

The Washington Department of Ecology's
Supplemental Modeling Report.
BEST AVAILABLE SCIENCE?

A Review of the Use and Misuse
of WDOE's Budd Inlet Model.

by

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THE TOP LINE ... GREAT CAPITOL – GREAT WATERS!

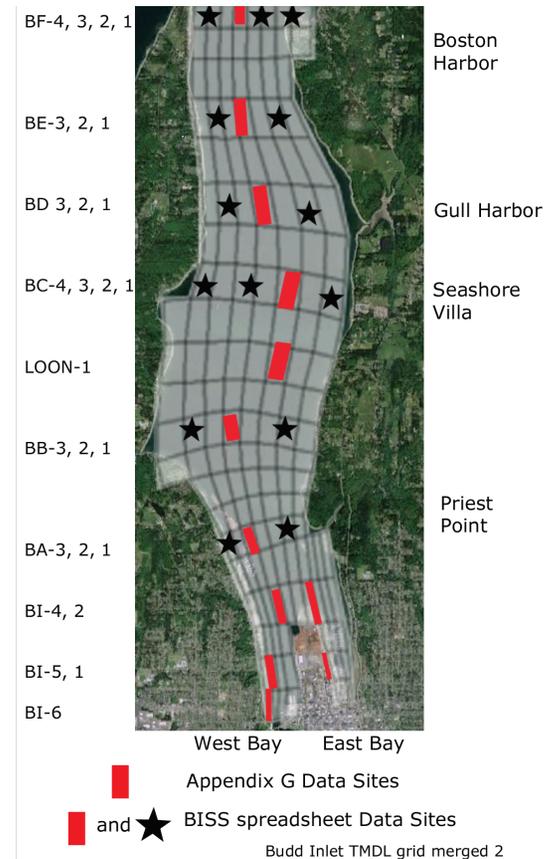
1. Capitol Lake is one of the healthiest lakes in our County.
2. The Lake takes tons of nutrients out of the Deschutes River every summer.
3. The Lake protects Puget Sound from oxygen depletion.
4. The Lake supports a healthy aquatic ecosystem.
5. The Lake is clean enough for swimming, sailing and kids' fishing.
6. *WDOE's Budd Inlet Model misrepresents many of these positive features!*



About the Budd Inlet Model. The Real and the Simulated Budd Inlet.

The Budd Inlet Model simulates the exchange of water and its chemical properties between about 160 grid cells, each divided into about 15 depths.

Water Quality (= Dissolved Oxygen Level) is calculated for every cell and depth every 6 minutes from Jan. 25 to Sept. 15, using 1997 data.



Stars and bars show the *only* sites where observed data can be compared with the computer's calculated values.

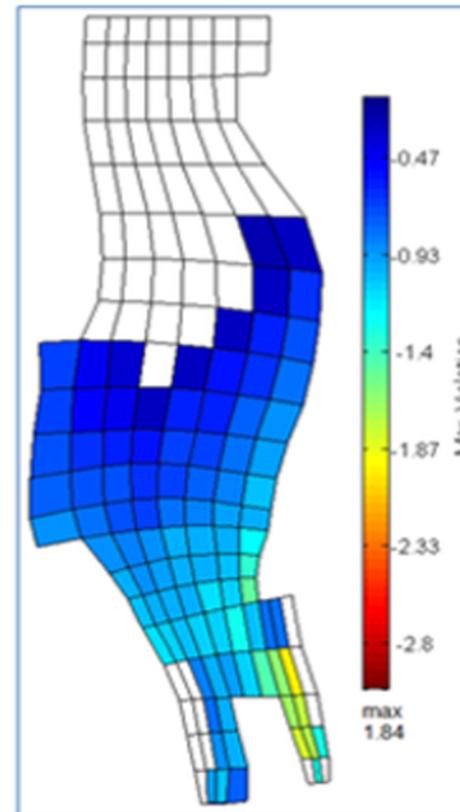
How the Model Shows Calculated Predictions of Water Quality Violations.

“Paint by Number” maps.

Each colored grid square shows by its color the maximum violation found there (depths & dates not specified). Where no violations are found, squares are left uncolored.

Violation sizes are shown by the scale. Blue is the smallest; 0.2 mg/L of dissolved oxygen lower than the Water Quality standard.

All of these “violations” are theoretical predictions calculated by the Model, not observed real values.



Violations “caused” by Capitol Lake “dam”

