir, Lake Billy Chinook, Odell Lake and Junipers Reservoir. We report high resolution congener analysis of these toxins together with their corresponding biosynthetic gene sequences. While many *Dolichospermum* or *Aphanizomenon flos-aquae*-dominated HABs in Oregon are non-toxic, toxic strains do occur in some lakes, and it is important to catalog their distribution and the toxin congeners that are present.

2.2. Natural and anthropogenic controls on lake water-level decline and evaporation-to-inflow ratio in the conterminous US. ***Emi Fergus****, US EPA.* Natural lakes and constructed reservoirs provide important ecosystem services that include water sources for human activities (e.g., drinking water, recreation), habitat for wildlife, and buffers against adverse effects of drought and flooding. Disturbances such as land use intensification, water extraction and diversion, and changing climate conditions may significantly alter lake water-level regimes and lead to declining water levels. EPA's Office of Water would like to understand how human interventions and management impact and interact with climate on declining water levels. We developed a conceptual framework of natural (lake morphometry, watershed hydrology, and climate) and anthropogenic (dam height and land use) drivers of lake water-level decline and used path analysis to test and quantify the relationships. Our results suggest that large water-level declines in Western lakes are primarily from dam operation and water management strategies and are less related to climate factors. In contrast, water levels in Midwestern lakes are more strongly influenced by climate (drought), and management strategies tend to promote full pools and stable water levels. These regional differences provide insight into the role of water management strategies on lake water levels under a changing climate.

2.3. Evaluation of mixing mechanisms in the control of cyanobacterial blooms. ***Desiree Tullos*** *and Kellie Vache, Oregon State University,* *Biological and Ecological Engineering Department*. As water temperatures rise and nutrient runoff continues unabated, the frequency, duration, and severity of Harmful Algal Blooms (HABs) are rising globally, threatening human and ecosystem health. The majority of HABs research has focused on their detection and far less is known about the effective control of blooms in situ. Of the few control strategies available for short time management, artificial mixing has the fewest unintended environmental impacts and represents the most promising solution in many waterways. However, the lack of detailed understanding on how hydraulics and cyanobacterial growth interact, and how those interactions are impacted by artificial mixing, has resulted in regular examples of mixing systems that fail to control HABs. Detailed understanding on how destratification and turbulence features influence cyanobacterial growth is needed, as is engineering guidance on how to produce the hydraulic conditions that make cyanobacteria less competitive.

This project integrated field observations and a coupled 2D hydrodynamic, water quality, and algal growth models of the Ross Island Lagoon (RIL), Willamette River, Oregon (USA) to understand how wind, tide, aeration, and mechanical mixing impacted cyanobacterial and diatom growth. Wind, tide, and aeration mixing impacted various turbulent mixing depths for suppressing the diurnal vertical migration of cyanobacteria relative to the depth of the photic zone. Mechanical pumping suppressed stratification and decreased surface temperatures by bringing up cold hypolimnetic water. For the range of conditions examined, results indicate that natural (wind, tide) and aeration mixing alone were not enough to suppress the bloom at RIL. Tidal and wind mixing did not have enough energy to mix more than the surface of the lagoon, whereas the depths and extents of aeration needed suppress blooms (via achieving the vertical velocities needed to overcome cyanobacterial migration across the lagoon) were practically infeasible. Instead, aggressive mechanical mixing (~3000 gpm @ 30m of head) was needed to reduce productivity of all phytoplankton via colder surface temperatures. The results provide mechanistic insight on why aeration mixing has been ineffective at multiple sites globally, the relative importance of different hydraulic mechanisms in suppression of HABs, and the scale of engineered mixing needed to effectively control HABs in reservoirs and rivers.

2.4. Water Quality Modeling in Lakes and Reservoirs. How Good Should Your Model Be? ***Scott Wells*** *Department of Civil and Environmental Engineering, Portland State University.* Evaluation of recent modeling approaches and results for lakes and reservoirs in the Pacific Northwest, such as Hagg Lake, Lawrence Lake, and Dexter Reservoir in Oregon, Chester Morse Lake and Spokane Lake in Washington, and the Brownlee, Oxbow and Hells Canyon reservoirs on the Snake River in Idaho/Oregon. What are some of the elements of successful modeling of temperature and dissolved oxygen? What kind of model-data errors are typical? Recommendations are made for successful modeling of these systems.

2.5. Online Boater Led Check-In/Check-Out Alternative to In-Person Inspections. A COVID-19 Response Pilot. ***Edgar Rudberg,*** *Ph.D., CD3, General Benefit Corporation.* Due to the high cost of high pressure, heated water decontamination, reducing the spread of aquatic invasive species (AIS) often relies upon the adoption of best management practices at the individual level. This is especially needed during a pandemic. This presentation will outline a pilot project in Minnesota in adopting a digital alternative to in-person inspections. In addition, the presentation will go over the biological efficacy for doing so.

