November 2010
Editor:
Roger Edwards

LAKE WISE

A Voice for Quiet Waters

The Oregon Lakes Association Newsletter

OLA Plays Well in Corvallis

By Karen Williams, OLA President, ODEQ NW Basin Coordinator

September's Oregon Lakes Association annual meeting and conference benefitted from locating in the scientific stronghold of Corvallis. As well as being the conference co-sponsor, the Oregon State University Department of Fisheries and Wildlife supplied several presenters. The Corvallis offices of the U.S. Environmental Protection Agency National Health and Environmental Effects Laboratory, and the U.S. Geological Survey also shared their research and expertise with the OLA conference audience.

Friday’s late afternoon workshop and discussion session about the 2007 and 2012 National Lakes Assessments preceded Saturday's technical presentations. Participants from the Oregon Department of Environmental Quality, OSU, U.S. Forest Service, OLA, EPA NHEERL, and others engaged in a lively discussion about possible additions to the 2012 assessment and potential funding or field partnerships. Fish assemblage, sediment core, and remotely sensed information topped the wish list, as did a method to incorporate lake data collected outside the national assessment framework. DEQ will reconnect with OLA as preparation for 2012 data collection commences.

OLA welcomed two new Directors to the Friday evening Board meeting: world renowned cyanobacterial toxicologist, Dr. Wayne Carmichael, Wright State University professor emeritus, and Trish Carroll, U.S. Forest Service. OLA Director Kit Rouhe will assume treasurer duties as we thank our out-going treasurer, Toni Pennington, for many years of service to OLA. A subcommittee of the OLA Board, led by past president Roger Edwards, will research and purchase a piece of lake monitoring equipment, likely a dissection microscope, to donate to an educational program or lake association. And the OLA Board decided to enhance our relationship with the Network of Oregon Watershed Councils by attending their next statewide meeting in 2011.

OSU's LaSells Stewart Center provided excellent presentation space, equipment, and staff assistance, all of which allowed the audience to focus on the exceptional content of the talks and posters. DEQ began the technical presentations with two related topics: DEQ's harmful algal bloom strategy and use of satellite-sensed algae bloom data. The audience then learned about the operation of Lake Billy Chinook's selective water withdrawal facility that has allowed reservoir discharge to mimic more natural flows and temperatures in the Deschutes River. Presenters from DEQ, EPA NHEERL, and OSU Fisheries and Wildlife presented results from the Oregon portion of the 2007 National Lake Assessment, the process to select candidate reference lakes, and potential survey designs for the 2012 assessment. The 2012 design may develop individual state surveys followed by a national design based on selected subsets from the state surveys. Following a hearty lunch, conference participants were treated to topics as diverse as research and science education at Oregon dune lakes, home to rare freshwater clams; ownership and boundary issues on the Rogue River; a new relational database for limnological data; and using nitrogen isotopes in lake sediment as an indicator of historical anadromy.

Poster presentations covered invasive macrophyte mapping at the Multnomah County Blue Lake; genetic analysis of changing populations of a *Microcystis* bloom; and the quality of dissection microscopes available by Internet order. Conference exhibitor, In Situ, Inc. displayed an impressive assortment of lake and other water monitoring instruments. Please join us at next year's OLA conference and watch the OLA website for the call for papers in Spring 2011.

Some 2010 HAB Advisories Are Still Active

There were 20 water contact advisories issued at Oregon lakes this year due to the presence of Harmful Algae Blooms. Six of these advisories were still active as *Lake Wise* went to press. The Public Health Division began systematically listing advisories for HAB in 2004, but not until 2008 did some of these blooms persist beyond mid November. It was January 29, 2009 before all of the 2008 advisories were ended. The growing record of these advisories is still insufficient to demonstrate significant trends, but for whatever reason, it is of interest to note that Hills Creek Lake did not make the list this year for the first time since 2004. A summary of this year's advisories is presented below:

2010 Advisories for Harmful Algae Blooms

water body	county	date posted	date lifted
Willow Lake	Jackson	21-Apr	19-Aug
		12-Oct	
Lost Creek Lake	Jackson	4-Jun	22-Jun
		20-Sep	
Lemolo Lake	Douglas	1-Jul	2-Aug
Diamond Lake	Douglas	15-Jul	3-Aug
Willow Creek Reservoir	Morrow	15-Jul	5-Nov
Fish Lake	Douglas	19-Jul	23-Aug
Fairview Lake	Multnomah	27-Jul	
Haystack Reservoir	Jefferson	4-Aug	
Golden Gardens Pond	Lane	5-Aug	14-Oct

water body	county	date posted	date lifted
Fish Lake	Jackson	9-Aug	23-Aug
Dexter Reservoir	Lane	11-Aug	20-Sep
Gerber Reservoir	Klamath	19-Aug	
Whetstone Pond	Jackson	24-Aug	9-Sep
Blue Lake	Multnomah	26-Aug	5-Oct
Sru Lake	Coos	30-Aug	5-Oct
North Fork Reservoir	Clackamas	2-Sep	14-Sep
Dorena Lake	Lane	10-Sep	4-Oct
Blue River Lake	Lane	10-Sep	5-Oct
Tenmile Lake	Coos	23-Sep	

