December 2006

Editor:
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LAKE WISE

A Voice for Quiet Waters

The Oregon Lakes Association Newsletter

Joint Conference a New Look for OLA

OLA is still sorting out the response to their first ever, regional meeting with WALPA and NALMS. The meeting was well attended and attracted many quality presentations. The promise of greater numbers to view products and services likewise caught the attention of northwest vendors, who were well represented with descriptions and demonstrations of their wares. While WALPA and NALMS members were very much at home amid this bu$tle, the meeting was a big change from past OLA gatherings, which typically focus on lake issues of interest at the site of the conference. Selecting one format over the other makes for a difficult choice that to a large degree depends on the viewpoint of the sitting OLA Board. Is it the role of OLA to actively participate in lake research and management, or is it more effective to provide lake managers and residents with insights from current research? These and similar questions will be considered in future weeks as the proceeds of the 2006 Conference are sorted out.

The keynote speaker for the recent Conference provides a good example of the dilemma facing the planners for future conferences. John Stockner is an esteemed limnologist with an impressive record of successfully implementing lake restorations. A speaker of this caliber would be out of place at many lakeside meetings because it would not be a good use of his time to address so small an audience with such a local scope of interest. Yet his message deserves dissemination so that the full range of options are available to local lake managers. How can OLA meetings serve both those there to listen and learn, yet still appeal to the speakers and teachers?

The presentation Dr. Stockner delivered was essentially the rationale for the growing practice of placing hatchery carcasses in salmon spawning streams. This is a simple way to provide essential nutrients in the proper proportions so energy transfer from microbial to macro levels of the food web is linked in a manner that can produce optimal conditions for anadromous fisheries. The balanced ratio of carbon, nitrogen, and phosphorus is defined as the Redfield ratio in honor of the researcher who found it to be a consistent component of ocean chemistry. By fertilizing lakes to achieve this nutrient ratio, Dr. Stockner produced compelling increases in salmon runs. Nutrient addition is a hard sell today, but anyone who can convince Swedish lake managers to fertilize a lake that was just cleared of sewage outfalls has to be persuasive.

While this and the subsequent presentations were under way, the news spread through the Conference that the rotenone treatment at Diamond Lake had begun. By now it is known that this work did progress much as was expected. In spite of being the big news about lakes in Oregon this year, Diamond Lake was absent from the 2006 Conference agenda. This omission will be remedied next year when the OLA Conference for 2007 convenes there on September 21-22. Hope you can be there; there will be a lot to talk about.

Nutrient Ratios May Hold Key To Salmon Recovery

by Richard Raymond, Ph.D., E & S Environmental Chemistry, Inc., Corvallis OR

At the recent Regional NALMS meeting sponsored by OLA at Portland State University, Dr. John Stockner caused a few raised eyebrows with his presentation about fertilizing British Columbia lakes with phosphorus. This was a bit of a surprise for many in the audience who have spent considerable time and effort trying to reduce or eliminate nutrient input to our lakes and streams to prevent or reverse eutrophication.

The need for phosphorus enrichment arises from, among other causes, the reduction in numbers of salmon returning from the ocean. Historically, this supply was annually augmented by salmon runs, which returned phosphorus from the sea and placed it directly in the streams where it would nourish the next generation of salmon. This has been especially important in some coastal B.C. lakes with large sockeye runs that may comprise as much as 40 percent of the annual phosphorus load.[1]

Although cultural "oligotrophication", or reduction in nutrient loads—the reverse process of eutrophication, has been the dominant management objective to control nuisance plant growth for several decades, in the case of some salmon lakes the reduction has resulted in ecosystems incapable of sustaining historic levels of productivity. By the addition of nitrogen and phosphorus in carefully controlled ratios it has been possible to fertilize oligotrophic lakes and streams to stimulate fish production without adverse effects on trophic status of the water body. This treatment strategy can become self-sustaining as healthy fish runs are re-established. An abundant food supply increases the smolt survival rate and produces healthier fingerlings for the downstream migration. Greater numbers that are more competitive increase the likelihood that more adults will return to spawn.

