4. THE BUDD INLET ESTUARY; "NATURAL" AND MODERN.

4-1. Overview of Chapter 4.

The Ecology modelers have found over the years that the Budd Inlet Model shows low DO levels that violate modern water quality standards in Budd Inlet, even in its "natural" (pre-modern) condition before it became modified by intense human activities. This runs counter to a popular bias that "natural" is always "good" or even "better than" "human-modified" and complicates their effort to blame Capitol Lake for low DO levels in the modern Inlet. The grid map of the "natural" inlet in the SM Report is loaded with water quality violations. So is the map of modern Budd Inlet with Capitol Lake and the dam in place. The "modern" map is no worse than the "natural" map – a finding that suggests that Capitol Lake has prevented Budd Inlet from getting worse as human activities have intensified around its shores.

This Chapter reports that finding by filling the blank in Figure 4-1. This Chapter also shows that "Budd Inlet with the dam" is no worse than "Budd Inlet without the dam" – and probably *better*. *"Better" because Capitol Lake provides the only factor in play that is able to reduce the natural nitrogen load reaching Budd Inlet as well as the human-caused load.*

4-2. The Missing Natural Budd Inlet Grid Map.

Ecology's SM Report has several repetitions of the modern Budd Inlet (with the dam) grid map showing water quality violations throughout most of Budd Inlet (Fig. 4-1b). A comparable grid map of the "natural" (= pre-dam) estuary is nowhere to be found (Fig. 4-1a). If the "modern" map showed Budd Inlet to be much worse than the Inlet in its natural state, that would help make a case for removing the dam. Why haven't the modelers shown us this?

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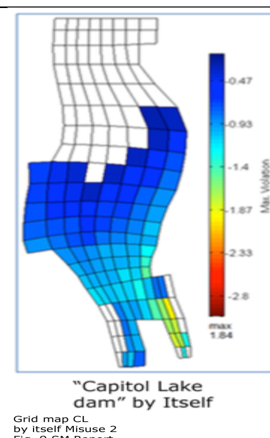
<tr><td>?</td><td>
</td></tr>
<tr><td>Figure 4-1a. The Budd Inlet "Natural" (Pre-Modern) Estuary without the dam.</td><td>Figure 4-1b. Modern Budd Inlet with the dam. Source: SM Report Fig. 9, p. 34.</td></tr>
</table>

The reason is that (in the SM Report, at least) the model shows that pre-modern and modern Budd Inlet are both about the same in terms of water quality violations, and that modern Budd Inlet with no dam would be astonishingly better than both. The model says that

1) the dam has kept Budd Inlet from getting significantly worse as human activity has intensified, and

2) all modern human activity would leave Budd Inlet's water quality about the same as it was in the natural pre-modern estuary if only the dam could be removed.

The first may or may not be true; the second is very unlikely.

The sections that follow "fill the blank" in Figure 4-1, and more.

4-3. Reminder. Interpreting Grid Maps.

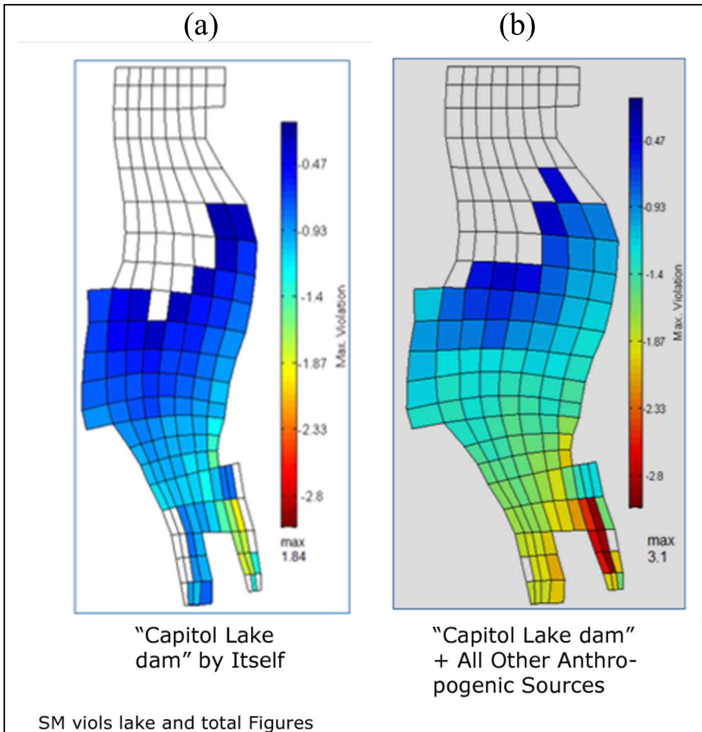


Figure 4-2. Figures from the SM Report showing calculated widespread DO depletion in Budd Inlet due to (a) "Capitol Lake dam" by itself, and (b) "Capitol Lake dam" plus all other anthropogenic (human-caused) sources. The scale colors show the maximum calculated violation in each cell. Source: SM Figures 9 (dam) and 8 (total), p 34 and 33.