NOTE! ODEQ has issued its 2010 Integrated Report, which names the impaired water bodies to be included on the next 303(d) List. The Report considers "data and information for aquatic weeds or algae and health advisories as indicators of impairment". Lakes and streams that have had recent health advisories for HAB or other problems appear in the Report in Category 5- water quality limited with a TMDL or equivalent needed. A few lakes, such as Diamond Lake, Upper Klamath Lake, and the Tenmile Lakes, have had nutrient TMDL's developed and are shown in Category 4- water quality limited with a TMDL. The comment period for the Report closes on December 15th. For more information, see www.deq.state.or.us/wq/assessment/2010Report.htm.

Laurelhurst Pond is Starting Over

When it comes to long lasting HAB advisories, the pond at Portland's Laurelhurst Park is in a class of its own. It was officially posted on 5 May 2006 and that warning to avoid water contact there was never lifted. Eventually, the pond just disappeared from the listings, and by the time that occurred, Portland Parks and Recreation had erected a prominent barrier completely around the 2.39 acre pond. Posters explained that the pond was being rehabilitated with a microbial digestion process This bioremediation approach was successful in removing an average of about 22 inches of the sediments deposited during the decades that the pond was a popular duck refuge.

The goal for cleaning out the pond bottom was to sufficiently increase the pond's volume so it would not warm to optimal HAB temperatures in the summer. This temperature was quickly reached when the pond's depth was just 12-18 inches. The increased depth gained with the sediment digestion was beneficial, but fell well short of the 8 foot depth that was considered necessary. So this summer, as construction fences replaced the perimeter barrier, the resident fish and turtles were rounded up for sorting. None of the turtles proved to be native Oregonians so they will not resume their residence. The pond was drained, and approximately 9300 cubic yards of pond bottom became fill dirt at another construction site. The mud that remained is highly organic and would not cohere in the intended bathymetry for the pond. This unforeseen complication is being overcome by mixing in sufficient cement powder to enable the lakebed material to retain the specified contours. This is the current state of the project. By year's end, refilling should begin so that the next phase of the project can get underway at full pool in the spring.

An early description of the Laurelhurst Pond is a spring fed pond on the cattle ranch of William S. Ladd. Ladd was a Portland founder and twice served as the Portland Mayor before he sold his east side land holdings in 1909. Portland purchased 30 acres around the pond in 1911 and immediately started laying out the park that remains today. The pond was enlarged to three acres and had a maximum depth between 13-15 feet. Documents show that the finished pond was to be called Firwood Lake, but it was only a privileged few that followed this decision. The park and the pond were and continue to be held in high esteem. Laurelhurst Park was entered in the National Register of Historic Places in 2001, and is the first city park to be so honored. It was the petitions of Laurelhurst neighborhood residents that caused the Portland City Council to fund the pond rehabilitation.

The hard part of this project lies ahead. Early next year, the pond will be fitted with four aerators and two circulators. A community of water plants will be established on the pond's three littoral benches, and the shoreline swale created to stop overland runoff into the pond will be evaluated. Equally important, a program of monthly water quality monitoring will begin. This monitoring is necessary to track the effectiveness of the management strategy, identify the range and cycling of the pertinent conditions, and warn of situations where intervention might be useful. For all of the improvements put into place, the reconfigured 13 acre-foot pond is still a seepage pool with no outlet. The springs that feed the pond can be supplemented from a dedicated well nearby, but the well produces water with elevated levels of nitrogen and phosphorus, and may tap the same aquifer supplying the springs. The pond has and can be used for irrigation in the park, where these nutrients would be better appreciated. Increasing the extent of emergent vegetation might be necessary to obtain the optimal nutrient balance. Successful pond management will be judged by avoiding future HAB advisories. This goal is not unrealistic, but it is still unlikely to occur spontaneously. The needed measures to achieve the goal will become better understood as the pond stabilizes.