viols caused by CL solo PP misuse

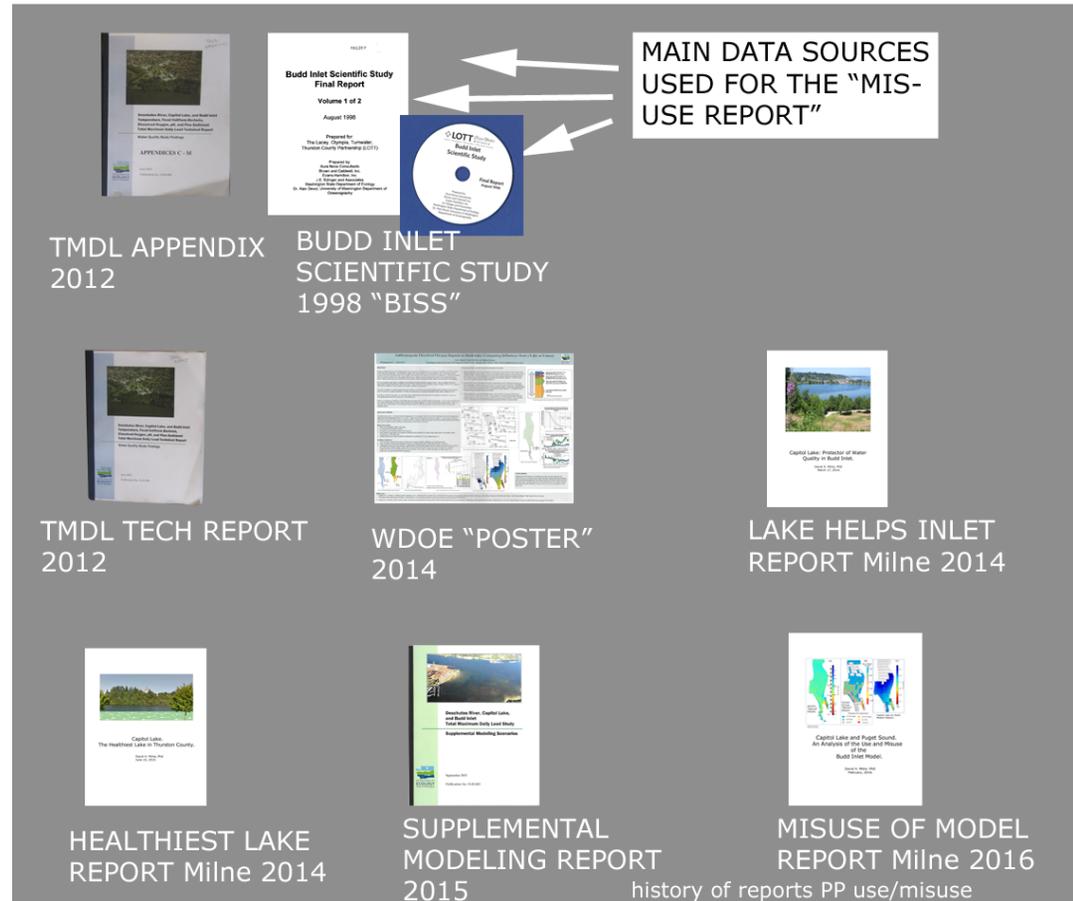
SM Report 2015

Relevant Reports & Data Sources

Milne's Review (lower right) analyzes WDOE's Supplemental Modeling Report (2015, lower center).

Data in the SM Report are calculations drawn from runs of the Budd Inlet Model and from previous WDOE Reports, particularly the TMDL Tech Report (2012, left center) and the "Poster" (2014, center).

Real-life observations of Budd Inlet water quality used by Milne for comparison with the Model's calculations are available in the TMDL Appendix (2012) and in the exhaustive Budd Inlet Scientific Study ("BISS", 1998), upper left.



Misuse of the Budd Inlet Model. Today's Topics.

Where its calculations can be compared with real-life water quality data, the Model gets wrong answers in most cases;

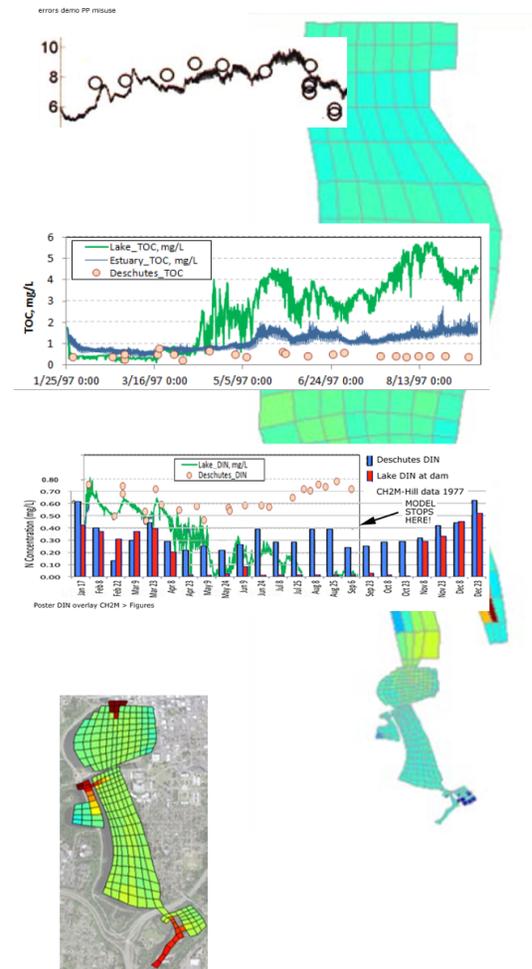
The water quality standards used are often based on an artificial concept, calculated by the error-prone Model (the “natural” Lake or Estuary), that no one can verify;

Model calculations “showing” the Lake degrading Budd Inlet have many serious discrepancies and shortcomings;

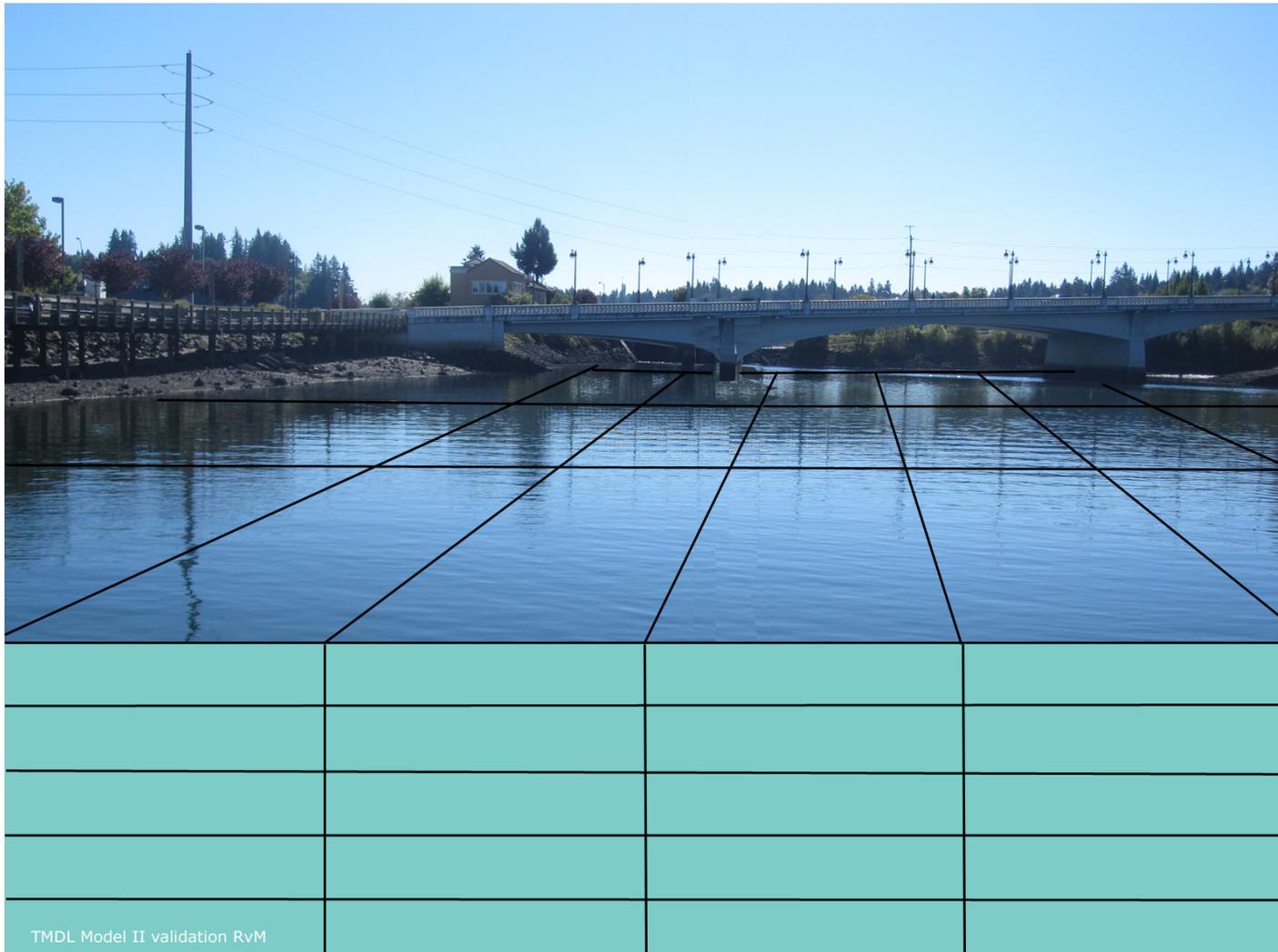
The Model can't simulate the whole growing-season ecology of Capitol Lake but is used as though it can;