Figure 4-2a (left) shows the modelers' calculated portrayal of DO violations in modern Budd Inlet allegedly caused by "the dam" by itself (same as in Fig. 4-1b above). Figure 4-2b (right) shows the effects of all modern anthropogenic (that is, human-caused) agents of oxygen depletion -- "the dam," the LOTT Wastewater Treatment Plant outfall between the KGY peninsula and Priest Point, several small creeks, and anthropogenic sources outside (external to) Budd Inlet.

The "all causes" map shows more of the Inlet affected by human activities and some areas more severely affected (redder and yellower colors) than would be the case with "the dam" by itself. In these grid maps, each colored square shows the worst DO "violation" of the entire simulated year (January 25 – September 15, 1997). Recall that these maps are made via a massive computer search of the water in each grid square for dissolved oxygen levels that are lower than the water quality standard. The square is "flagged" (colored) if a violation is detected but left uncolored if there are never any violations. The square would be flagged even if a violation occurred just once, at just one depth, and lasted for just six simulated minutes, and would be indistinguishable on the map from a violation of that size that occurred all summer long at that location at all depths.

All of the grid map Figures have colored DO scales. The scales usually show the size of the calculated water quality violation, measured in mg/L below the standard for each location. Dark blue is usually the smallest possible violation (= 0.20 mg/L below the DO standard).

The overall blue color of most violations in Figure 4-2a shows that the about half of the widespread calculated violations "caused" by the dam are the smallest possible "violations." Small, ephemeral, and prone to calculating error though they may be, they create the visual impression that Capitol Lake has a huge negative effect on Budd Inlet.[1]

4-4. Ecology's "Non-Grid" Natural Estuary Map.

The SM Report does contain a "natural estuary" grid map – but not like the one that should fill the blank in Figure 4-1. It's shown in Figure 4-3, which reproduces Ecology's Figure 7 from the SM Report (p. 32). The leftmost grid map (a) shows the dissolved oxygen standards for Budd Inlet, namely 5.0 mg/L in the southernmost reach (orange grid), 6.0 mg/L in all of the rest (green grid). The rightmost map (b) shows the calculated "natural" pre-modern Budd Inlet estuary with no anthropogenic (human-caused) sources of DO depletion, including "no dam."

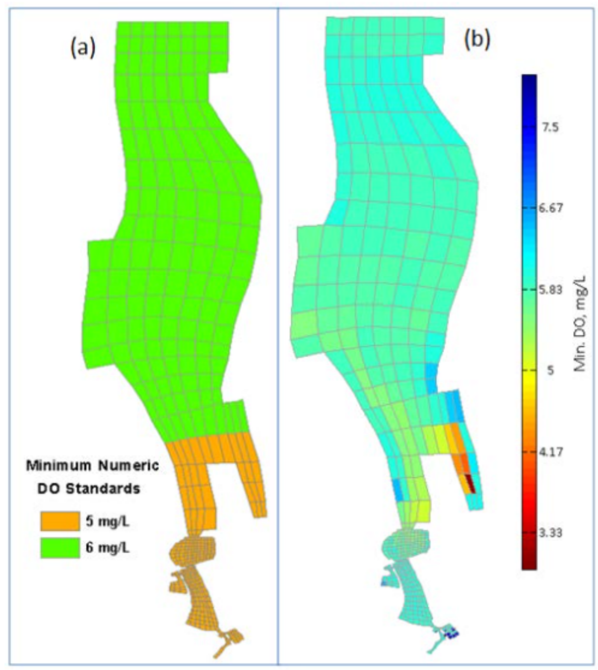


Figure 4-3. (a). Modern water quality standards that apply to Budd Inlet. (b) Minimum dissolved oxygen levels in Budd Inlet as calculated by the modelers for 'natural' waters before they were altered by human activity. (In Fig. 4-3b, the "Capitol Lake" area is an estuarine extension of West Bay.) Source: Both images constitute Figure 7 (p. 32) in the SM Report.

The pre-modern estuary is shown in a format that makes it impossible to see at a glance whether its water quality is better or worse overall than that of modern Budd Inlet. The scale that accompanies it shows the minimum level of DO present at each location when the worst violations occurred – not the sizes of the violations themselves, as do the scales of all other grid maps of modern Budd Inlet (see Figure 4-2 above). Readers must figure out for themselves from the subtle gradations of color whether and where parts of the natural estuary were "in violation."

