The Department of Ecology's Supplemental Modeling Report.
A Critical Review.
David H. Milne PhD July, 2018

9. CAPITOL LAKE: ERRORS AND FALSE CLAIMS.

Page 58 of the SM Report begins a short, error-filled section on Capitol Lake itself. A key image repeated three times in that section is reproduced here (Figure 9-1). The first appearance of this image was in 2012 in the TMDL Report, there shown as Figure 92. Wherever it appears in the SM Report, the caption refers to "oxygen depletion" in Capitol Lake. In real life, there is *never* any meaningful, real-life oxygen depletion in Capitol Lake, and the theoretical "depletions" shown in this image are grotesquely in error. If you see it in any Ecology presentation, know that whatever the speaker is saying about it is wrong.

This Chapter analyzes this worst-of-all-Ecology-modeling-failures. The findings in summary:

1) The modelers ran the simulation that produced this result with demonstrably wrong initial input data;

2) The modelers have wasted near-endless time, energy, and simulation focus on their mistaken view that phosphorus controls the Lake's ecology (it doesn't …);

3) The modelers have overlooked the critical role of nitrogen nutrients in Capitol Lake.

A few introductory words on how lakes and marine waters become oxygen-depleted and why that doesn't happen in Capitol Lake are as follows.

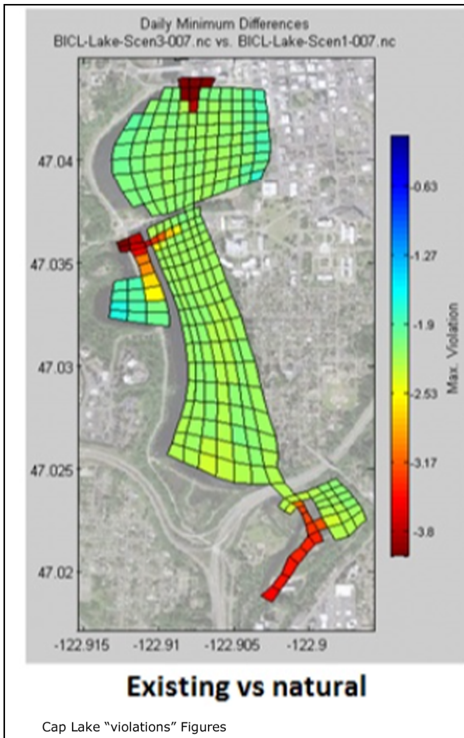

Figure 9-1. Output of the Ecology computer model that portrays all of Capitol Lake in "violation" of some dissolved oxygen water quality standard. Source: SM Report Fig. 35, p. 60.

9-1. There is *No* Real-Life "Oxygen Depletion" in Capitol Lake.

The oxygen depletion story begins with the addition of excess nutrients (usually nitrogen and phosphorus) to the water. There they fuel the growth of plants and phytoplankton, which eventually sink to the bottom and decay. The decay (by bacteria) uses up oxygen. If there is enough sunken plant material, its decay can use up virtually all of the dissolved oxygen (DO) in the bottom water.

This process is well known to aquatic ecologists. An example is shown in Figure 9-2, which depicts a vertical DO profile in Hicks Lake in Thurston County. On June 20, 2011, the amount of oxygen in the water declined from a high level at the surface to zero at the bottom, almost certainly as the result of decay by bacteria of sinking plant matter.

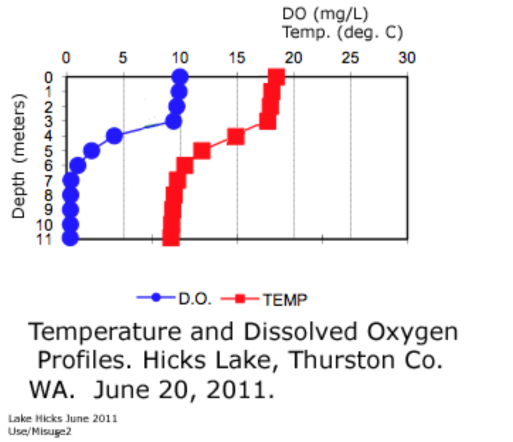

Figure 9-2. Change in dissolved oxygen and temperature with depth, Hicks Lake, Thurston County, June 20 2011. Source: Thurston County Water Resources Report 2012. (The TCPHSS original Figure has been simplified by removal of vertical profiles of pH and conductivity.)

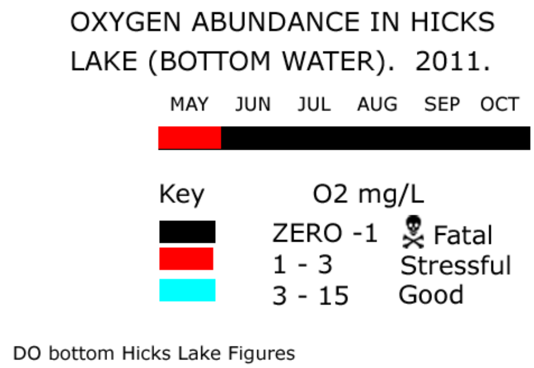

Figure 9-3. Dissolved oxygen in the bottom water of Hicks Lake, growing season May – October 2011. Source: TCPHSS 2012.