The key to this outcome is the timely addition of nitrogen and phosphorus to maintain the relationship of phosphorus and nitrogen that has come to be known as the "Redfield ratio". The Redfield ratio is named for the American oceanographer Alfred C. Redfield (1890-1983). In 1934, he wrote a now classic paper[2] in which he described the remarkable congruence between the chemistry of the deep ocean and the chemistry of living things in the surface ocean. Both have N: P ratios of about 16:1 (atoms to atoms). When nutrients are not limiting, the molar element ratio C: N: P in most phytoplankton is 106:16:1 (40:7:1 by mass). This is similar to the elemental ratio in seawater, and does not vary a great deal in marine systems. Redfield proposed that the N: P ratio of plankton (16:1) causes the ocean to have a remarkably similar ratio of dissolved NO_3^{-2} and PO_4^{-3}. This similarity is not mere coincidence, but is the result of the interaction of nitrogen fixation, denitrification, and sedimentation in the world oceans.[3] This hypothesis suggested that, devoid of life, the chemical composition of the oceans would be markedly different. Despite many reports that the elemental composition of organisms in a region of the ocean does not conform to Redfield ratios, or that the elemental composition of marine phytoplankton grown in cultures is not 16:1, Redfield's fundamental concept remains valid. The specific elemental composition that is the Redfield ratio reflects the interaction of multiple processes, including the acquisition of the elements by plankton, the formation of new biomass, and the remineralization of the biomass by bacteria in the ocean interior, as well as losses of nutrients from the ocean because of burial in the sediments (for example, phosphorus in apatite), or outgassing to the atmosphere

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[1] Stockner, J. G., and K. I. Ashley. 2003. Salmon nutrients: closing the circle. American Fisheries Society Symposium 34:3-15.
[2] Redfield A.C., On the proportions of organic derivations in seawater and their relation to the composition of plankton. In James Johnson Memorial Volume, ed. R.J. Daniel. University Press of Liverpool, pp. 177-192.
[3] Falkowski, P. G., and J. A. Raven. 1997. Aquatic Photosynthesis. Blackwell Science, p. 308 ff.

(for example, production and loss of N_2, due to denitrification).[4] The concept of Redfield ratios has been fundamental to our understanding of the biogeochemistry of the oceans ever since.

The Redfield ratio is not, however, an intrinsic, optimum ratio. It is an empirical relationship that is subject to change as environmental conditions change.[5] In contrast to the oceans, the C: N: P proportions in lakes can vary substantially. The difference in elemental ratio of nitrogen and phosphorus in lakes, compared to the 16N: 1P ratio in marine phytoplankton has come to be used as an indicator of nutrient limitation. Ratios of N: P greater than 10:1 (by mass, the usual measure) are taken to indicate phosphorus limitation, while ratios less than 7:1 are assumed to indicate nitrogen limitation. But algae differ in the N: P ratio required for optimum growth, from, for example 7:1 for some diatom species, or 9:1 for *Microcystis*, to 20-30:1 for some species of Chlorococcales (green algae). These differences may influence the competitive interaction of algal species under conditions of differing nutrient concentration.[6]

Although the Redfield ratio concept is well established, there are practical problems in its application to lake management. One issue is what exactly should be used to develop the ratio. Some argue for use of DIN:DIP (dissolved inorganic nitrogen, phosphorus), some for TN:TP (total nitrogen, phosphorus) and some have noted that use of DIN:TP, although flawed, might be the closest to appropriate. It seems clear that simplistic comparisons of nitrogen to phosphorus could be easily misconstrued. Factors such as release of particle bound phosphorus, sediment phosphorus releases, and phytoplankton recycling make simplistic use of the ratio inappropriate.

Nevertheless, the Redfield ratio remains a valuable concept to guide our efforts in the protection and restoration of Oregon lakes. We should consider not only the total concentration of nutrients, but their relative abundance as well. Increases in the concentration of nitrogen may result in a positive change in the relative abundance of phytoplankton species.[7] The successful restoration of fish populations in B.C. lakes by application of N and P in varying amounts to maintain a desired N:P ratio highlights the power of the concept to guide management efforts.