Session 3: Our beautiful lakes: past and present, chaired by *Ron Larson*
Wednesday, December 1st, 3:00-5:00 pm

*3.1. A multiproxy approach to reconstruct paleotemperature, vegetation change, fire history, and lake productivity in the Pacific Northwest, Gold Lake, Willamette National Forest, OR. **Jamila Baig** (2021 OLA Scholarship recipient), Daniel Gavin, and Patricia F. McDowell, University of Oregon*. This study aims to reconstruct paleotemperature, vegetation change, fire history, and lake productivity using multiple proxies from Gold Lake. There are several pollen studies, but no work has been done so far in Oregon to reconstruct paleotemperature based on chironomids (midges living in the lake). This study will be the first attempt to reconstruct paleotemperature in Oregon. Taking multiple proxies will help to have a complete picture of climate change and disturbances that shaped today's vegetation and change in temperature.

Two parallel lake sediment cores were recovered in June 2018 from the deepest point of Gold Lake and marked as Drive I (total 13-meter core) and drive II (8-meter core) with a two-meter highly laminated section after the mazama eruption, showing a higher sedimentation rate. The age-depth model is being developed not only on radiocarbon dating but also on the varves that have been counted manually. It fits well with the radiocarbon dates done at several depths to verify it. Any change can be studied at a fine temporal scale with the help of varved lake sediments to see the sensitivity of vegetation to environmental changes. In addition, the large eruption from Mt. Mazama at 7600 cal yr BP and several other small tephras are found in the core, which allows us to examine the effects of volcanic disturbances on terrestrial vegetation and the aquatic environment.

Sampling was done at different intervals for different proxies. High-resolution charcoal data shows a cluster of peaks in younger dryas, right before and after the Mazama eruption and a little bit around 2000 cal yr BP, and it goes down again in the top 40cm. Pollen data was analyzed at every 50cm for the whole core, and around Mazama, the resolution was increased up to every cm. Early Holocene did not stand out in pollen concentration, but Pine, Douglas fir, and Alnus still had a high concentration during that period. Douglas fir is low in the glacial period and then increases in early Holocene and has the same pattern in the remaining part of the core. Fossilized chironomid data shows a significant variation in the number and abundance of species over time. Gold lake % carbon is negatively correlated with $\delta 13C$. The highest values of $\delta 13C$ are recorded in the post-mazama period; then, it goes down at 6000 cal yr BP where varves end abruptly, and sedimentation rate slows down. The unusual about Gold Lake is that isotopic nitrogen is very negative, except at the bottom of the core. One reason might be cyanobacteria (blue-green algae) that fix nitrogen from the atmosphere. This research will be a great addition to regional paleoenvironmental data, and it will fill the gaps and answer the questions that cannot be answered using a single proxy.

*3.2. A progression of understanding of the turbid, shallow Malheur Lake: Restoration implications. **Casie Smith** and Tammy Wood, USGS Oregon Water Science Center.* USGS has partnered with US Fish and Wildlife Service and High Desert Partnership for the past 5 years to study the currently turbid, non-vegetated state of Malheur Lake. High suspended sediment concentrations in the lake likely are negatively affecting the survival of aquatic plants, and therefore, the habitat and food resources for waterfowl. Data collected during 2017 and 2018 to develop a predictive light model showed that turbidity responds strongly to wind events that suspend bottom sediments. Nearly 100% of all suspended material was fine material (less than 63 μm) which strongly attenuates light through the water column. Data collection in 2019 and 2020 was aimed at understanding the nutrient dynamics in the lake, including the concentrations of nutrient fractions, external loading, and the effects of internal resuspension. Resuspension of fine sediments (and the nutrients sorbed to the sediment) occurs in the open water through wind/wave action, but resuspension also occurs as the shallow lake expands in area in response to a wet water year, inundating previously exposed land. Land use practices along the tributaries (such as water diversions and channelized reaches) affect nutrient and suspended sediment loading into the lake.

In 2021, a mesocosm study was initiated in Malheur Lake to manipulate turbidity and light in the water column. Mesocosms (or enclosures) were constructed to manipulate 1) wind/wave action with a wave reduction barrier, 2) suspended particulates through flocculation, and 3) a combination of both. Preliminary results show that wave reduction barriers functioned when the wind was blowing from the southwest, and that they caused localized sediment deposition, resulting in topographic heterogeneity. Flocculation substantially reduced the suspended material in the water column for multiple days. Results are being used to evaluate possible restoration strategies for portions of Malheur Lake.