Figure 9-3, constructed from all of the monthly vertical profiles presented in TCPHSS Report 2012, shows that Hicks Lake's bottom water was devoid of oxygen from June through October, 2011. Similar constructions for all of the lakes monitored by the Thurston County Health Department (Figure 9-4) show that *all* of the county's monitored lakes experience severe oxygen depletion at their bottoms … except one.

The exception is Capitol Lake. There, the North and Middle Basins *never* became fully or even partially DO-depleted at the bottom in 2011 (and in 2005, included to show that the data gaps for 2011 weren't hiding DO problems).

Why is Capitol Lake the exception, despite the enormous load of nutrient nitrogen and phosphorus dumped into it daily by the Deschutes River? The River itself is the answer.

Unlike the other lakes, which are enclosed basins, Capitol Lake is a flow-through ecosystem that is constantly refreshed by the entry of river water at its southern end. The river water is supercharged with oxygen by its passage over Tumwater Falls. The result is that *the water entering Capitol Lake is always as high in dissolved oxygen as it can naturally get* (100% saturated) without the additional help of plant photosynthesis. *Always*. Because it is almost always cooler than the Lake water, the river flows along the bottom, slowly upwelling as it goes. The result is that the bottom water of Capitol Lake (and all of the rest of the water as well) *never* runs out of oxygen no matter how much decay of sunken plant matter takes place. In this regard Capitol Lake is an “oxygen superpower,” an “oxygen blast furnace” unlike every other lake almost everywhere else and unlike the marine water just beyond the dam.

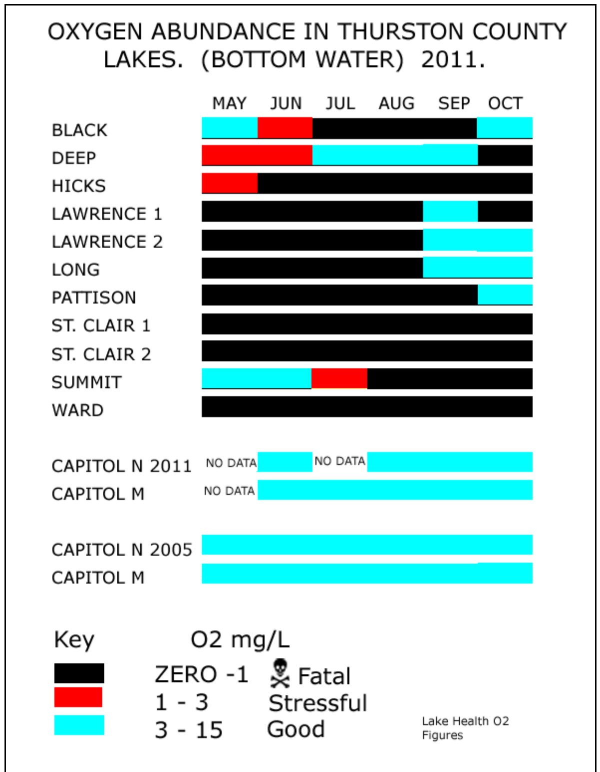

Figure 9-4. Seasonal bottom water DO concentrations in 10 monitored Lakes in Thurston County in 2011. Source: TCPHSS Report 2010-12.

Figure 9-5 shows dissolved oxygen levels in the Middle Basin of Capitol Lake during the 2014 growing season. The Basin’s DO levels remain at values classified as “extraordinary” all season long, never dropping to the level of the standard for the lower Deschutes River (8.0 mg/L).

There is *never* a real-world problem with “oxygen depletion” in Capitol Lake.

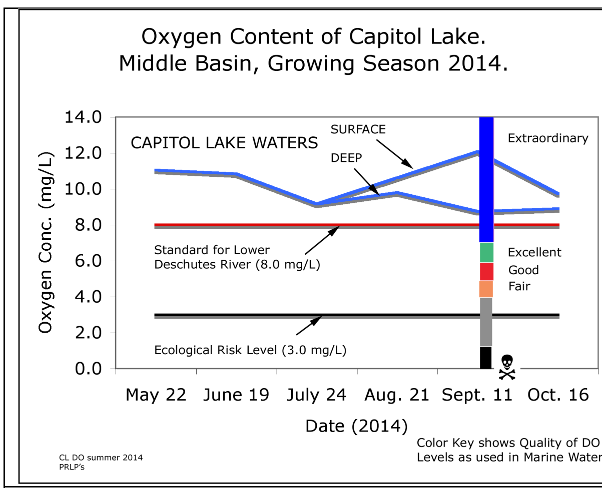

Figure 9-5. Capitol Lake dissolved oxygen levels, 2014. Measured DO levels of Capitol Lake (upper lines), May – October 2014, Middle Basin. Water quality standards for the lower Deschutes River (8.0 mg/L) and low-DO ecological risk level (3.0 mg/L) are also shown. Water quality labels used to describe DO levels of various amounts are shown on the colored scale. Sources: TCPHSS 2012-14; Ahmed et al 2013; Vaquer-Sunyer and Duarte 2000.

9-2. Ecology’s “Dissolved Oxygen Deficiencies” in Capitol Lake Were Calculated Incorrectly.

9-2a. Background for the Correct Calculation.