Short Sighted Introductions Have Long Term Consequences

The disruption caused by the competition between chub and trout at Diamond Lake was completely predictable. Besides the fact that it has happened before, there are countless examples elsewhere that show how the introduction of a new species into a stabilized ecosystem will shift the relationship of the inhabitants there. Think of parrot feather outside of the Amazon or zebra mussels in the Great Lakes. Closer to home, the clandestine addition of bass disrupted a successful trout fishery in Crane Prairie Reservoir, which was further destabilized by a subsequent introduction of sticklebacks.

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[4] Falkowski, P. G. et al. 2004. The Evolution of Modern Eukaryotic Phytoplankton. Science 305: 354-360.
[5] Klausmeier, C. A., E. Litchman, T. Daufresne, and S. A. Levin. 2004. Optimal nitrogen-to-phosphorus stoichiometry of phytoplankton. Nature 429: 171-174.
[6] Reynolds, C. S. 1984. The Ecology of Freshwater Phytoplankton. Cambridge University Press, London, p 180
[7] Increases in nitrogen concentration in the epilimnion of Lake Simtustus (Ore.) may contribute to fewer cyanophyte blooms than occur in Lake Billy Chinook, just upstream. Raymond, R., J. Eilers, K. Vache, and J. Sweet. 1997. Limnology of Lake Billy Chinook and Lake Simtustus, Oregon. Portland General Electric, Project 2003.

The blue ribbon rainbow trout fishery that had been established at Crane Prairie was compromised in the early 1980's when largemouth bass were illegally introduced. The reservoir is now recognized more for the trophy bass it produces. Efforts to maintain the presence of rainbow trout are hampered by direct predation of the bass, and the overlap of diet preferences between rainbows and other fish in the reservoir. In 1994, biologists began noticing a three-spined stickleback among the fish species present. While this fish is prey for both large trout and bass, its population is nevertheless increasing. The young of the stickleback out compete young trout and bass, causing reduced recruitment to their older age classes. The appearance of the stickleback has also coincided with a shift in zooplankton dominance. Cladocerans of the species *Daphnia* are now less abundant than a calanoid copepod. The greater complexity of food web relationships that result from additions to the species composition in a lake, makes lake management more difficult because the outcome of management actions are harder to predict.

In another example, the illegal introduction of northern pike into a lake in Alaska led to the extirpation of salmon and trout throughout much of the Susitna River drainage. The northern pike's natural range includes northern and western Alaska, but the Alaska Range provided a mountain barrier that kept them out of the south, central region of the state. In the early 1950's this barrier was violated and within 30 years, northern pike were common in the lakes and streams within the 19,400 square mile Susitna basin, an area historically dominated by salmon, trout, char, and grayling. These salmonids co-exist with pike in deep-water lakes where they can escape predation, or in clear, cold, fast moving streams where the pike are at a disadvantage. In the shallow lakes and slow flowing streams of the basin however, only pike are found today. A method has yet to be devised that would eliminate these unwanted pike without causing further harm to the native, anadromous runs.

The consequences of species introductions are logical and well studied. Survival is an instinctive behavior common to all organisms. In a new environment, individuals of an introduced species will do what they must to survive. If they can out-compete their neighbors for food, shelter, and reproductive success, then they will become an established member of the neighborhood, either co-existing with, or forcing out the native species. In the end it is the most adaptable, or the species best suited to the local conditions that will persist. Deliberate introductions must be the realm of competent authorities after careful consideration of intended and unintended consequences. Unintended introductions may be accidental, but they can cause major impacts nonetheless. These observations should be kept in mind when planning a lake trip and also when shopping for pets, aquarium supplies, or landscaping plants.