National Lakes Assessment a Major Topic at OLA Conference

In his opening statement at the Friday afternoon NLA session in Corvallis, Shannon Hubler of the ODEQ Laboratory and Environmental Assessment Division, encouraged the two dozen lake managers in attendance to consider ways they could partner with, and help enhance this national effort. Shannon was a member of the

ODEQ team that sampled the 30 Oregon lakes for the NLA, and co-authored the Oregon summary of these surveys.

The NLA sampling was conducted in 2007 at 1028 lakes in the lower 48 states, using a standardized methodology for sampling and analyses. The individual lake results from these analyses were compared to those of previously selected reference lakes to determine the percentage of the nation's lakes that are in Good, Fair, or Poor condition. The process is scheduled to be repeated in 2012 so there is growing interest in using the 2007 experience to refine the conduct of the next assessment.

If local lake jurisdictions would make their monitoring data public, the NLA would benefit in multiple ways. Where these data overlap, results from on-going, systematic monitoring programs could validate those obtained from the single site visit used in the NLA. If the two monitoring approaches do indeed produce equivalent data, then the NLA could achieve greater efficiency in costs and labor by making use of local jurisdiction monitoring. Publicizing private monitoring results could also lead to more lakes being recognized as candidates for the selective criteria required of reference lakes. Establishing a data repository with a fixed format might be a first step to attract private lake monitoring summaries.

Both the EPA and ODEQ stressed the statistical nature of the NLA, insisting that the study was not designed for assessing the condition of individual lakes. It is true that the full range of a lake's dynamics cannot be captured in a single visit, but it is also true that all lake monitoring programs begin with a single visit. Each subsequent visit increases the understanding of the seasonal cycles underway there. So there is value to the individual lake data from the NLA, and the work performed at these survey lakes will be especially appreciated on the next occasion when a question about one of them is raised.

ESD – A Different Sort of Lake Monster

Lake Wise readers are aware of the danger of using hair dryers in the shower, but they may not know that there is similar risk in swimming at marinas. The combination of electricity and water is actually a greater hazard at marinas because drowning is added to the threat of electrocution. Every powerboat at a marina has a DC battery and AC electric outlets are often available on marina docks for use on the boats. After a fatal accident at a Scappoose OR dock in 1999, a random survey of three Portland area marinas found electrical faults on 13 of 50 boats checked. This finding is important because it demonstrates that the water at a marina can be a source of electric shock. While this inherent danger rarely causes a problem for dock users, it can be fatal for people who dive or fall into these waters.

Electric Shock Drowning has become a recognized cause of death in numerous instances across the country. Drowning can be the actual cause of death in these cases, but the drowning was due to the presence of sufficient electrical current to paralyze the swimmer's muscles, making it impossible for them to save themselves. A shock victim may be able to break contact from an electrical source if the current they encounter is less than the "let go" threshold. For common AC sources, this value is about 15 milli-Amperes, and 75 mA for DC. The likelihood of contacting such currents increases with wet skin. Dry, intact skin has an electrical resistance in the range of a hundred thousand ohms, but this protection is lowered to about 300 ohms when the skin is wet. Furthermore, the entire submerged surface area of a swimmer becomes a point of contact in an electrical field. A swimmer then is more susceptible to electric shock. Muscle paralysis occurs with contact to 15 to 30 mA of

AC currents, and fatal ventricular fibrillation occurs at 60 to 100 mA AC. A DC shock of 300 to 500 mA is needed to cause ventricular fibrillation.

Electrocution on land occurs when someone contacts an electrical source greater than the natural resistance of the skin. High voltage electricity typically burns a hole in the victim’s skin at the entrance and exit site, and the current moving between these points can cause muscle contraction, respiratory arrest, ventricular fibrillation, hemolysis, and tissue necrosis. These findings may not be evident at the low current levels in Electric Shock Drowning, and so the electrical shock element of these fatalities can be overlooked. There are only about two dozen known incidents of Electric Shock Drowning, some of which had multiple victims, since the Portland marina survey was performed. The difficulty in recognizing the actual conditions causing these deaths makes the true number of these incidents uncertain.

A boat sitting idle in a lake presents a pleasant image. If there is an electrical short on-board however, this boat could be surrounded by an unseen electrical field in the shape of a hemisphere. The highest voltage would occur immediately around the boat, and the voltage would dissipate over the distance to the edge of the field. The radius of the field would be proportional to the leaked voltage and the conductivity of the lake water. The conductivity reported for the 30 Oregon lakes sampled in the National Lakes Assessment ranged from 4.35 µmhos/cm at Waldo Lake, to 895 at Mann Lake. Electric Shock Drowning is a fresh water phenomenon and does not occur in salt water, where the water has a higher conductivity than the human body. The conductivity of sea water is about 50,000 µmhos/cm. Conductance is the inverse of resistance, so if human swimmers have a resistance of 300 ohms, then their conductance would be 1/300 ohms = 0.0033 mhos x 1,000,000 µmhos/mho = 3333 µmhos.