[1] See Chapter 3, this Review, for a demonstration that about half of all "blue" grid squares result from calculation errors (as do some uncolored squares). See Chapter 6 (Figure 6-6) for a visual impression of the gigantic size of the external anthropogenic source compared with the Capitol Lake/dam source and a demonstration that "the dam" is probably overshadowed by the external source in its effect on DO water quality violations in Budd Inlet.

This critically important Figure is described by just one sentence in the SM Report; "*The minimum DO under natural conditions is predicted to fall below the water quality standards in portions of Budd Inlet, with lowest DO predicted in East Bay.*" (p. 32, SM Report). One could hardly guess that this bland presentation shows the water quality in the pre-modern inlet to be no better than that in modern times.

<u>4-5. Ecology's Natural Estuary Converted to Standard Grid-Map Format.</u>

It is possible to convert Figure 4-3b to the format and scale of all of Ecology's other grid maps of Budd Inlet for easy comparisons at a glance. The result of that conversion is shown in Figure 4-4a (left). That is the dissolved oxygen violations grid map that should have been in the empty frame of Figure 4-1a. *It is a grid map that the Department of Ecology hoped the public would never see.*

Figure 4-4a shows that calculated water quality violations were about as widespread in the pre-modern undammed "natural" estuary as they are in modern Budd Inlet (Fig. 4-4b). If an interpretation were needed in just one sentence, it would be this; "*Despite decades of intensifying human activities around its shores and in its watershed, modern Budd Inlet with the dam is shown by the model to be about as unimpaired as it was in pre-modern times.*"

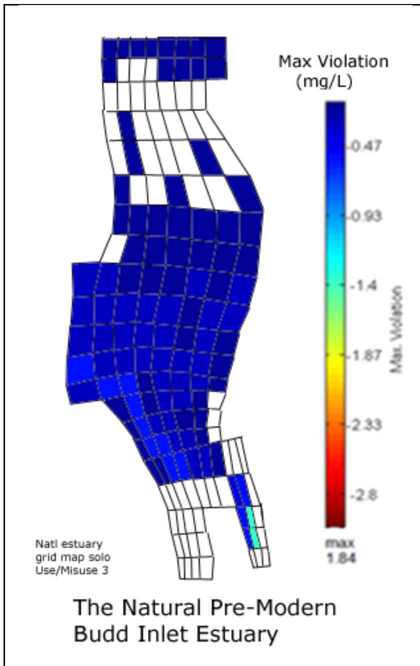


Figure 4-4a. Dissolved Oxygen standards violations in the Budd Inlet "Natural" (Pre-Modern) Estuary. See text for derivation.

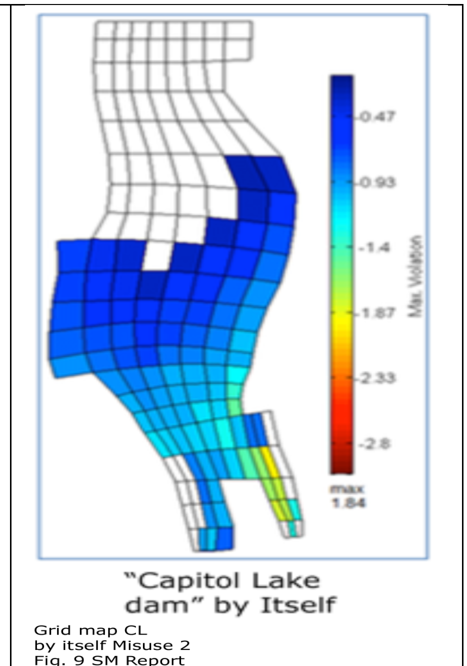


Figure 4-4b. Dissolved Oxygen standards violations in Modern Budd Inlet with the dam. (Same as Figs. 5-1b and 5-2a above.) Source: SM Report's Fig. 9, p. 34.