2006 Recreation Advisories for Cyanobacteria

LOCATION	DATE POSTED	DATE LIFTED
Laurelhurst Park Pond	May 5th	
Hills Creek Reservoir	June 2nd	June 22nd
Lost Creek Lake	June 24th	July 19th
Lemolo Lake	July 11th	August 2nd
Paulina Lake	August 2nd	September 1st
Hyatt Lake	September 12th	September 19th
Willow Creek Reservoir	September 13th	October 31st
Lemolo Lake	September 26th	October 13th
Diamond Lake	October 6th	November 16th

New Fresh Water Field Guide Available

One of the benefits of attending OLA Conferences is the opportunity to join into conversations between strangers who are discussing a topic of interest. This strategy and the promise to write a book report won this reporter a copy of the newly published field guide, "Freshwater Mussels of the Pacific Northwest". It is written by Ethan Nedeau of BioDrawVersity, Allan Smith of Pacific Northwest Native Mussel Workgroup, and Jan Stone of USFW Columbia River Fisheries Program in Vancouver WA. The 42-paged pamphlet has detailed color photographs and descriptions of the Northwest's seven documented species of freshwater clams, the introduced Asian clam, and the Zebra mussel that we need to watch out for. The natural history of these bivalve mollusks is discussed in both general and species-specific sections. The Blitzen River, in the Malheur National Wildlife Refuge, is credited for serving as home for four mussel species. An identification key and a bibliography are included. Funding for the work came from the US Fish & Wildlife Service, Water Tenders, and the Xerces Society. Copies are available at www.fws.gov/columbiariver/, Pacific NW Native Freshwater Mussel Work Group.

The text is a fine biology lesson for those who have always been content to admire clams at the beach or in a chowder can. The terms "clam" and "mussel" are equivalent common names that differ most in their derivation. Clam celebrates the ability to clasp, and mussel is a reference to the strength of their substrate connection. The book points out the possibility that the uneven footing encountered while wading NW streams or lakes could be due to beds of freshwater clams. The shells of these aquatic cousins of geoducks and razor clams can grow to 8 inches in length, and some of the species can live in excess of 100 years. They all rely on fish migrating upstream to maintain their presence in freshwater habitats, giving rise to the chicken or egg question of whether mussel evolution began in streams or the ocean. There are nearly 300 species known in North America but the Continental Divide is a substantial barrier to their distribution. As filter feeders, they have a positive impact on their habitat and are themselves a food source for other predators. Their long lives and restricted ability to move about make them useful as biomonitors of water conditions. They also have a long history of serving more basic needs of mankind. This field guide serves as both a good introduction and an authoritative reference for these freshwater creatures.

Native and Introduced Univalve Mollusks also Common in the Northwest

Slugs, snails, limpets, conchs, and whelks are all grouped together as univalve mollusks, in reference to their one-piece shell. They also share a common ability to move on a ventral "foot", which justifies their classification as gastropods. The New Zealand mud snail is a member of this group and is becoming increasingly prominent in Oregon's lakes, streams, and estuaries. It was first noticed in the U.S. about 1986. The importation of rainbow trout from New Zealand to an Idaho hatchery may have provided the means for their introduction. Regardless of how they got here, there are now established populations in the Snake River drainage, the Columbia River at Youngs Bay and the mouth of the Deschutes River, the lower Rogue River, the Umpqua River, New River, Garrison Lake, Floras Lake, Devils Lake, and Coffenberry Lake. They are very small creatures, but can reach densities in excess of 500,000 individuals per square meter. At high densities they have an impact on their environment, consuming much of the available periphyton that grows on submerged materials. In so doing, they compete with native aquatic snails and insect larvae that also rely on this food source. Unlike these natives however, New Zealand mud snails offer little benefit to fish because they can seal their shell and pass through fish digestive tracts unscathed.

This invasive alien species has generated significant research. In New Zealand, their numbers are kept in check by at least 14 parasite species that prey specifically on these snails. By perverting the snail's substantial power of procreation to produce parasites, the parasites prosper at the snail's expense. The sexes are separate in these snails but most reproduction is an asexual cloning of parthenogenic females. A female will give birth to 20-120 live snails every three months from March to October, the variables being controlled largely by water temperature. Snails can survive in waters ranging in temperature from near freezing to 32˚C., but do best between 18-24˚C. The young are capable of reproducing after a 6-9 month maturation period. Full grown snails are 6 mm, or about ¼" in length, although most are only half this size and they are as small as a grain of sand at birth.