Low water conductivity can be a significant factor in Electric Shock Drowning incidents because the electrical charge is dissipated over a shorter distance. A gradient of decrease of 2 volts per foot could produce a 10 mA current through the outstretched arms of a swimmer with a 5 foot arm span. A swimmer in this position has become a conductor stretching across a voltage difference.

The other way a swimmer can become a conductor in an aquatic electrical field is to contact an even better conductor, such as the metal ladder at the side of a pool or a boat. In this scenario, establishing a better path to an electrical ground produces a surge of current through the swimmer’s body and a predictable outcome, which is largely based on the strength of the surge, the duration of the current flow, and whether knowledgeable rescuers are nearby. To avoid adding to the list of victims, rescues are best performed from the dock or a boat with non-conductive implements. Recovery operations should first shut down power to the dock.

Survivors of these incidents often recall a tingling or numbness in their extremities when they entered the water. For shocks applied to the back of the hand, the terrestrial threshold of perception to electrical currents has been measured at 1 mA AC and 5 mA DC. Wet skin is likely more sensitive as well as more susceptible to electrical shock, and it is thus logical to conclude that swimmers can sense electrical fields too weak to cause harm. If they recognize this sensation, they can move to a location farther from a likely source of electricity.

It is AC sources that pose the greatest threat for swimmers. Providing Ground Fault Circuit Interrupter protection to dock outlets would be one way to lessen this threat. These devices continuously compare the current passing through them to the current returning on the neutral wire, and they automatically break the circuit if the two legs are not equal. GFCI outlets guard against electrical faults in attached appliances, and Equipment Leakage Circuit Interrupters can be installed to extend this protection to hard wired appliances.

GFCI outlets have long been required for terrestrial applications wherever electrical outlets are near to plumbing fixtures. This protection has yet to be mandated for docks and marinas however. Another approach would be to monitor for electrical fields in the water around a dock or boat, and investigate the problem when one is detected. Placing the positive lead of a grounded voltmeter in the water will indicate if an electrical field is present there.

The electrical precautions needed to minimize Electric Shock Drowning are technical and complicated. The American Boat and Yacht Council is actively working on standards to address the issue. While these discussions are underway, public education about this hazard works to minimize future deaths and will hasten the implementation of the ABYC standards once they are decided upon.

Snail Eradication Experiment Underway in Jackson County

In October the Oregon Department of Fish and Wildlife reacted to a new infestation of an aquatic invasive species. This time it is the Chinese mystery snail, *Cipangopaludina chinensis*. This gastropod mollusk can live legally in Oregon, so long as they remain in aquariums where they are popular as an algae eater. But this status is under review. There are known populations of these snails in Klamath County's Lost River, Crane Prairie Reservoir, and Big Butte Pond near Bend.

The snails were discovered last year in two ponds of the Jackson County Sports Park, which is east of White City, south of Eagle Point, and northwest of Agate Lake. The ponds were treated with copper sulfate crystals, at a dosage of about 2 parts per million. At last report, about 31,000 dead snails have been collected from the heavier infested pond, and about 800 from the other. Sadly, live snails are still showing up in both ponds.

Chinese mystery snails, and its similar relative from Japan, were introduced to the US as early as the 1890's as a specialty food or in the pet trade. They are operculate, gilled snails with conventional sexual reproduction. They bear their young alive and ready for free living. They prefer slow water habitats with mud substrate and a calcium content >3 mg/L. Their shells can reach a maximum length of 2.5 inches. They feed on algae, zooplankton, and phytoplankton by scraping surfaces harboring these organisms. They can host parasites known to infest humans, and can obstruct intake pipe screens. Their introduction can also disrupt the established relationships of native species.

ODFW reasons that the appearance of the snails at the Jackson County ponds came from someone emptying an aquarium there. Three koi fish, the largest weighing 11 pounds, were also found in the ponds. The New Zealand mud snail is another non-native, operculate snail now found in Oregon, and it can pass through a fish gut unharmed by sealing its shell. If Chinese mystery snails can also perform this feat, then they may have arrived in the Jackson County ponds in a koi rather than an aquarium. This possibility is another justification for the severe penalty for transporting live fish that became Oregon law this year.