Repeated mention is made *ad nauseam* of “DO depletion” in Capitol Lake throughout the “Capitol Lake Scenarios” section of the SM Report. In real life the oxygen levels in the Lake are always at the "extraordinary" highest level of classification at all depths (Figure 9-5). What DO standards could possibly be violated in a Lake that is always extraordinarily high in dissolved oxygen? The answer is that the "DO depletions" (violations) are not in the real world; they exist only in computer "cyber space;" a simulation of the "natural conditions" of a "natural" water body compared with its simulated modern conditions.

The "violations" obtained by the Model from the comparison with "natural" water are gigantic – fully 4 mg/L in the parts of the Lake closest to the Deschutes River, Percival Creek, and the dam (red zones, Figure 9-1). How does this relate to the Lake that we know? A few explanations and reminders are in order here.

Lakes do not have set numerical water quality standards (TMDL Report, pp. 19-20). Instead, the method used to determine whether a lake's waters are degraded is to compare its condition in modern times with its condition in some pre-modern era when it was "natural" and to declare a DO Standards Violation if the modern water is 0.2 mg/L (or more) below that bygone "natural DO level." As always, the challenge is to determine what the "natural" DO levels actually were in the Lake before the modern era. In this case, a "natural" Lake didn't exist in pre-modern times, but it is easy to envision a similar natural impoundment (say, fresh water dammed by a rock barrier as seen in some coastal British Columbia estuaries) and proceed from there.

There is a second difficulty, namely; "Should the 'natural' Capitol Lake be considered a lake, or simply a slow-moving part of the 'natural' Deschutes River?" If it were considered a slow-moving river, the standard for the lower Deschutes River (8.0 mg/L) would be used and the 'natural' lake DO would need to drop below that value before its DO content could be used for finding "violations." It never does that. That would be the complete, final and definitive end of the computer modeling story. Indeed there would be no computer modeling at all -- the case would be closed; "no violations."

However, a dammed reservoir can be defined as a "lake" in this way (used by the modelers). Divide the reservoir's volume by the lowest average 30-day river flow of the past 10 years and if the answer (= residence time of the water in the basin) is greater than 15.0 days, the dammed reservoir is considered a "lake," not a slow-moving "river." The modelers did so, using a low flow value apparently obtained by word of mouth,[1] and found that the residence time of water in the lake at this low flow rate is 15.2 days – just long enough to qualify as a "lake."[2]

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[1] They cite "D. Kresch, personal communication 2003", p. 13 TMDL Report, not cited in their references.

[2] In doing so, the modelers are simply following legal guidelines for defining lakes and for examining best-guess 'natural' conditions to advise on modern water quality. I have used this "flow through" procedure to calculate low-flow residence times and find that, in some summer months of some years, the residence times can be as high as 20 days. Orsborn and others (1975) show that such residence times would have been expected only once in every 47 years, back in the era before widespread awareness of climate change. This frequently recurring modern condition is now only tentatively comparable with typical past 'natural' conditions (Orsborn and others, p. 45).

With that definition the 8.0 mg/L DO standard for rivers goes out the window and the modelers are free to use the ‘natural’ DO levels calculated for some theoretical Lake-of-the-Past as the moving, changing, unknowable standard against which modern levels can be compared. Since there are no modern standards for lakes, any modern DO levels that are lower than their calculated counterpart ‘natural’ levels in Capitol Lake by 0.2 mg/L or more result in “violation” labels for their locations in the Lake. Figure 9-1 above, showing virtually every location in this modern observable high-oxygen Lake plastered with large “violations,” is the result of that process.

When I first saw this Figure in the TMDL Report, I found it so contrary to expectation and common sense that I wondered whether it really showed something else; namely how much more oxygen would be present in the Lake water than in an estuary’s water if the estuary replaced the Lake. I asked the modelers how they obtained such results. Their answer (long delayed) was that they considered the ‘natural’ Deschutes River to be 3^{o} C colder than the modern river, thanks to global warming. Since cold water holds more oxygen than warm water, the violations shown resulted from that assumption.[3]

This assumption was a trade secret. Nowhere in the entire SM Report, or in any other Ecology publication, is the reader informed that this underlying assumption about the “natural” conditions of the past is the basis for the Capitol Lake simulation.

The critical drawback of using ‘natural’ conditions to find DO “depletions” in modern water is that it is almost always impossible for others to check up on the calculated findings. To do so one would need to know all of the ‘natural’ DO’s calculated by the computer for every depth, every location, every 6 minutes, from January 25 to September 15, then all of the same values as calculated for modern waters. The Capitol Lake case provides a rare exception. Here, for some of the grid cells, we can “know” what the natural values must have been, assuming that the river was 3^{o}C colder in the past.

The exceptional circumstance that makes a checkup possible is that the water entering the south end of Capitol Lake must always be 100% saturated with oxygen from its passage over Tumwater Falls. Whatever its DO level was when it started over the Falls, that churning tumbling exposure to the atmosphere will always “re-set” it to 100%. That knowledge enables us to calculate the ‘natural’ DO levels at the south end of the Lake

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[3] The relevant part of the modelers’ answer to my question is as follows: “The other change reflected in the model is the Deschutes River temperature that would occur under natural conditions. We consulted the river projections for temperature, which would be over 3^{o}C cooler under natural conditions. Cooler water holds more oxygen at saturation, so the river would also have higher oxygen concentrations. The differences between natural and existing oxygen concentrations predicted in the south basin of Capitol Lake mostly reflect the river temperature and dissolved oxygen differences. This effect is limited to the south basin, however (red cells in [TMDL’s] Figure 92). Oxygen levels in the middle and north basins reflect productivity within the lake.” (Ahmed et al, 2014).)