It is important to recall how the "modern" Budd Inlet grid map (Figure 4-4b) was created. During that simulation, calculated DO levels in "modern" Budd Inlet were compared, grid cell by grid cell, depth by depth, moment in time by moment in time, with their counterpart DO levels in the "natural" estuary (Fig. 4-3b). Wherever and whenever the "natural" estuary's waters were in violation of modern DO standards (as shown in Figure 4-4a), the "modern" Budd Inlet water was compared with the "natural" water to see if its DO levels had dropped even lower. If so, a violation was flagged for that instance. The "modern" Budd Inlet map showing the effect of the dam (Figs. 4-2a and 4-4b) therefore shows *how much worse* the Budd Inlet water has gotten compared with its condition in the pre-modern Inlet. Over most of its blue extent, it is not much worse than during "natural" times. (In fact, "blue" violations represent about 0.20 mg/L, a difference so small that one can hardly measure it in the field.) And in some areas (for example the uncolored northern two tiers) the water quality in modern Budd Inlet is the same as (or better than) that in the "natural" estuary. And always recall that "blue" violations are the most likely ones to be errors resulting from the computer's large "margin of error" (see Chapter 3).

How was Ecology's portrayal of the natural estuary (Figure 4-3b) converted to the one shown in conventional grid map format (Figure 4-4a)? My procedure is described in an optional section at the end of this Chapter for readers who care to follow it or try it for themselves.

4-6. The Modern Budd Inlet Estuary.

The SM Report portrays Budd Inlet "without the Capitol Lake dam" – a grid map of the effect of removing the dam on the Inlet's water quality (Figure 4-5). In that scenario, tidewater extends from West Bay all the way up the present-day Lake basin to Tumwater Falls. The map shown is actually not just the result of removing the dam; it also shows the effects of all other human-caused nitrogen inputs to Budd Inlet.

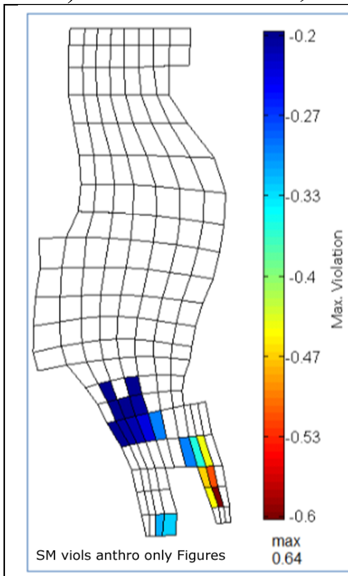


Figure 4-5. Budd Inlet DO violations; no dam, all other anthropogenic nutrient sources present. Source: SM Report's Figure 17, p. 40.

At face value, this "modern estuary" grid map shows that removal of the dam makes the estuary "worse" in DO terms in only a few areas compared with its "natural" condition (Fig. 4-4a); at the "big blue patch" opposite Priest Point Park and (as always) in East Bay.

A closer look at the bewildering array of simulations of different scenarios that accompany it makes it seem likely that the "no-dam-by-itself" scenario is artificially packaged to look good (in fact "too good to be true") and that the *real* "Capitol-Lake-dam-by-itself" scenario is much better than presented in Figure 4-4b above. But first, it is useful to keep in perspective the sizes of the anthropogenic factors affecting Budd Inlet.

4-6a. The Sizes of the Nutrient Nitrogen Sources Affecting Budd Inlet.

Figure 4-6 is a thumbnail sketch of the sources of nutrient nitrogen to Budd Inlet. (For close-up details, see Chapter 6.) The sizes of the human-caused inputs are shown by red bars, natural inputs are shown by blue bars, and totals of the two by light green bars.

The first take-away message is that the "external" inputs (from outside Budd Inlet, far right) are gigantic compared with all internal shoreline sources discharging directly into Budd Inlet. The second take-away message is that in all cases, the human-caused inputs (red bars) are smaller than the natural inputs (blue bars). The effect of human activity has been to add a thin "veneer" of additional nitrogen to large natural components that existed before intensive human activity began affecting the water quality. Numbers (not readable in this miniature Figure) are: Deschutes River 327 N, 153 A; Other shoreline sources 51 N, 14 A; LOTT Plant 0 N, 92 A, and External 6860 N, 1488 A; where "N" is the natural daily nitrogen input and A is the anthropogenic daily load in kg N/day. (The Deschutes River figures are the loads before Capitol Lake reduces them by 50-90%.)[2]

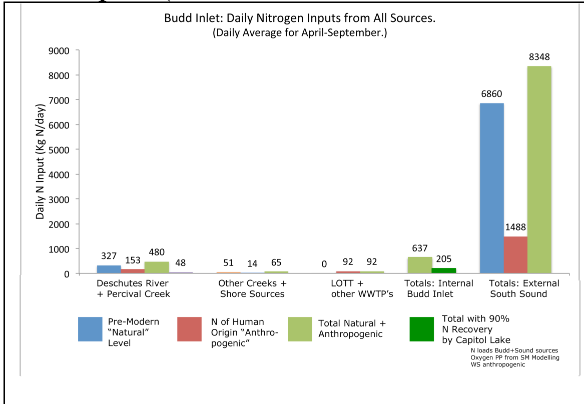


Figure 4-6. Sizes of nutrient inputs to Budd Inlet from four categories of sources. See Fig. 6-4, Chapter 6, for a detailed derivation of this Figure.