The ponds that are subject to this attention are immediately east of Kershaw Road, and to the north and south of Thunder Road. The northern pond has the larger surface area, but with an average depth just over a foot, it has a smaller volume. It only had a light infestation of snails and was treated with 13 pounds of copper sulfate.

The southern pond has an average depth of about 5 feet. The snail infestation there reached up to 166 snails/m^2. When live snails were still observed after broadcasting 30 pounds of copper sulfate in the pond, a second application of 17.5 pounds was made two weeks later. The guidelines for this use of copper sulfate only allow two applications.

The two ponds are only separated by about 700 feet, and the Hoover Ponds are just twice that distance to the west. Fortunately, gilled aquatic snails have a limited ability to move overland on their own. The difference in snail population densities suggest they have spent more time in the southern pond. They are obviously reproducing in the ponds and the newborn snails are tiny enough to be readily dispersed in the mud on the feet of waterfowl or wading dogs. The potential for passive dispersal by these or other means makes it prudent to consider an eradication operation for each instance of infestation. The conditions at the Sport Park ponds are suitable for this effort.

Of all the agents the US EPA has approved for snail eradication, copper sulfate is an attractive choice. It is effective at low doses for snails, but has low toxicity for higher animals. Copper is in fact, a micronutrient for many organisms so metabolic pathways exist to deal with exposures. When dispersed as a solid crystal, it sinks to the lake bottom, where the target snails are concentrated, and dissolves there into the water column. The freed cupric ions bind to gill membranes and disrupt their function. Fish are less affected because their mobility allows them to avoid higher concentrations. The limited mobility of snails and the short time needed for copper sulfate to dissipate permits a pond to be treated incrementally, giving an even better way for fish to escape exposure.

For all of its advantages however, ODFW research found no description of copper sulfate use against *Cipangopaludina* species. It has proved effective with other snails and there is now experience for treating mystery snails too. The failure to obtain a complete kill is still being evaluated. If additional treatments are deemed worthwhile, ODFW may investigate other methods or other agents. Even when not fully successful, the fieldwork conducted in this episode is adding to the knowledge needed to better respond to infestations elsewhere.

A Fast Start for the Aquatic Invasive Species Prevention Program

Another of the new Oregon laws that went into effect on 1 January 2010 is the Aquatic Invasive Species Prevention Act. This law authorized the Oregon Department of Fish and Wildlife and the Oregon State Marine Board to jointly administer a program to curtail the introduction or spread of aquatic invasive species. The law added a $5 surcharge to the annual powerboat registration fee and created a new fee for paddle boats greater than 10 feet in length. Out of state powerboats must pay an additional $22 to operate in Oregon waters under this law.

The OSMB issued a press release on September 29 summing up the accomplishments of the new law in its inaugural year. A total of 128,900 AIS permits were sold, which generated $680,094 in revenue for the program. The greatest part of this sum came from renewals of powerboat registrations. This money allowed the hiring of 10 new AIS inspectors, who were stationed as two man teams in Central Point, La Grande, Madras, Clackamas, and Salem. Each of the teams has a mobile, hot water decontamination unit. In their first season, the teams conducted 1,898 inspections on boat ramps, and 690 more along the roadside. The inspections found four boats that required decontamination. Training sessions for marine officers and various public groups are also activities of the AIS teams.

LAKE WISE
The Oregon Lakes Association
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PO Box 345
Portland OR 97207-0345

OLA Mission: The Oregon Lakes Association, a non-profit organization founded in 1990, promotes understanding, protection, and thoughtful management of lake and watershed ecosystems in Oregon. For additional information on OLA, write to the address above, or visit our website.

OLA welcomes submissions of material that furthers our goals of education and thoughtful lake management in Oregon, and is grateful for the corporate support that helps sustain the organization. Corporate members are offered a one-time opportunity to describe their product or service to Lake Wise readers. These descriptions are not endorsements, and opinions appearing in Lake Wise are not OLA policy statements.

Visit our website: www.oregonlakes.org

Aquatic Invasive Species . . . (cont.)

A review of the prevention program brought a request for different registration formats. By the start of next year OSMB is working to offer paddle boaters two year permits in addition to the one year registrations. They will be available as a sticker or as a Tyvek tag, and color-coded so enforcement officers can easily view them at a distance. The reviewers agreed that it is educating the boating public rather than inspections and decontaminations that is the ultimate goal of the program. The inspections however are important, not only because of the surveillance they provide for aquatic invasive species, but also because they give the AIS program a high profile and provide the opportunity to educate the boating public. For all these reasons, increasing the number of inspections will be a focus in the coming year.