(the "red zone," Figure 9-1) back when the river is said to have been 3°C cooler and compare them with the modelers' grotesquely mistaken findings.

That calculation, for readers interested in checking up on it, is shown in the following Optional sections. (To skip it, go to section 9-3 below.)

9-2b. Optional: Checking The Dissolved Oxygen Calculation.

Figure 9-6 is a "nomograph" that was used in the pre-computer era for fresh-water dissolved oxygen calculations. It is a diagram with three carefully arranged scales that show the following (top to bottom); (1) water temperature; (2) per cent DO saturation of the water; and (3) DO level in mg/L. If you know any two of those quantities, you can use the nomograph to find the value of the third.

The nomograph is used by placing a straight-edge (ruler) on the diagram aligned so that it crosses two of the scales at the known values, then finding the third value by seeing where the straight edge crosses the third scale. For example, if you know that the water temperature is, say, 8.64°C and its per cent saturation with oxygen is 100%, a ruler placed at these values on the upper two scales crosses the lower (DO) scale at 11.35 mg/L. That is the amount of oxygen that fresh water will contain after prolonged contact with the atmosphere if its temperature is 8.64°C to become 100% saturated.

I used the nomograph to calculate the sizes of the "violations" of DO standards for five dates in the river's 'natural' past. Table 9-1 illustrates the procedure and the values obtained.

The calculation begins with observed modern water temperatures and DO's for the river water as measured at Tumwater Falls Park, a location just above the Falls (Cols. A, B and C, Table 9-1; 2010 data TCPHSS 2012). I used the nomograph to determine that the water there is just below saturation (values in the high 90's, Col. D). Using the nomograph, I found the DO levels that would occur in the water at 100% saturation below the Falls (Col. E). That is marginally the southernmost part of Capitol Lake. Column F shows the 'natural' temperatures that the modelers would assign to the pre-modern era water, namely temperatures 3°C lower than those in Column B. Column G shows the dissolved oxygen levels that would have been present if the water were 100% saturated with oxygen at those 'natural' temperatures. (Because of the colder 'natural' water, these levels are higher than the modern levels.) The differences are shown in Column H. A "violation" is declared if that difference is greater than 0.2 mg/L. The amount of difference in excess of 0.2 mg/L – that is, the size of the 'violation' – is shown in Column I.