3.3. Effects of climate change on Lake Abert: Initial results based primarily on ground-acquired data. ***Ron Larson***[1] *and Dorothy K. Hall*[2]*.* [1]*Oregon Lakes Association;* [2]*University of Maryland and Goddard Space Flight Center.* Recent wildfires and dangerous heat waves have alerted us to some of the adverse effects of climate change. Less well known are impacts to aquatic systems, especially lakes. We examined effects of climate change on Lake Abert, which was nearly dry in 2014-2015 and again in 2021. We will show that changes in climate, coupled with upstream water diversions, was likely the cause of these events. Evidence suggests that the contributing factors were: 1. A lack of substantial precipitation since about 1998; 2. Several annual droughts preceding the desiccation events; and 3. Elevated evapotranspiration rates. Thus, the lack of wet periods and associated high inflows to the lake, coupled with increasing ET, led to a decline in lake storage, and that put the lake at a high risk of desiccation. That condition was by made worse by low precipitation during several consecutive years, and as the lake got shallower, was exacerbated by its large surface area relative to its volume. Consequently, Lake Abert is now dependent on episodic high inflows to prevent desiccation. Upstream water diversions also likely contributed to low inflows to the lake.

Historically, the lake was severely desiccated between 1924 and 1937, owing to Chewaucan River flows of <50% of the long-term average. Studies of regional tree rings indicated this was perhaps the driest period in the past 500 years, so it's evident that the recent desiccation events are remarkable and good evidence of the effects of climate change. Unfortunately, based on this, the lake ecosystem will experience more desiccation events in the future if nothing is done to prevent it.

3.4. Effects of climate change on Great Basin playa lakes in Oregon: Initial results using mostly satellite data. ***Dorothy Hall*** [1], Ron Larson[2], Nicolo E. DiGirolamo[3]. [1]Earth System Science Interdisciplinary Center/University of Maryland and Cryospheric Sciences Laboratory, NASA/Goddard Space Flight Center; [2]Oregon Lakes Association; [3]SSAI and Cryospheric Sciences Laboratory, NASA/Goddard Space Flight Center. Approximately 72% of the state of Oregon is undergoing Extreme Drought (D3) or Exceptional Drought (D4) according to the U.S. Drought Monitor (August 2021), contributing to a decline in the playa lakes in eastern Oregon. We use remote sensing to examine factors associated with desiccation of the playa lakes in a study area consisting of five contiguous lake basins: Lake Abert, Goose Lake, Surprise Lakes, Upper Klamath Lake (UKL) and Warner Lakes. All are terminal lakes except UKL. We studied 21 years (WY 2001-2021) of 500-m resolution Moderate-resolution Imaging Spectroradiometer (MODIS) snow-cover and evapotranspiration (ET) satellite data products, and 19 years of 1-km resolution land-surface temperature (LST) data products, finding increases in surface temperature and ET, and a decreasing number of days of snow cover (#snowdays) in the study area. Specifically, the mean-annual LST increased 0.65°C and ET increased at a mean rate of ~1.35 mm/yr (WY 2003-2021) within the 5-basin study area. The #snowdays generally decreased over time; WY 2014 and 2015 showed the greatest departures from the mean #snowdays during the 21-year period at -49.5 and -56.4

days, respectively, while in WY 2021 the departure from the mean was only -9.3 days. Using 30-m resolution Landsat data we show a general decrease in the areal extent of Lake Abert, for example, since 2000. In 2021, the extent of water in Lake Abert is near the 2015 low (11.40 km^2), at 11.66 km^2. Increasing surface temperature and ET appear to be the primary factors that have caused the dramatic reduction of the extent and volume of the four terminal lakes, and the volume of UKL in 2021. In future work, we will examine air temperature, precipitation, snow cover and streamflow in the context of lake desiccation in this 5-basin study area.

3.5. We just bought a lake. Now what? ***Judy Sims***[1] *and Richard Lycan*[2]. [1]*waterfront resident;* [2]*Portland State University.* My husband Harry and I searched for a waterfront location not far from our Portland-based children and grandchildren--a property where family and friends could gather. After four years and several unsuccessful attempts, we purchased a 92-acre plot with no structures, 11 miles NW of North Plains, OR. The 8 acre, natural portion of the otherwise planted 14 year-old DG timber forest, includes a 3 acre lake, resulting from the creation of Spaniol Reservoir, developed nearly 70 years ago. The reservoir is impounded by two dams and rests on what is classified in the NWI as a wetland. With earth dams at two ends and fed by springs, water drains at one end to form Grebe Creek. The opposite end spills into wetland, and both water exits eventually become tributaries of Dairy Creek. Initial water quality tests indicated safety for swimming, but we seek ongoing, more detailed testing amongst many other ways we wish to learn about this park-like, lake setting. Previous owners planted warm water fish species and we have also observed cutthroat trout. We've seen a variety of wildlife in, on and around the lake ecosystem--beaver, lynx, bobcat, deer, coyote, bats, birds (ducks, kingfisher, osprey, quail, and more), damsel and dragonflies, newts, a crawdad and 100's of small fish. We are aware of at least one invasive animal species, having killed a large bullfrog. While we've been enjoying Forest Lake Farm since June 8th, we realize there's a lot more to learn about Spaniol Reservoir. We understand the water quality depends on nutrients in the lake, phytoplankton, and vertical circulation. We recently joined OLA and hope that over the years it will educate us to become informed and responsible owners of this beautiful property.