NALMS Conference is Coming to Spokane

OLA's parent organization, the North American Lake Management Society, will convene their 2011 international symposium in Spokane on October 23-28. The theme of this conference is "Diverse and Sustainable Lake Management". These meetings typically draw 500-600 citizens, scientists, and professionals, who mingle and share ideas about the protection and management of lakes and reservoirs, and other things too. There are workshops to teach hands-on skills and a wealth of presentations in concurrent sessions to choose from. The meeting attracts a variety of vendors exhibiting the specialty instrumentation, services, and equipment with lake applications. The NALMS website at www.nalms.org will display more details about the conference as the time draws closer. Information about Spokane has already been posted. If the idea of a major conference close to home is appealing, give thought too, to preparing a presentation or poster for the meeting. Any project worthy of doing has aspects that would be of interest to others.

2007 LAKE SURVEY - Monitoring Results

WATER BODY		WQ									CONDITION									TROPHY			
	Date	pH	Conductivity	ANC	Ca	Turb	Chlphyl	Secchi	TP	TN	Plankton	Shoreline	Riparian	Littoral	Litt/Rip	TP	TN	Turb	Chlphyl	Secchi	Chlphyl	TP	TN
			umhos/cm	ueq/L	mg/L	ntu	ug/L	m	mg/L	mg/L													
BACA	18-Jul	7.8	447	4473	35.36	11	16.67	0.76	2.67	5	poor	fair	poor	fair	poor	poor	poor	fair	fair	Eu-	Eu-	Hypereu-	Hypereu-
BEULAH	13-Jul	8.5	141	1222	11.02	16	8.16	1.04	0.136	0.775	good	fair	poor	poor	poor	poor	poor	poor	poor	Eu-	Eu-	Hypereu-	Eu-
BIG	6-Aug	6.3	5	29	0.26	<2	0.23	15.13	0.006	0.05	good	fair	good	good	good	good	good	good	good	Oligo-	Oligo-	Oligo-	Oligo-
CLEAR CK	15-Aug	8.2	92	829	15.78	<2	1.14	2.53	0.015	0.256	good	poor	poor	fair	poor	good	good	fair	good	Meso-	Oligo-	Meso-	Oligo-
CLEAR (Lane)	26-Jul	7.3	59	218	1.99	<2	1.12	6.65	0.005	0.11	good	fair	good	good	good	good	good	good	good	Oligo-	Oligo-	Oligo-	Oligo-
CLEAR (Wasco)	21-Aug	7.2	23	203	1.75	<2	1.23	bottom	<0.004	0.172	good	fair	poor	good	poor	good	good	good	good		Oligo-	Oligo-	Oligo-
COOPER CK	27-Jun	8.6	219	706	13.65	<2	1.22	4.97	0.008	0.259	good	fair	good	good	good	good	good	good	good	Oligo-	Oligo-	Oligo-	Oligo-
EMIGRANT	4-Sep	7.9	118	1070	12.78	3	3.57	2.1	0.017	0.496	good	fair	poor	fair	poor	fair	poor	fair	poor	Eu-	Meso-	Meso-	Meso-
FERN RIDGE	25-Jun	7.5	62	404	4.55	13	6.18	0.85	<0.004	0.096	fair	fair	fair	fair	fair	good	good	poor	poor	Eu-	Meso-	Oligo-	Oligo-
HILLS CK	27-Aug	7.9	54	500	5.02	<2	0.67	4.63	0.01	<0.02	good	fair	poor	good	poor	good	good	good	good	Oligo-	Oligo-	Oligo-	Oligo-
HORSFALL	23-Jul	6.4	64	70	1.01	<2	12.37	1.15	0.035	0.557	poor	fair	fair	good	good	poor	poor	fair	poor	Eu-	Eu-	Eu-	Meso-