Asexual reproduction has the capacity to quickly increase the size of a population because most, if not all of the population members can produce offspring. This capability is very effective for introduced species as the likelihood of their being spread to new locations increases with their numbers. When they have become widespread within a region, environmental pressures can induce a change to sexual reproduction. This switch has been observed in New Zealand mud snails when parasite prevalence becomes too great. The advantage of sexual reproduction under these conditions is thought to lie in improved resistance to parasites from the greater genetic variability that is acquired by sexually produced individuals. Parasites rely on camouflage to limit the ability of their host to identify them as alien. Greater genetic variability of the host makes it harder for the parasite to remain unnoticed. The uniformity of asexual clones presents a serious drawback. Any fatal flaw that they possess can wipe out the entire population. Populations of New Zealand mud snails have experienced such sudden crashes in Europe.

The feeding habits of gastropods require them to be mobile. New Zealand mud snails scrape algae and organic detritus from the surface of their surroundings. They can meander up to a meter per hour on their own, but can also float or raft downstream, or can be passively moved in the gut of a fish. Attachment to wading boots is another more serious method of travel. Examination of the boots of 50 people in an infected California stream found all had attached snails. The average discovered was 33 snails per wader. Boots, boats, trailers, fishing gear, anchor ropes, Secchi disks, construction equipment, or just about anything that gets wet in an infected lake, stream, or estuary can serve as a way to spread mud snails to new locations. Snails from the Oregon sites of infestation do not show the variability seen in their natural habitat, suggesting they have spread here from a single source rather than coming from multiple introductions. Scrubbing surfaces that could contain snails and then using a physical or chemical agent to kill any remaining would minimize their spread. Recently, concern about spreading a variety of unwanted problems has suggested that a scrub brush workout would be helpful in at least localizing particular infestations. Research at Oregon State University has found that heavily used lakes near an area with New Zealand mud snails were more likely to become infested with the snails than lakes farther away or with lighter use. Another study found that spores causing whirling disease in trout can survive drying for more than a week on boots used in an infected area. Boat washing stations are under consideration at Diamond Lake as a safeguard against new introductions of invasive species. The list of plant and animal pests or disease vectors that cause alarm continues to grow. Perhaps it is time to discuss a rule for boaters that insists they must shower before entering the pool.

Boat washing prior to launch would provide an added level of protection from invaders. In this case, wash water would have to treated or kept out of the lake. A more thorough cleansing would be logical when leaving a water known to harbor a particular pest. Would soap and water, pressure washing, steam cleaning, or an immersion facility be most effective? How will this requirement be fulfilled without creating a bottleneck larger than the one at the boat ramp? Would washing off-site present a risk of spreading the problem over a wider area? Please don't say an inspector must be hired. There are devils in the details but a means can be found if boaters are convinced of the program's benefits. A drive through boat washer might prove workable. Steam cleaning is attractive because the way water expands when heated to become steam means it would require less water than other washing methods, and much of the heat to produce steam could be taken from the lake through a heat exchanger, which would simultaneously provide cooling for the lake. Heating the water would also serve as the treatment necessary to assure it would carry no live pests back to the lake. The small size of New Zealand mud snails, whirling disease spores, and the reproductive parts of problem plants allows them to quickly achieve lethal temperatures when exposed to a heat source. Modern medicine realized a milestone in the mid-19th century when it was proven that washing hands between patient examinations greatly reduced hospital cross infections. Extending this practice to boating offers similar benefits for lakes.

East Lake Cabins Are No Longer Available

It doesn't appear that Measure 37 will make building lots for summer cabins available at East Lake after all. The claim that was filed in Deschutes County on June 1, 2006 envisioned one-acre lots for the 157-acre parcel, but recognized that not all of the land would be suitable for building. Permission to mine the known pumice deposits and geothermal resources at the site were also part of the request. The claim generated much discussion leading up to the November 20, 2006 meeting where the request was denied in a unanimous 3-0 vote. As is the case with so many Measure 37 filings, this vote does not mean the claim is resolved. The decision could be appealed, but more likely, continuation will come from a second claim, requested on October 30, 2006, which was refined from the discussions produced by its predecessor.