WDOE's mistaken claims of “oxygen depletion in the Lake” are based on calculation errors, the contrived “natural lake” water quality standard, and a fundamental misunderstanding of a key feature of Lake ecology.

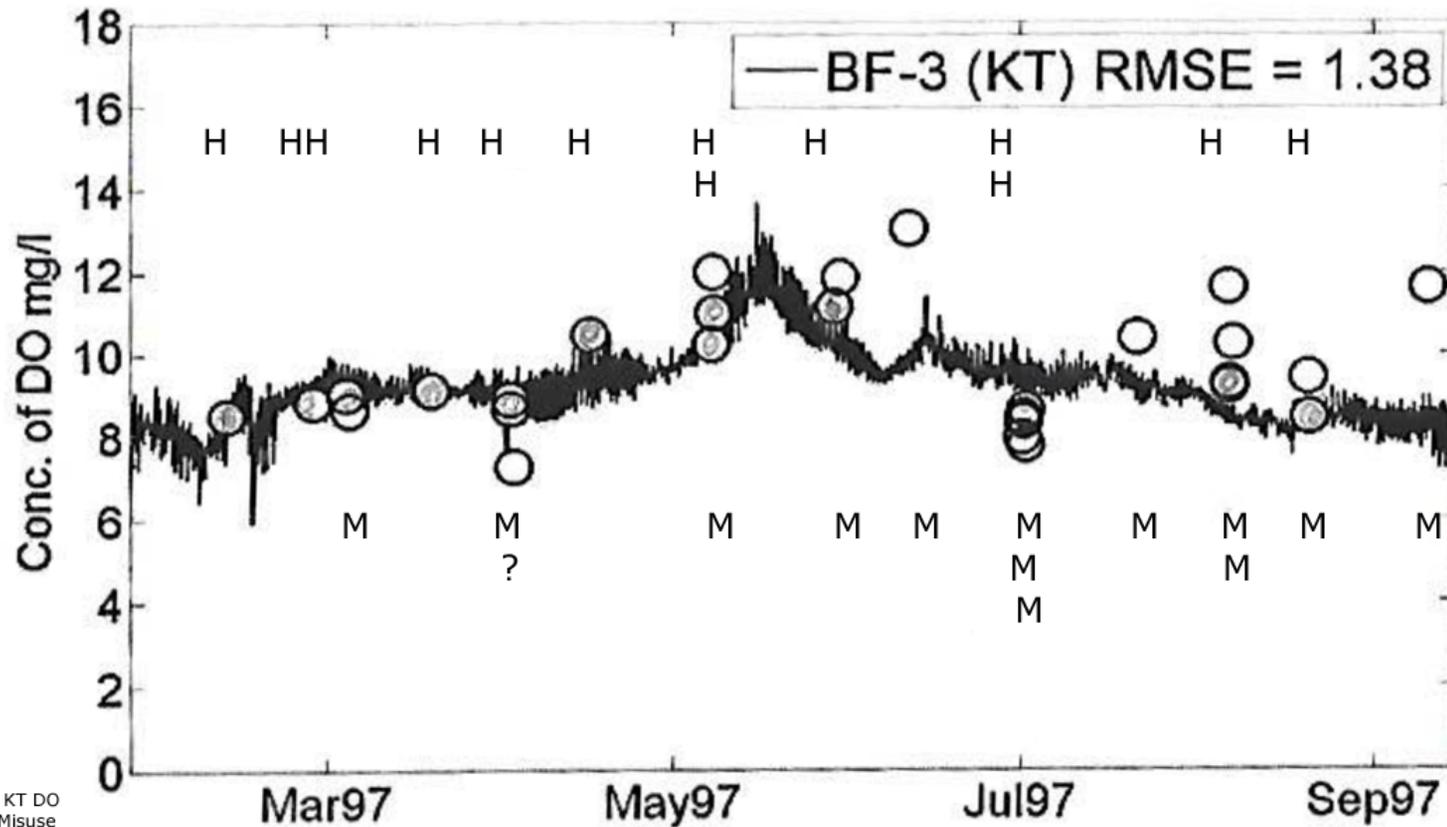
Red = problems too complex for in-depth presentation today; see the Use/Misuse Report for detailed discussion.



1. The Budd Inlet Model gets wrong answers.



ASSESSING THE BUDD INLET MODEL'S ACCURACY. 1.