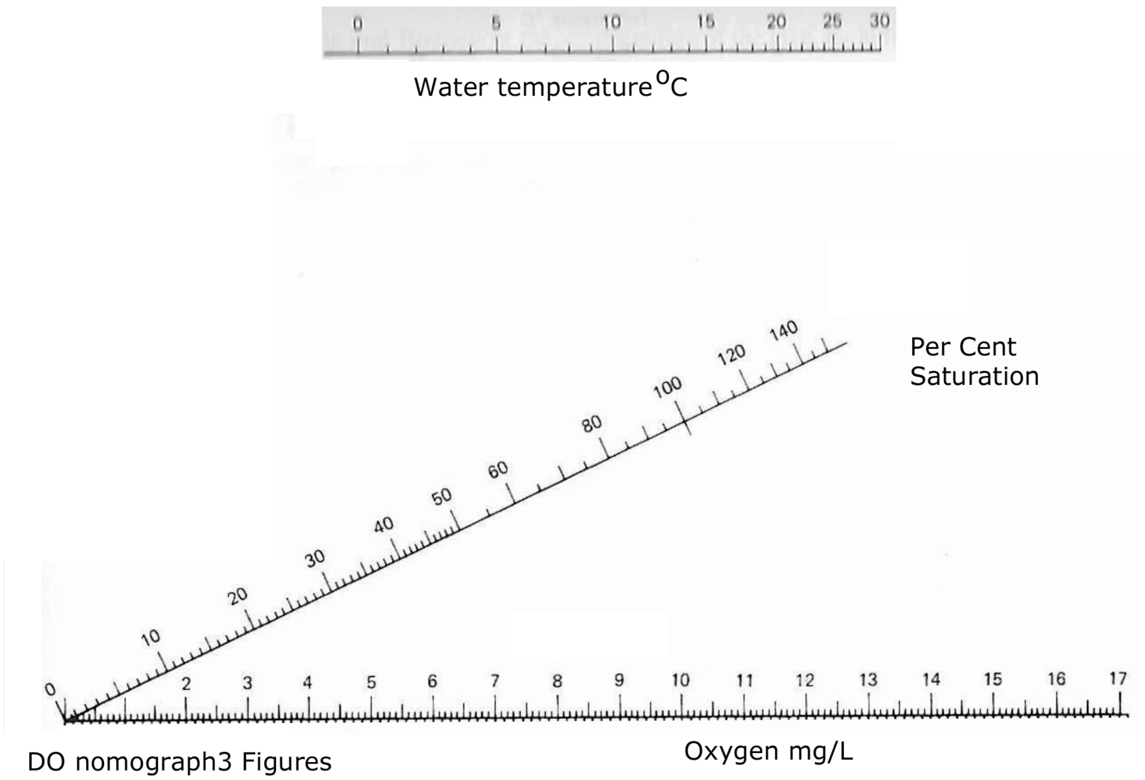

Figure 9-6. Nomograph for determining the amount of dissolved oxygen in fresh water at full (100%) saturation, using the temperature of the water (at sea level atmospheric pressure). Full (100%) saturation is the amount that the water acquires via contact with the atmosphere with no additions from plant photosynthesis or subtractions via respiration or chemical contamination. Source: Horne and Goldman, 1994. The original nomograph's corrections for lakes at high altitude are not shown.

A	B	C	D	E	F	G	H	I
--	observed	observed	nom	nom	(= B-3)	(nom)	(= G-E)	(= H - 0.2)
Date	Temp	DO	% Sat.	DO at	Temp.	DO 100% sat.	Δ DO natl.	violation
				100% sat.	"natural"	natural Temp	- modern	
(2010)	(°C)	(mg/L)	(% sat)	(mg/L)	(°C)	(mg/L)	(mg/L)	(mg/L)
Apr 19	11.64	10.24	98	10.55	8.64	11.35	0.80	0.60
May 10	11.64	10.18	97	10.55	8.64	11.35	0.80	0.60
Jun 15	11.92	10.37	99	10.50	8.92	11.30	0.80	0.60
Aug 16	16.58	9.31	98	9.50	13.58	10.10	0.60	0.40
Sep 13	13.27	9.52	95	10.20	10.27	10.90	0.70	0.50

Table 9-1. Calculation of the DO levels that would exist in the Deschutes River and southernmost Capitol Lake if the 'natural' River were 3°C cooler than at present. Columns A, B and C; dates and observed data for Tumwater Falls Park, 2010, above the falls. (Source: TCPHSS 2012.) Column D; percent DO saturations of observed waters (using Cols B & C & nomograph). Column E; DO of water of temperatures in Col. B at 100% saturation below the falls (from nomograph). Column F; 'natural' water temperatures (Col. B values minus 3°C). Column G; DO's at 100% saturation at 'natural' temperatures in Col. F (from nomograph). Column H; 'natural' DO's minus modern DO's (Col. G values – Col. E values). Column I; sizes of the DO "violations" (Col. H values – 0.2 mg/L). Grey headings show nomograph calculations.

9-2c. Optional: The Corrected Dissolved Oxygen Calculations.

Column H of Table 9-1 shows that the largest difference between the DO levels of modern waters and 'natural' waters at 100% DO saturation would be about 0.80 mg/L, using 2010 observed water temperatures and DO's. The theoretical water quality "violation" on that date would be about 0.60 mg/L (Column I). The modelers' depiction of Capitol Lake (Figure 9-1) shows "violations" of about 4 mg/L in the 100%-saturated area – more than six times the size of the one calculated here. Their calculation is wildly wrong for the south end of the Lake.

There is a "modern" way of performing this calculation. That is to go to the USGS website and use the "DOTABLES" tool (USGS DO Tables, 2018). That calculation tool uses additional data, namely the electrical conductivity of the water due to the lake's (greatly diminished, nearly zero) "salinity." The "violations" calculated (shown in Table 9- 2) are almost identical to those calculated from the nomograph (Table 9-1). A complete USGS-derived table analogous to the nomograph table is shown in an optional section near the end of this Chapter as Table 9-3.)

A	*C-1	I	*I
--	Conductivity	nom.	DOTABLES
Date	(observed)	violation	violation
	μmho/cm		
(2010)	[= μS/cm]	(mg/L)	(mg/L)
Apr 19	101	0.60	0.60
May 10	105	0.60	0.60
Jun 15	103	0.60	0.59
Aug 16	136	0.40	0.45
Sep 13	147	0.50	0.54

*Table 9-2. "Violations" of DO water quality standards in modern Capitol Lake obtained via nomograph and USGS calculation tool "DO TABLES" (Tables 9-1 and 9-3, this Review). Column *C-1; additional data used by DO TABLES but not the nomograph. Sources: TCPHSS 2012, USGS DO Tables 2018.*

9-3. The Lake's Calculated Water Quality Violations are Tiny or Nonexistent.

Ecology's DO level "violations" in the southernmost stretch of Capitol Lake (the Deschutes River "red zone," Figure 9-1) are grotesquely in error. What about the rest of the Lake?

The modelers' depiction of DO "violations" (Figure 9-1) shows two other "red zones" (at the outlet of Percival Creek and at the dam) in addition to that in the southernmost Lake. Percival Creek, like the Deschutes River, experiences aeration from the rush of its water over a cataract just north of the Highway 101 bridge (at the Auto Mall). I expect that the theoretical violations at the Percival Creek outlet arise from the same computer error as in the Deschutes River case. The "red zone" at the dam is probably traceable to the inability of the salt water ponded there in a deep hole in the bottom to hold as much DO as the fresh water overlying it, compounded by the modelers' mistaken assumptions about past river temperatures.