HOSMER	7-Aug	8.8	40	345	1.32	3	8.27	bottom	0.052	0.462	fair	good	good	good	good	poor	poor	fair	poor		Eu-	Eu-	Meso-
ICE	13-Aug	8.2	59	504	10.72	<2	0.34	10.3	<0.004	0.068	fair	good	fair	good	good	good	good	good	good	Oligo-	Oligo-	Oligo-	Oligo-
JUNIPER	11-Jul	8	142	1404	12.19	47	4.3	0.45	0.178	0.273	poor	fair	poor	poor	poor	poor	good	poor	poor	Hypereu-	Meso-	Hypereu-	Oligo-
JUNIPER	11-Sep	8.1	184	1787	14.84	194	15.6	0.1	0.629	1.231	poor	poor	poor	poor	poor	poor	poor	poor	poor	Hypereu-	Eu-	Hypereu-	Eu-
L EDNA	24-Jul	7.2	87	219	2.23	<2	0.9	7.48	<0.004	0.148	good	fair	good	good	good	good	good	good	good	Oligo-	Oligo-	Oligo-	Oligo-
L WOODS	5-Sep	7.7	31	289	2.67	<2	0.8	6.45	<0.004	0.171	good	poor	good	good	good	good	good	good	good	Oligo-	Oligo-	Oligo-	Oligo-
LUCKY	12-Jul	7.6	141	1546	6.97	574	0.93	0.04	0.933	2.228	poor	poor	poor	poor	poor	poor	fair	poor	good	Hypereu-	Oligo-	Hypereu-	Hypereu-
MANN	17-Jul	9	895	9844	18	34	25.72	0.48	0.15	1.864		poor	poor	poor	poor	poor	fair	poor	fair	Hypereu-	Eu-	Hypereu-	Hypereu-
MOON	16-Jul	8.3	330	3432	24.2	96	38.73	0.15	0.271	1.525		fair	poor	fair	poor	poor	fair	poor	poor	Hypereu-	Hypereu-	Hypereu-	Hypereu-
OFFICERS	1-Aug	9.8	216	2006	13.24	9	0.95	3.98	0.036	0.421	good	poor	poor	fair	poor	poor	poor	poor	good	Meso-	Oligo-	Eu-	Meso-
PHILLIPS	30-Jul	9.3	106	878	11.19	4	15.89	1.19	0.042	0.531	fair	fair	poor	poor	poor	poor	poor	fair	poor	Eu-	Eu-	Eu-	Meso-
PIUTE	11-Sep	7.7	152	1511	7.65	152	4.64	0.11	0.636	1.674	poor	poor	poor	poor	poor	poor	fair	poor	good	Hypereu-	Meso-	Hypereu-	Hypereu-
POWERS	26-Jun	9.2	101	830	6.49	10	73.73	0.82	0.176	2.287	poor	poor	poor	good	fair	poor	poor	poor	poor	Eu-	Hypereu-	Hypereu-	Hypereu-
POWERS	6-Sep	9.5	107	886	7.79	14	81.5	1.84	0.096	1.027	poor	poor	poor	fair	poor	poor	poor	poor	poor	Eu-	Hypereu-	Eu-	Eu-
SMITH	9-Aug	7.8	56	497	4.07	<2	0.49	12.51	0.043	0.087	fair	fair	good	good	good	poor	good	good	good	Oligo-	Oligo-	Eu-	Oligo-
S TWIN	12-Sep	8.5	152	1485	8.6	<2	1.18	6.99	0.005	0.191	good	fair	good	good	good	good	good	good	good	Oligo-	Oligo-	Oligo-	Oligo-
SPARKS	8-Aug	7.3	25	217	1.42	<2	0.45	bottom	0.036	0.162	good	fair	good	good	good	poor	good	fair	good		Oligo-	Eu-	Oligo-
STRAWBERRY	18-Sep	8.5	45	408	3.76	<2	1.33	5.5	0.072	0.423	poor	good	good	fair	good	poor	poor	good	good	Oligo-	Oligo-	Eu-	Meso-
TORREY	29-Aug	7.3	11	98	0.64	<2	0.78	bottom	<0.004	0.228	good	good	poor	good	fair	good	good	good	good		Oligo-	Oligo-	Oligo-
VAN PATTEN	19-Sep	6.8	22	159	2.22	<2	0.62	7.55	<0.004	0.055	fair	good	fair	fair	poor	good	good	good	good	Oligo-	Oligo-	Oligo-	Oligo-
WALDO	28-Aug	6.6	4.35	23	0.2	<2	0.07	36.71	<0.004	<0.02	good	good	good	good	good	good	good	good	good	Oligo-	Oligo-	Oligo-	Oligo-

2007 LAKE SURVEY - Lake Characteristics (extracted from "2007 Survey of Oregon Lakes: Individual Lake Summaries", at www.oregon.gov/DEQ.)