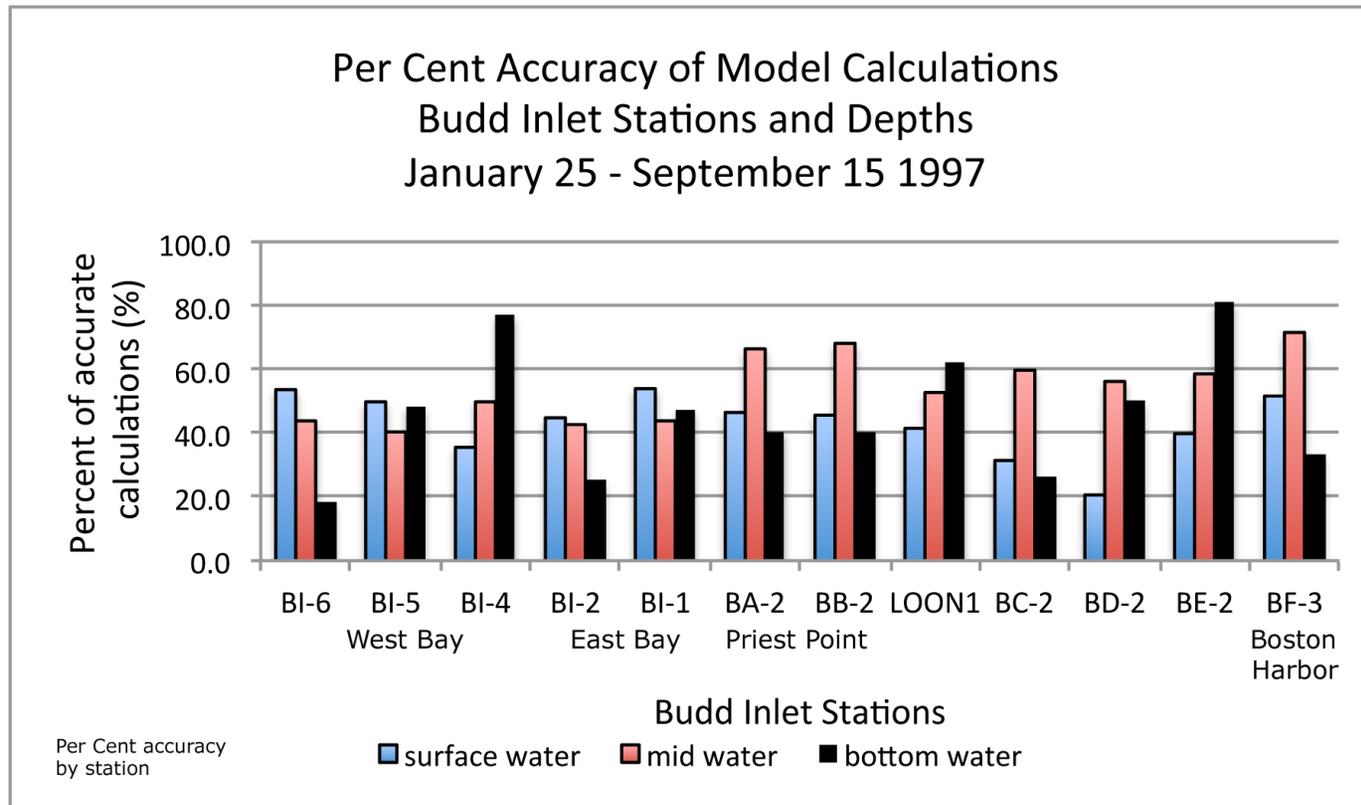


BF-3 KT DO
Use/Misuse

Budd Inlet Model's calculated DO values compared with observed DO's. Surface water near Boston Harbor. Jan. 25 – Sept. 15, 1997.

This graph correctly predicts ("hits" H) 13 observed data points, "misses" (M) 13 points, and is uncertain in one case (?). If all uncertain points are included with the "hits," the computer was "right" in $14/27 = 52\%$ of its calculations.

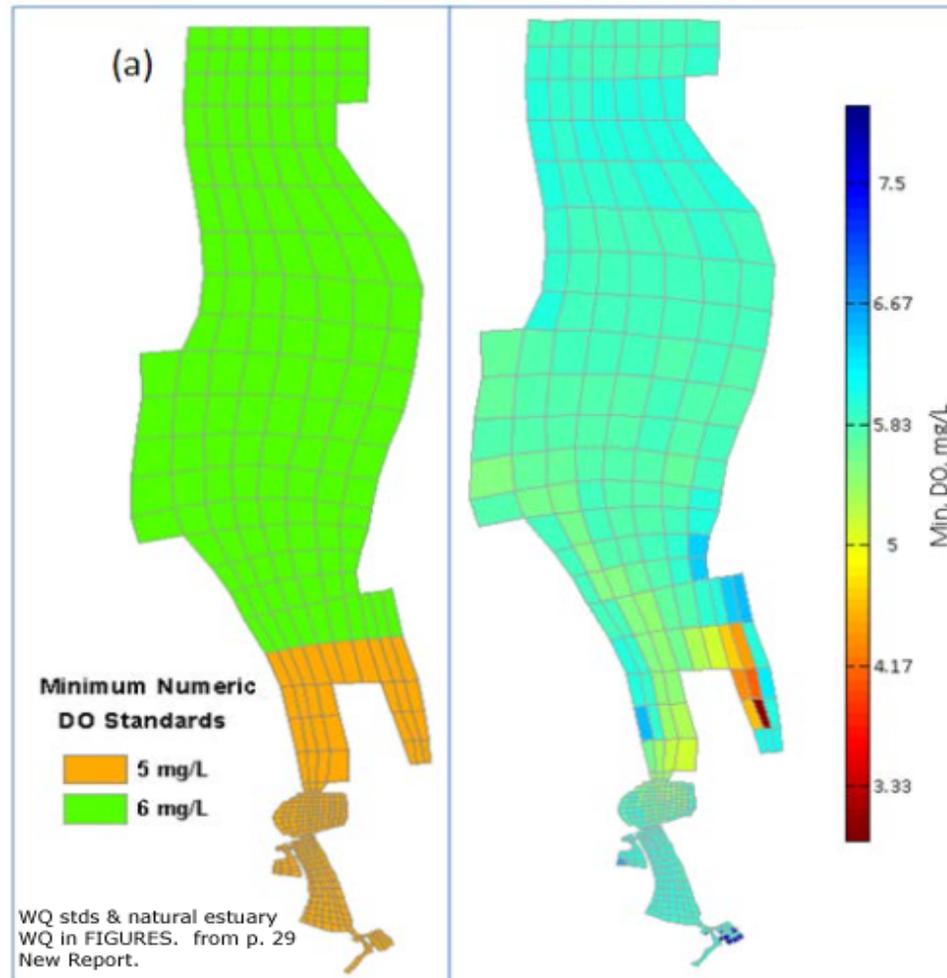
ASSESSING THE BUDD INLET MODEL'S ACCURACY. 2.



Bars show per cent of DO calculations that got the right answers.
20% wrong at best, 80% wrong at worst.
Average overall, about 50% accurate answers.

This Figure is derived by analyzing all 36 calculated DO graphs in TMDL Appendix G in the same way as in the previous Figure. The Model's calculations range from about 80% accurate at two locations to about 20% accurate at three locations. That is, about 80% of its calculations are accurate at best, and only 20% are accurate at worst. Most are about 50% accurate.

2. The water quality standard used by the Model is often theoretical (= fictitious) and almost always unverifiable.



See the Use/Misuse Report for a detailed discussion of the problems caused by this approach.

3. Uptake of Nutrient Nitrogen from the Deschutes River by the Lake's plants helps Budd Inlet resist low oxygen conditions. WDOE's calculation to the contrary is flawed and not ecologically credible.