Throughout the rest of the Lake, the green areas (Figure 9-1) show the success of plants at raising the water's dissolved oxygen level and reducing the sizes of the 'violations' shown by the modelers where water enters the Lake. There the percent saturation of the water is unknown and unknowable and the nomograph and USGS's corrections can't be applied.

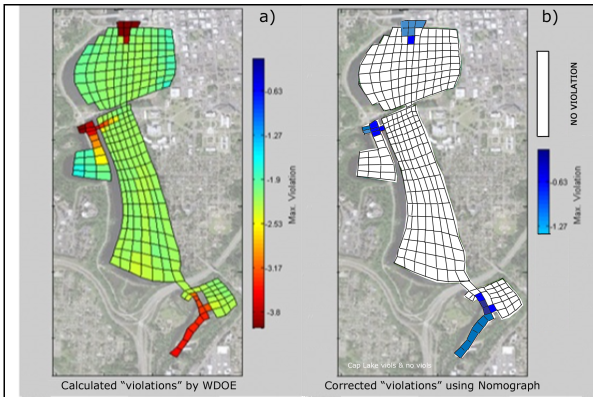

Figure 9-7. Water Quality standards violations in Capitol Lake as calculated by Ecology's computer model (left) and as recalculated by the author (right) using a nomograph and an on-line USGS tool. The value in each "blue zone" (right) is the violation calculated in Table 9-1. The "red zone" (left) violations are in error by about 3 mg/L. All other calculated violations shown in mid-Lake are about 2 mg/L or less. If they were also overestimated by 3 mg/L, the corrected Capitol Lake map (right) would show no significant violations at all.

The violations shown by the modelers in the red zones are some 3+ mg/L higher than are indicated by the nomograph calculations. Errors of the same size (that is, 3 mg/L higher than "real" or "likely" over most of the Lake) probably characterize the whole green zone. If calculated correctly, the "violations" of cyberspace water quality would appear as shown in Figure 9-7b.

The modelers tell us almost nothing about how they adapted the Budd Inlet Model to simulate Capitol Lake. They divided it up into 280 grid squares (nearly twice as many as for all of Budd Inlet), apparently lumped all large plants (macrophytes), the small plants that grow on them (epiphytes), and "attached algae" into one category, and concentrated on phytoplankton and phosphorus (see below) for calculating oxygen levels (see their one-sentence description in the TMDL Report, p. 188). It would not be surprising if this approximation to the complex reality of a rich freshwater ecosystem resulted in large errors of estimation of its real-world conditions.

Common sense and familiarity with real-world dissolved oxygen levels and changes should have prompted the modelers to take a second look at the enormous DO changes calculated by their model. Apparently they never did so. The result was a depiction of Capitol Lake, now widely disseminated, that has mislead everyone who has taken it at face value into believing that Capitol Lake has serious dissolved oxygen depletion conditions.

Modern reality is that Capitol Lake's dissolved oxygen levels are always higher than the standard for the Deschutes River, (almost always) higher than the adjacent salt water DO levels at their highest, and never "depleted."

9-4. The Phosphorus Wild Goose Chase.

Figure 9-8 is from Ecology's TMDL Report of 2012 (their Figures 23 & 24, pp. 79-80). It shows the measured concentrations of phosphorus and nitrogen nutrients at points along the Deschutes River and at two points in Capitol Lake (the two leftmost "boxes," each graph). Aquatic ecologists will recognize that they show unequivocal evidence that nitrogen is the "limiting nutrient" in Capitol Lake – not phosphorus. No one in the then-TMDL-Advisory-Group or on the computer modeling team appears to have ever noticed that.

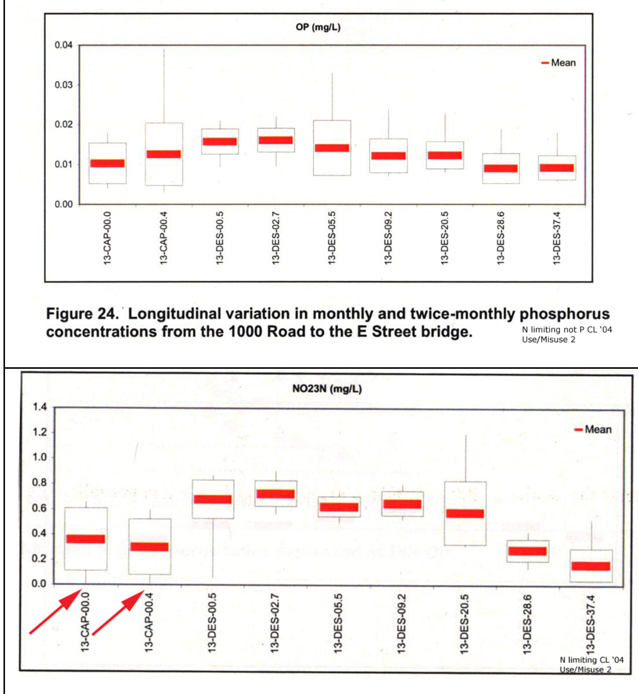

Figure 9-8. Phosphorus (upper) and Nitrogen (lower) concentrations in Capitol Lake (leftmost two boxes) and the Deschutes River (rightmost 7 boxes). Source: TMDL Report Figs. 23 and 24 in part, pp. 79, 80. The year represented is 2004.