WATER BODY	LOCATION				WATERSHED					LAKE			
	County	Basin	Category	Ecoregion	Area	Pop	Precip	Geology	Land Use	Area	Elev	Depth	Manager
					ha	per sq mi	cm		%	ha	m	m	
BACA LAKE	Harney	Malheur Lake	lake	xeric	1,431	0	34	Felsic Pyroclastic	range	157	1265	1	US
BEULAH RESERVOIR	Malheur	Malheur River	reservoir	w mtn	115,607	0	64	Mafic Volcanic	range 53	482	1018	7.3	OR/US
BIG LAKE	Linn	Willamette	lake	w mtn	1,636	0	216	Calc-Alkali Volcanic	forest	93	1416	21.3	US
CLEAR CREEK RESERVOIR	Baker	Powder	reservoir	w mtn	384	0	119	Mafic Volcanic	forest	14	2107	3.7	US
CLEAR LAKE	Lane	Mid Coast	lake	w mtn	169	27	192	Sandstone	forest 76	60	29	22.2	Prvt
CLEAR LAKE	Wasco	Deschutes	reservoir	w mtn	2268	0	177	Glacial Drift	forest 98	125	1065	2.5	US
COOPER CREEK RESERVOIR	Douglas	Umpqua	reservoir	w mtn	1,174	5	152	Sandstone	forest 99	52	204	16	OR/US
EMIGRANT LAKE	Jackson	Rogue	reservoir	w mtn	16,624	4	81	Mafic Volcanic	forest 70	283	679	21.8	OR/US
FERN RIDGE LAKE	Lane	Willamette	reservoir	w mtn	66,596	111	159	Sandstone	forest 71	2587	113	5.3	OR/US
HILLS CREEK LAKE	Lane	Willamette	reservoir	w mtn	100,911	0	168	Calc-Alkali Volcanic	forest	1086	467	43.8	OR/US
HORSFALL LAKE	Coos	South Coast	lake	w mtn	544	1	169	Dune Sand	other 53	90	6	1.4	OR/US
HOSMER LAKE	Deschutes	Deschutes	lake	w mtn	5,428	0	161	Mafic Volcanic	forest 99	41	1505	3.1	OR/US
ICE LAKE	Wallowa	Grande Ronde	lake	w mtn	524	1	127	Shale/Mudstone	forest	26	2378	29	OR/US
JUNIPER RESERVOIR	Lake	Summer/Goose	reservoir	w mtn	4,390	0	59	Mafic Volcan/Lake Sed	forest 55	69	1475	2.4	Prvt
LAKE EDNA	Douglas	South Coast	lake	w mtn	96	2	186	Sandstone	forest 86	15	67	10.5	Prvt
LAKE OF THE WOODS	Klamath	Klamath	lake	w mtn	6,419	0	133	Mafic Volcanic	forest 99	510	1501	16.4	OR/US
LUCKY RESERVOIR	Lake	Klamath	reservoir	xeric	867	0	66	Mafic Volcanic	range	14	1743	1.5	Prvt
MANN LAKE	Harney	Malheur Lake	lake	xeric	10,624	0	46	Mafic Volcan/Lake Sed	range 94	74	1263	3.2	OR/US
MOON RESERVOIR	Harney	Malheur Lake	reservoir	xeric	174,392	0	40	Felsic Pyroclastic	range 58	137	1263	1.5	OR/US
OFFICERS RESERVOIR	Grant	John Day	reservoir	w mtn	1,030	0	51	Shale/Mudstone	forest 83	8	1374	5.6	Prvt
PHILLIPS LAKE	Baker	Powder	reservoir	w mtn	42,693	1	75	Argillite/Slate	forest 97	434	1234	11.6	OR/US
PIUTE RESERVOIR	Lake	Malheur Lake	reservoir	xeric	11,609	0	61	Mafic Volcanic	range	13	1596	1.7	OR/US
POWERS POND	Coos	South Coast	reservoir	w mtn	62	82	203	Allumvium	forest 61	9	84	2.2	OR/US
SMITH RESERVOIR	Linn	Willamette	reservoir	w mtn	4,564	0	222	Mafic Volcanic	forest	65	789	42.4	OR/US
SOUTH TWIN LAKE	Deschutes	Deschutes	lake	w mtn	131	0	99	Mafic Volcanic	forest	41	1313	15.2	OR/US
SPARKS LAKE	Deschutes	Deschutes	lake	w mtn	9,185	0	171	Mafic Volcanic	forest 98	99	1645	3	OR/US
STRAWBERRY LAKE	Grant	John Day	lake	w mtn	875	0	100	Mafic Volcanic	forest	14	6263	6	OR/US
TORREY LAKE	Lane	Willamette	lake	w mtn	90	0	187	Calc-Alkali Volcanic	forest	26	1596	3.6	OR/US
VAN PATTEN LAKE	Baker	Powder	lake	w mtn	120	0	111	Calc-Alkali Volcanic	forest	8	2241	12.9	OR/US
WALDO LAKE	Lane	Willamette	lake	w mtn	7,619	0	188	Calc-Alkali Volcanic	forest	2423	1641	>45	OR/US