4. The Model is not suitable for evaluating the effects of the Lake's plants on Budd Inlet.



Background. The Key to Low Oxygen in Deep Water.

THE OXYGEN / NUTRIENT-OVERLOAD STORY IN A NUTSHELL: WHAT IT MEANS FOR NATURAL WATERS.

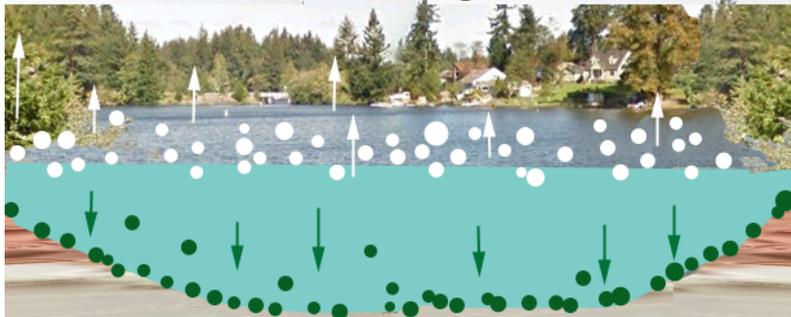
1. People add Fertilizer to Lawns!!
... it gets into the lake ...



2. Nutrients feed Algae! Creating huge oxygen production at the surface ...



3. Most extra oxygen fizzes up into the air ...
Most of the new biomass goes to the bottom.

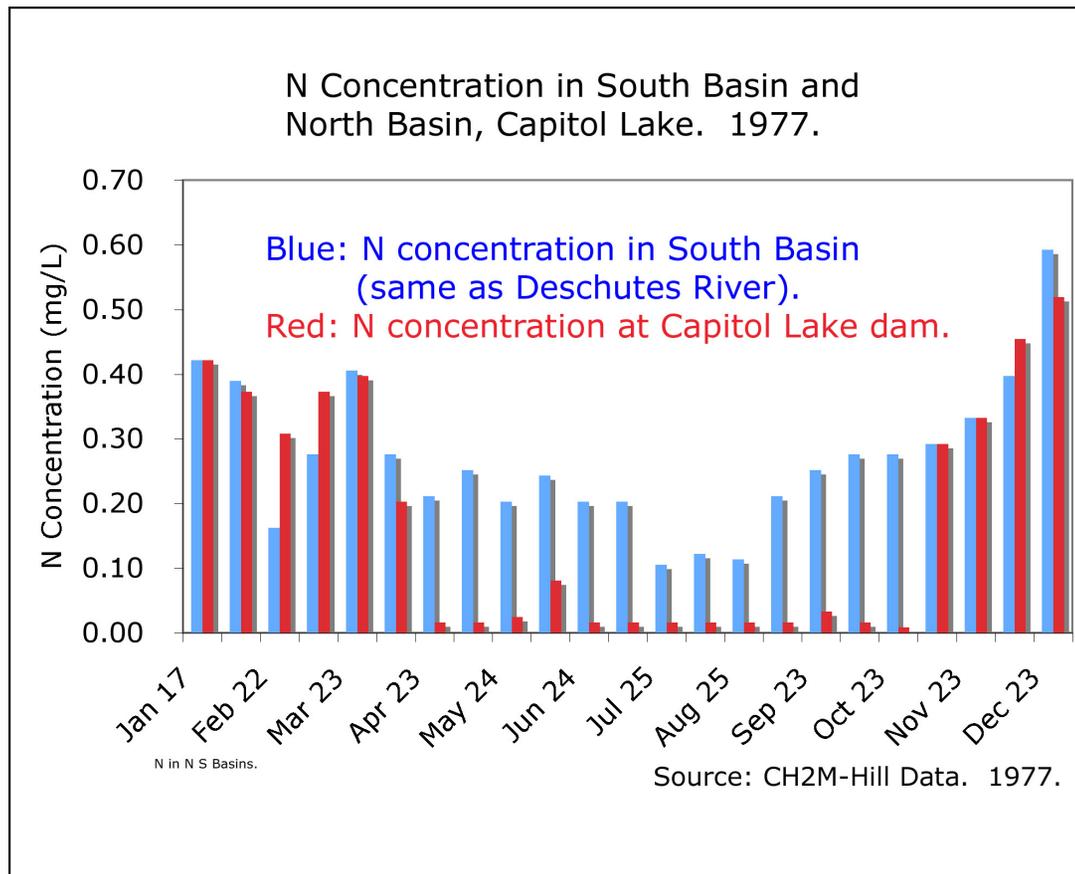


4. Bacteria on the bottom consume the abundant new biomass ... *and can use up ALL of the oxygen.*



For most lakes, PHOSPHORUS is the key “limiting” fertilizer nutrient.
For Capitol Lake, the key limiting fertilizer nutrient is NITROGEN.

Capitol Lake's plants trap the tons of nutrient nitrogen delivered to the Lake by the Deschutes River each summer. This prevents the River's Nitrogen from (ultimately) depleting oxygen in Budd Inlet. WDOE tries to downplay this benefit by "showing" that the new carbon photosynthesized by the Lake's plants quickly goes over the dam into Budd Inlet, releasing the stored nitrogen. Their calculation follows ...



Harvest and removal of the plants; a way of helping the Lake protect Puget Sound ?

WDOE's Claim: "The Lake's Removal of Nutrient Nitrogen (NN) from Deschutes River Water Doesn't Help Budd Inlet."

These graphs are the Centerpiece of WDOE's claim that Capitol Lake's removal of Nitrogen from the Deschutes River water doesn't help Budd Inlet.

This is too complex to analyze here. A detailed analysis of whether or not these graphs are accurately calculated is in the Use/Misuse Report.

The short version: These graphs overestimate the effect of the Lake on Budd Inlet and underestimate the effect of an Estuary replacement for the Lake. WDOE claims they show the Lake is worse for Puget Sound than the Estuary; in fact the corrected calculations show the opposite.