The "limiting nutrient" in an aquatic ecosystem is the one that the plants and phytoplankton completely use up. They take up all of it; the amount left in the water is zero. From then on, it doesn't matter how much of the other nutrients are present; the plants can no longer use those others and their growth stops.

In lakes, the limiting nutrient is almost always phosphorus. In the coastal ocean, it is almost always nitrogen. Capitol Lake is the glaring exception to the usual lake condition; there the limiting nutrient during the growing season is nitrogen (CH2M-Hill 1978).

"Box plot" graphs like Figure 9-8 confirm this. Each "box" spans the range of the middle 50% of measured concentration values. The "whiskers" at the tops and bottoms of the boxes span the highest 25% and the lowest 25% of values, respectively, with the ends of the whiskers showing the extreme highest and lowest values of all. For the limiting nutrient, *the lowest value is zero* (arrows, Figure 9-8). For all other nutrients, the lowest value is never zero. The extreme low end of the whisker shows no hint of how often that extreme value occurred. If the "zero" value shown in the nitrogen graph occurred just once (1% of all measurements) or in fully 25% of all measurements, the box plot would look the same. As is clearly shown in that Figure, nitrogen – not phosphorus – is the limiting nutrient in Capitol Lake.

Despite that, the Ecology modelers mistakenly think that phosphorus is the limiting nutrient in Capitol Lake. They've expended endless effort simulating the effect on water quality of reducing phosphorus levels in the Deschutes River and Capitol Lake (for example, Figure 9-9). The model keeps telling them (accurately) that that will make no difference whatsoever toward changing DO levels in the Lake water. Fully 10 pages of text, tables and figures of the 80 pages in the SM Report are devoted to "phosphorus".

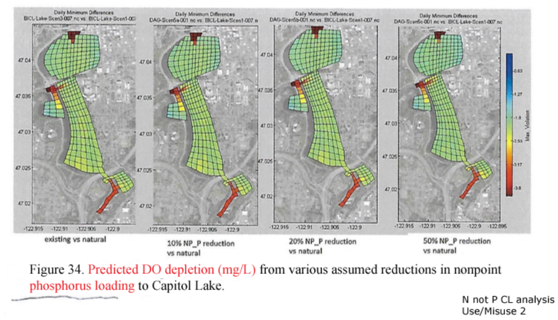

Figure 9-9. Ecology's analysis showing that even a 50% reduction in phosphorus doesn't eliminate the [bogus, see above] "oxygen depletion" calculated for Capitol Lake. SM Report Fig. 34 p. 59.

This amusing wild goose chase would be of no real consequence, except for one thing; the modelers use the "no improvement" results to constantly browbeat the public with the idea that there's nothing we can do (except remove the dam, of course) that can make any positive difference in DO levels in Capitol Lake and Budd Inlet.

9-5. The Eutrophic "Hopeless Phosphorus Red Herring" and the 303-d Listing.

Figure 9-10 from the SM Report is another way of showing the public that "phosphorus-control-is-hopeless-therefore-our-only-recourse-is-to-remove-the-dam." This one appears regularly in the agency's public presentations. The graph's scales are the amount of phosphorus entering lakes in general (from stream flow, local fertilizer use, etc, vertical axis) vs. the mean depths of lakes (horizontal axis). Capitol Lake's annual average position is shown by the black dot at the extreme top, its average position during the growing season is the green square below the dot.[5]

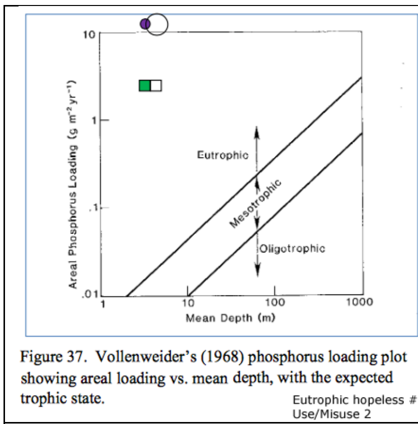

Figure 9-10. Diagram used by Ecology to show the hopelessness of improving Capitol Lake by manipulating phosphorus levels. Source: SM Report Figure 37 p. 65.

This particular graph shows the simulated change in the phosphorus situation that would result from dredging the Lake. The open circle (top) and square (below) show the tiny shift in position of Capitol Lake's status that would result from dredging. To "cure" the Lake's phosphorus "problem" would require that the shift move the Lake's position sideways all the way over to the uppermost diagonal line (labeled "Eutrophic") on the graph. (That is, dredge the Lake to a depth of 1000 meters or so …) Clearly dredging the Lake would be utterly hopeless as a way of "curing" its "phosphorus problem."

[5] The dot and square show that the annual and summer phosphorus entries to Capitol Lake are about 11- and 4 grams P per square meter per year vs. the mean depth of the Lake, about 3-4 meters.

What is “eutrophic?” That term refers to water bodies with very high biological productivity, visible as lush growth of aquatic plants and/or phytoplankton. Such waters often have low or zero dissolved oxygen near the bottom, a consequence of sinking and decay of the plants from the surface. Because of this, the term “eutrophic” has a second, negative connotation in addition to its primary definition; that is, “having impaired water quality.” Capitol Lake is indeed eutrophic but it has high oxygen levels at the bottom all year round – a fact never mentioned by the modelers when showing Figure 9-10.