The original claim came from James Miller, a partner of La Pine Pumice Resources, which formed in 1988 from the personnel and assets of the La Pine Pumice Company. Mr. Miller was a shareholder in this company as well. The La Pine Pumice Company signed an unrecorded mining lease/option, dated May 7, 1969, to extract pumice from property on the southwest shore of East Lake. The option part of this agreement allowed them to purchase the property if the lease grantor gained ownership through the recognition, or patenting, of her mining claim there. Until her claim was recognized, she only had a "possessory interest" in property owned by the US Government. The mining claim was patented on July 3, 1980 and the La Pine Pumice Company purchased this land on October 31, 1980, which is after the County had enacted land use restrictions that zoned the property for open space and conservation in the previous year. On November 5, 1990, additional protection to the area was established when Congress established the Newberry National Volcanic Monument, which directs the Deschutes National Forest management to preserve and protect its geologic, ecological, and recreational resources.

The Miller claim is based on the provision in Measure 37 that defines a property owner as "the present owner of the property, or any interest therein". Mr. Miller was seeking a ruling on whether the La Pine Pumice Company lease/option agreement constituted "any interest therein". The claim was rejected instead because his personal status on the 1969 lease/option was unclear. In deliberations leading to their vote, the Commissioners voiced the opinion that his claim would only be valid from the 1980 purchase date, not 1969. While this opinion could be overturned in subsequent hearings, they further stated that damages based on loss of residential and geothermal development rights should not be considered because the lease only allowed the property to be mined.

The subsequent claim was filed in the name of La Pine Pumice Resources, which removes the basis for rejecting the first claim. It is also limited to a request for an industrial use on the property, which rules out the possibility of owning one of a hundred or so East Lake cottages with its own well and septic system. The

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OLA Mission: The Oregon Lakes Association, a non-profit organization founded in 1988, 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 OLApolicy statements.

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claimants estimate the property contains 8.5 million cubic yards of high-grade pumice roughly worth $179,800,000 at current prices. They also argue that steam extraction fits the definition of mining and so is justified in their claim. Exploratory wells have found 500-degree temperatures at 300 feet so the site has potential for energy generation. This land is the southwest quadrant of section 30, Township 21S, Range 13E, and is shown as private land on the Deschutes National Forest map. On the Oregon TOPO! map, this quadrant shows two mines, and the adjacent section 31 shows a geothermal well and a prospecting site. The use requested therefore, is not unprecedented for the area, but at the same time, visitors to the Newberry National Volcanic Monument are cautioned not to remove souvenir chips of obsidian. It is also true that at 6381 feet elevation, East Lake is only accessible from about May to October each year, and the location of the property 16 miles from Highway 97 might not be the most convenient source of pumice in the region. While the lawyers debate who owned what and when for some time to come, it appears we must be content to watch the sun rise over East Lake from the Lodge or campgrounds there.

East Lake & Paulina Lake Featured in *LakeLine*

Since their Fall issue in 2005, NALMS has been publishing Featured Lake articles in their flagship publication, *LakeLine.* The latest in this series, in the Fall 2006 issue, is Oregon's own Newberry Crater lakes. The article is written by Doug Larson and includes some lovely photos of the lakes and their surroundings, as well as an authoritative discussion on the two lakes. He has also written descriptions of Waldo Lake (Fall 2005), and Wallowa Lake (Summer 2006) for this feature. Single issue copies are available for sale on the NALMS website, www.nalms.org, or you can become a regular subscriber there. Dr. Larson also presented an entertaining and insightful luncheon presentation at the OLA Conference about his efforts to document the disruption and recovery process to the lakes in the Mount St. Helens blast zone. Some of these findings are available in his article in the September 1998 issue of *LakeLine*.