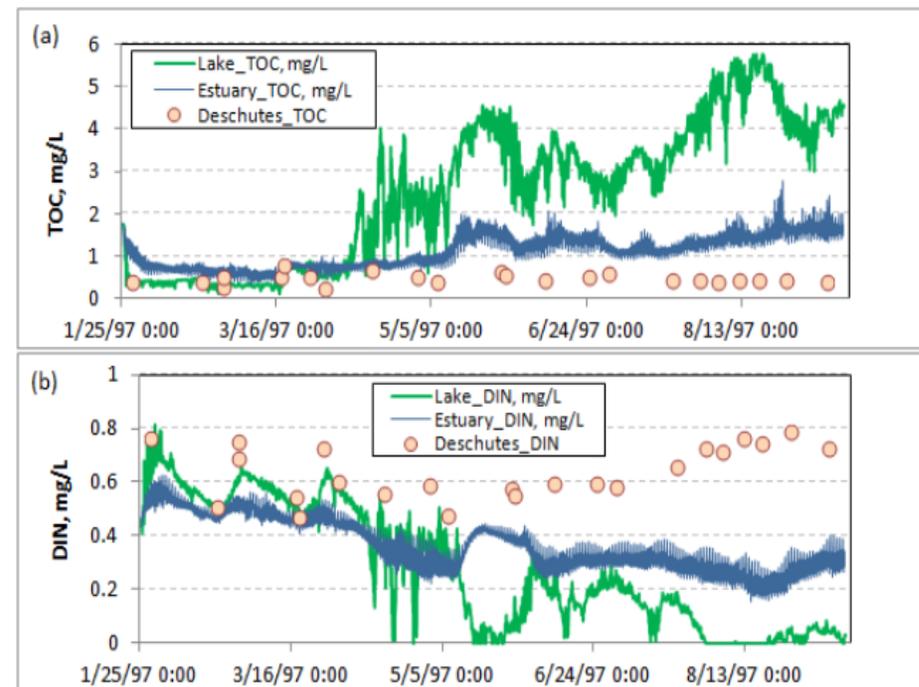
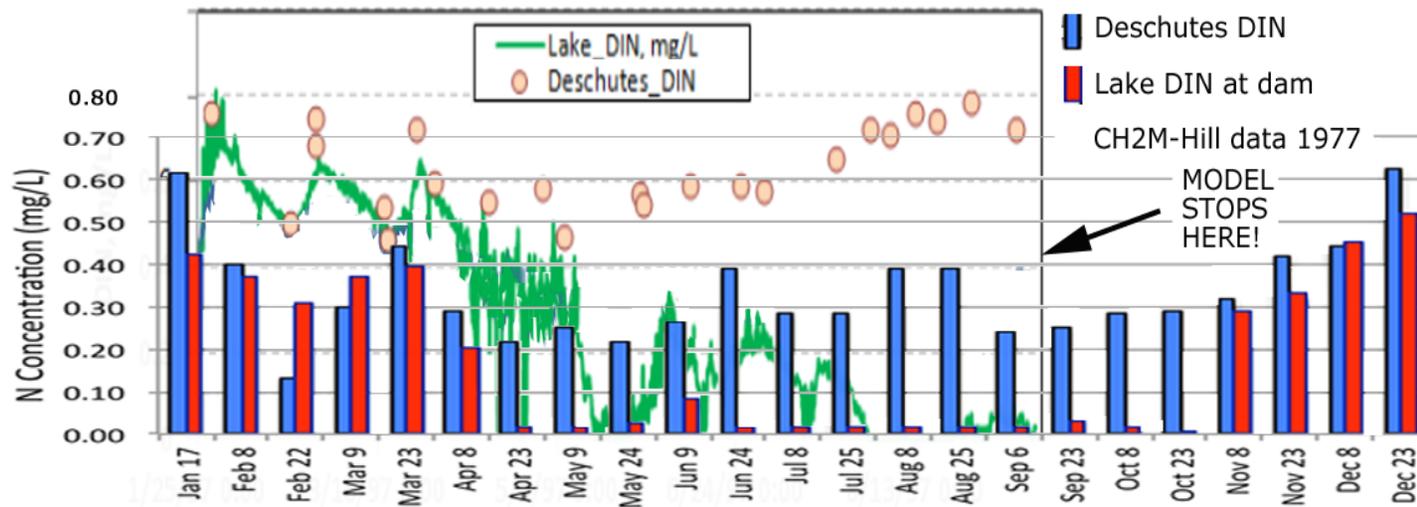


Figure 11. a) Total organic carbon (TOC) and b) dissolved inorganic nitrogen (DIN) concentrations at the location of the Capitol Lake dam under Lake (with the dam) and Estuary (without the dam) scenarios compared with concentrations in the Deschutes River at E Street.

Poster graph Grab2 > Figures

Source: SM Report Figure 11 p. 36.



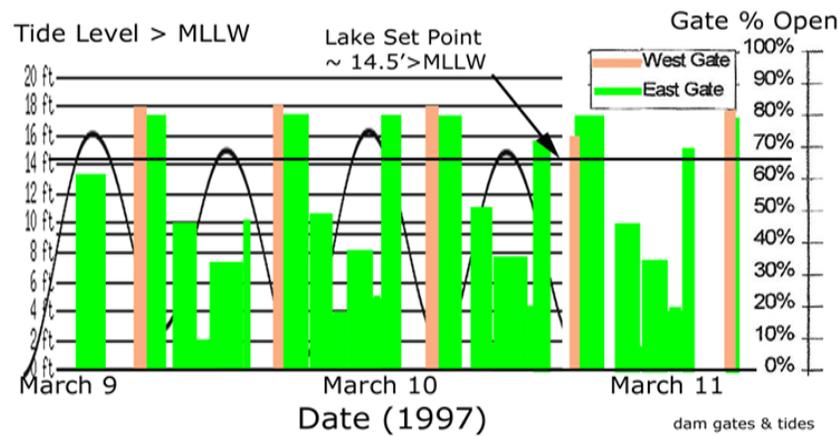
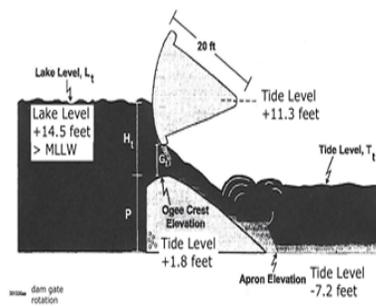
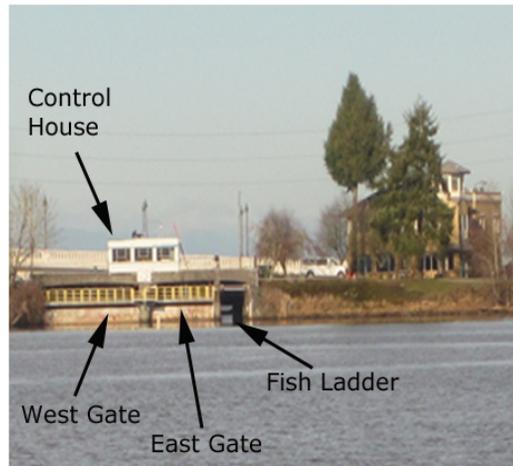
Poster DIN overlay CH2M > Figures

The Budd Inlet Model Can't Predict End-of-Growing-Season Events.