Figure 9-11 is a warmed-over version of Figure 9-10 used by Ecology in the same way for the same purpose. With their log scales, their technical terms, references to scientific experts, the out-of-the-ballpark positions of Capitol Lake, and their diversion of public attention to something that is not really a problem in the Lake, they are ideal for advancing the idea that removing the dam is the only feasible alternative for “improving” that water body.

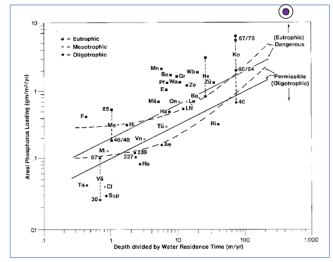

Figure 38. Vollenweider’s (1975) phosphorus loading plot to include the residence time with trophic state.

Eutrophic hopeless #2. Use/Misuse 2

Figure 9-11. A second way of showing Capitol Lake as resistant to improvement by dredging for phosphorus control. Source: SM Report Fig. 38 p. 66.

Ecology uses phosphorus to perpetrate another negative image of Capitol Lake; namely keeping the Lake on the EPA’s “303-d” (“Clean Water Violation”) list on account of its high phosphorus levels. Four other Thurston County lakes are also listed as high-phosphorus violators.[6] As typical eutrophic lakes, unlike Capitol Lake, their phosphorus loads really do reduce their bottom water DO levels to zero. That critical ecological difference apparently doesn’t qualify Capitol Lake for “escape” from the list.

9-6. Nutrient Nitrogen – Seldom Mentioned, Never Simulated.

Figures in Ecology’s own TMDL Report show that various forms of nitrogen are the key nutrients in Capitol Lake (their Figures 24 and 25, shown as Fig. 9-8 above). But the modelers have studiously avoided simulating its effects on Capitol Lake and Budd Inlet, focusing instead on the irrelevant phosphorus situation. A section at the end of the SM Report (p. 68) goes so far as to mention scenarios that have *not* been simulated – “solar powered aeration,” “back-flush the lake,” and “harvest lake macrophytes,” – but doesn’t mention “simulating nutrient nitrogen effects.” That avoidance (as well as of the macrophyte harvest scenario, which would physically remove nutrient nitrogen from the water) seems intended to obscure public understanding of the Lake’s critical role as a protector of Puget Sound. That understanding is crucial to making the best decisions regarding the Lake’s future. Ecology’s efforts have thus far prevented that understanding.

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[6] The other four listed lakes are Black, Lawrence, Long, and Pattison Lakes.

9-7. Optional. The DO TABLES Calculations.

Table 9-3 shows the complete calculation of DO "violations" in Capitol Lake making use of the USGS "DOTABLES" tool (USGS DO Tables, 2018).

A	B	C	C-1*	C-2	C-3	F	G	H	I
						= B - 3.0		= G - C3	= H - 0.2
Date	Temp	DO	Cond.	% sat	DO 100% sat	Temp natural	DO 100% sat	Δ DO natl.	violation
	obs.	obs.	observed		modern		at Temp F	- modern	
2010	(°C)	mg/L	μmho/cm	%	mg/L	°C	mg/L	mg/L	mg/L
			[μS/cm]		[=100@T=B]			(G - C-3)	
Apr 19	11.64	10.24	101	94.29	10.86	8.64	11.66	0.80	0.60
May 10	11.64	10.18	105	93.74	10.86	8.64	11.66	0.80	0.60
Jun 15	11.92	10.37	103	96.11	10.79	8.92	11.58	0.79	0.59
Aug 16	16.58	9.31	136	95.49	9.75	13.58	10.40	0.65	0.45
Sep 13	13.27	9.52	147	90.93	10.47	10.27	11.21	0.74	0.54

Table 9-3. Use of the USGS "DOTABLES" tool to calculate DO "violations" in Capitol Lake, using knowledge that the South Basin Water would have been 100% saturated in pre-modern ("natural") times. Columns A, B, C and C-1; observations in 2010 of Deschutes River water above Tumwater Falls. (Cols. A, B, C same as in Table 9-1; data in C-1 were not used in that (nomograph) calculation.) Column C-2; % DO saturation of the above-falls water using the DOTABLES tool with data from Cols. B, C, & C-1. Column C-3; DO of the water at 100% saturation after passage over the falls, using the DOTABLES tool. Column F; "natural" Deschutes River temperatures = modern temps in Col. B minus 3 degrees. Column G; DO of 100% saturated water at "natural" temperatures in Col. F, using the DOTABLES tool. Column H; difference between DO of "natural" 100% saturated water [Col. G] and modern 100% saturated water [Col. C-3]. Column I; size of violation = values in Col H. minus 0.20. Grey headings show values obtained by DOTABLES tool. Sources: TCPHSS 2012, USGS DO Tables 2018.

These calculations avoid the "fit by eye" uncertainty inherent in the nomograph calculation and by virtue of using more data probably give the more accurate results of the two methods.

9-8. Not Optional. The Bottom Line. Capitol Lake is NOT "Oxygen Depleted." ECOLOGY STOP SAYING THAT IT IS!

The subtitle says it all.