Uptake of Nutrient Nitrogen (NN = "DIN") continues in Capitol Lake until late October. The Budd Inlet Model simulation ends in mid-September. The Model can't be used to simulate the full growing season, even if discrepancies of the preceding slides are fixed.

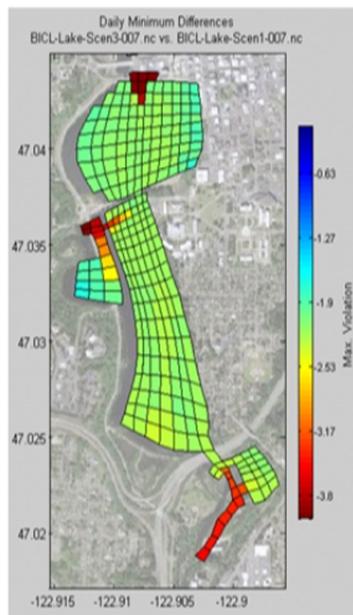
Superposition of the CH2M-Hill nitrogen uptake chart (blue & red bars) over WDOE's calculated Lake DIN concentrations (green graph).

5. WDOE's analysis of Capitol Lake: Errors at many levels.



“Oxygen Deficiency in Capitol Lake ...” Worst Available Science?

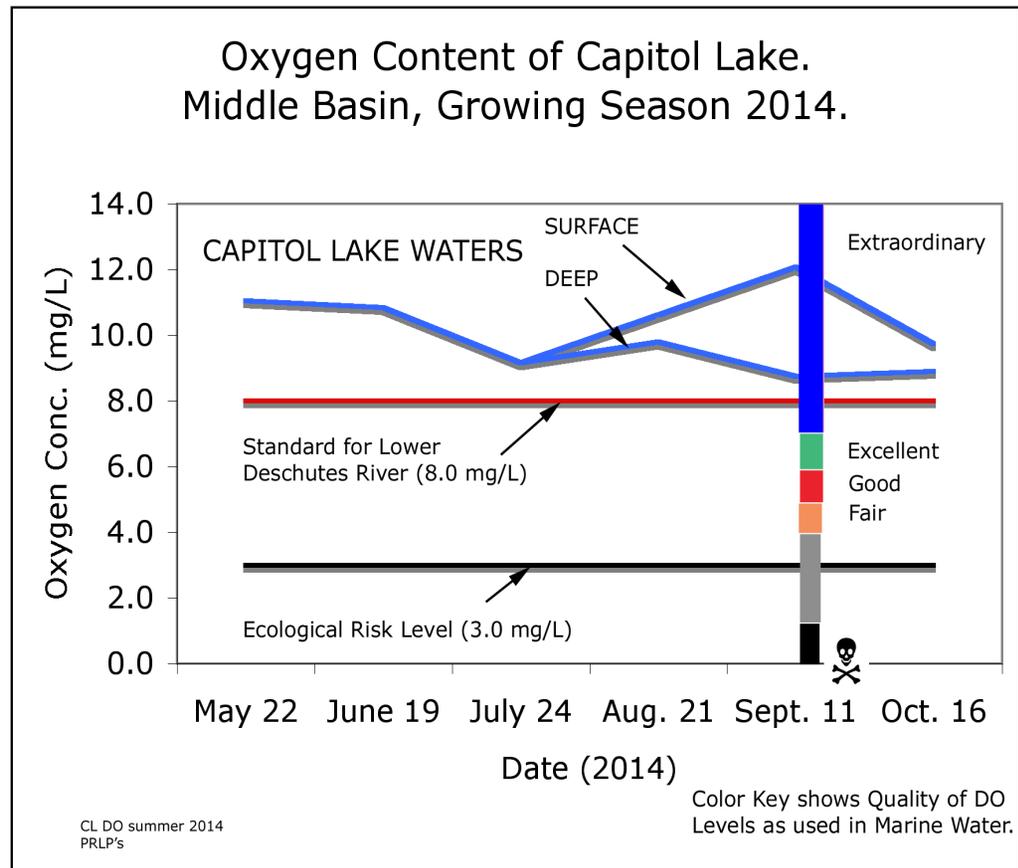
WDOE’s alleged gigantic “Oxygen Deficiencies” in modern Capitol Lake as compared with “natural” pre-modern Lake water.



Existing vs natural
Cap Lake “violations” Figures

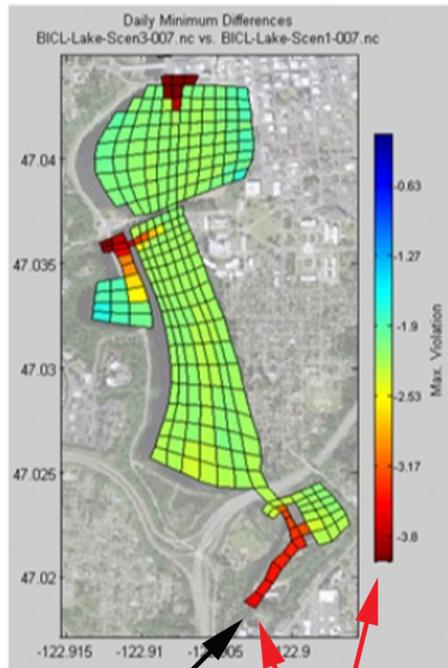
WDOE TMDL Tech Report and SM Report.

Modern-Day Reality. Observed Oxygen Levels in Capitol Lake, Summer 2014.



Data from Thurston Co. Water Resources, 2014.

Unlike the usual situation, there is a way to calculate the dissolved oxygen levels in the theoretical “natural lake” used by WDOE as the water quality standard for Capitol Lake.*



Existing vs natural

Cap Lake "violations" Figures

100% saturation due to Tumwater Falls

"violation" 4+ mg/L

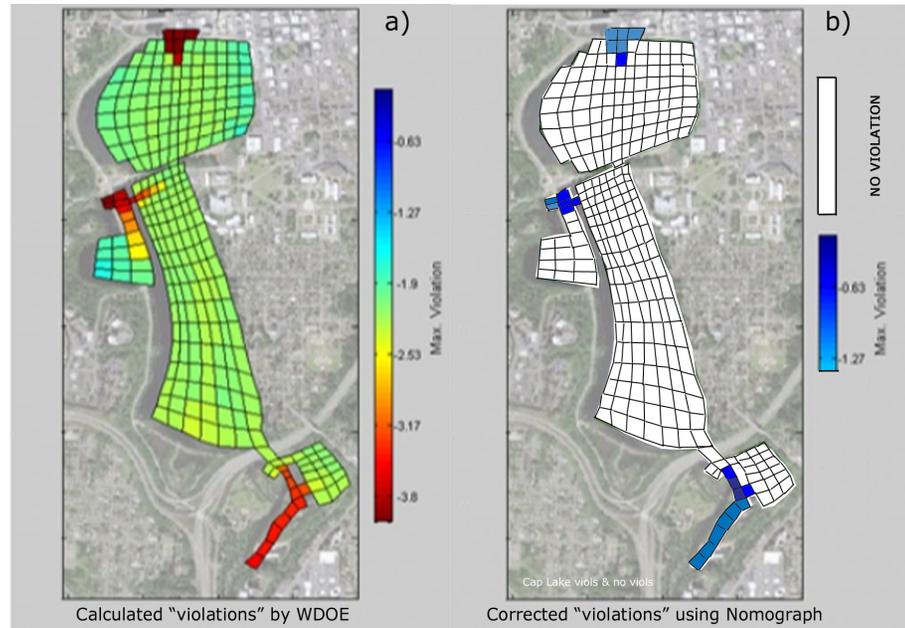
CL viols w labels PP use2



* See Use/Misuse report for full details ...

LEFT. WRONG ANSWER. The whole theoretical Lake awash with large theoretical WQ Standards violations compared to its theoretical 'natural' condition in the past. WDOE.

RIGHT. CORRECTED ANSWER. Almost no theoretical "violations" and all of them are small. Use/Misuse Report calculation.



But ... who cares? It is the modern lake that concerns us. There, dissolved oxygen levels are always "extraordinarily" high, top to bottom, every day of every year. Comparing it to a fictitious 'natural' Lake of bygone years is meaningless and misleading.

REALITY: There are NO "oxygen deficiencies" in modern Capitol Lake. The Lake has better dissolved oxygen conditions than any Monitored Thurston County Lake and better DO's than those in nearby West Bay.

MISSING THE MARK ON LAKE ECOLOGY

The Lake's plants capture both phosphorus and nitrogen nutrients. Occasional shortages of nitrogen during the growing season stop their growth; the plants never run short of phosphorus.

Of the two, nitrogen is by far the more damaging to Budd Inlet. However WDOE focuses on phosphorus – an irrelevant nutrient. N is the key limiting nutrient; not P.

Sources: CH2M Hill and TMDL Tech Report Figs 23 & 24.

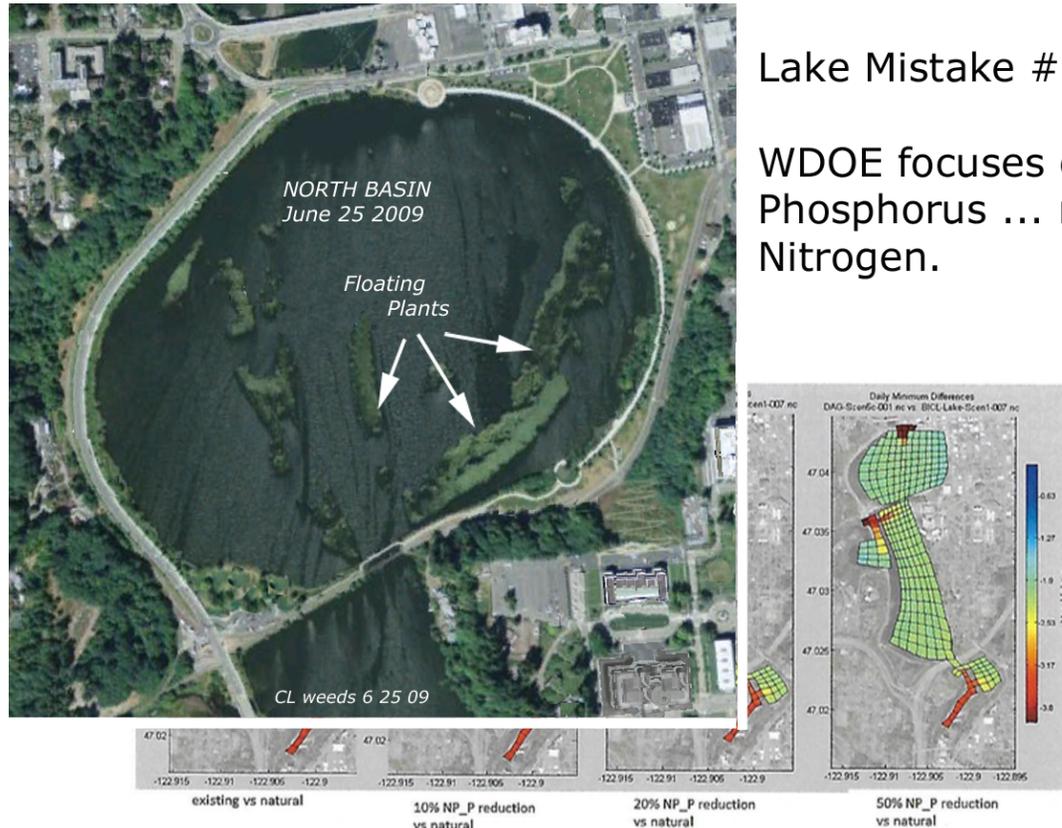


Figure 34. Predicted DO depletion (mg/L) from various assumed reductions in nonpoint phosphorus loading to Capitol Lake.

CL P O2 Defs detail
PP Use/Misuse

The background simulations show WDOE's preoccupation with the fictitious "DO depletions" in Capitol Lake and also their belief that phosphorus is the key fertilizer for Lake plants. They overlook the fact that nitrogen is the key to the system during growing seasons.

CL weeds 6 25 09 PP Use/Misuse

Lake Mistake #2.

WDOE focuses on Phosphorus ... not Nitrogen.

Where do we go from here?

- 1) Engage independent reviewers to assess WDOE's Supplemental Modeling Report, Milne's "Use & Misuse of the Budd Inlet Model" report, and WDOE's TMDL Tech Report's chapter on Capitol Lake;
- 2) Post a link to Milne's Use/Misuse report alongside the link to WDOE's Supplemental Modeling Report on the DES Capitol Lake page (or remove the latter);
- 3) Conduct a year-long Field Study of organic carbon production and release by Capitol Lake;
- 4) Base NO POLICY DECISIONS on the contents of WDOE's Supplemental Modeling Report or Milne's "Use/Misuse" report until all identified discrepancies are resolved by independent reviewers.

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NOT THE END!