<u>4-6b. Budd Inlet Without "The Capitol Lake Dam." Getting Organized.</u>

A major portion of the SM Report consists of a bewildering scramble of grid maps, text, Figures, Figure captions and passing mention of numbers, all analyzing the effects on Budd Inlet with "no dam" and how the effects change if one or another of the anthropogenic nitrogen source inputs is reduced or eliminated. (Natural nitrogen inputs are *never* reduced in any scenarios.) Table 4-1 (separate page) organizes and summarizes these scenarios.

The columns in Table 4-1 show the following.

Column A describes the scenario conditions simulated and names the Figure showing that simulation outcome as numbered in the SM Report.

Columns B, C, D and E show the changes made (if any) in the anthropogenic nitrogen inputs from each of the four sources shown in Figure 4-6; the Deschutes River watershed, the other small creeks around Budd Inlet's shores, the LOTT wastewater treatment plant, and the external waters of Puget Sound outside Budd Inlet. (The anthropogenic inputs are the red bars in Figure 4-6). 100% means no change in that input, 50% means it has been reduced by half in this scenario, and 0 means that that input has been eliminated entirely.

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[2] Ecology does not list the sizes of the inputs used in the simulations in the SM Report. The numbers in Fig. 4-6 are taken by me from tables in the TMDL Appendix, used by Ecology in previous simulations. It is possible to reconstruct a few of the numbers used by Ecology from tangential remarks in the simulation descriptions (see optional section 4-10.) They are the same (external) or slightly larger (LOTT, Deschutes watershed, other watersheds) than those in the Fig. 4-6 caption. Their sizes don't matter, for this discussion.

Column F gives a brief description of "what happened" when that simulation was tried and identifies the Figure in this Review (on a later page) that shows that outcome.

The second row in Table 4-1 was inserted by me. That is a scenario that shows the "effect of no dam" by itself. Ecology's much-repeated Figure 17 (SM Report; Figure 4-5 above), supposedly showing that, actually does not. It shows the effect of no dam but with all other sources contributing their full loads of anthropogenic nitrogen. I have also indicated in Row A ("with dam by itself" scenario) the sources that Ecology should have used or eliminated to simulate that scenario. (Perhaps these were the values that Ecology actually did use; however they are not listed in the SM Report.)

Why bother with this huge Table? The answer is, I use it to try to make a "best guess" at the effect on Budd Inlet of *removing the dam by itself* – not compounded by including the effects of other anthropogenic nitrogen sources (as Ecology does in Figure 4-5) – and also to give a second opinion "best guess" at the effect of retaining the dam by itself.

4-6c. Table 4-1. Summary and Overview of the SM Report's Scenario Simulations.

A	B	C	D	E	F
Right: Sources → Below: Ecology Figure in SM Report.	Deschutes River	Other Watersheds	LOTT	External	Effect (compared with Ecology Fig.17; shaded).
A) Fig. 9 with dam by itself;	*10%	*0	*0	*0	"violations" all over the map. Fig. 4-7a, this Review.
B) no dam by itself (No Ecology Figure.)	*100%	*0	*0	*0	not shown by Ecology. Fig. 4-7c, this Review.
C) Fig. 17 no dam all sources present;	100%	100%	100%	100%	baseline; Figs. 4-5, 4-7d, this Review.
D) Fig. 18b no dam external source only	0	0	0	100%	huge; clears whole inlet except East Bay.
E) Fig. 19c no dam, watersheds reduced	50%	50%	100%	100%	eliminates "blue patch" opposite Priest Point Park.
F) Fig. 22d no dam all sources @ 100% but LOTT outfall moved to Boston Harbor	100%	100%	~ 0	100%	same as Row E, slightly better. Fig. 4-7c
G) Fig. 23c no dam external reduced	100%	100%	100%	50%	same as Row E, slightly better.
H) Fig. 24c no dam LOTT zero with watersheds reduced	50%	50%	0	100%	same as Row E, notably better.

Table 4-1. Comparison of simulation scenarios in the SM Report (pages 14 – 47). Scenarios are listed in Column A in the order of their appearance in the SM Report, with one addition (Row B) by me. All rows show Budd Inlet with no dam except the first row. Numbers show the percent of each source's anthropogenic nitrogen inputs still operating in each scenario (100% = that source's inputs have not been reduced.) All natural inputs are at 100% in all scenarios. Starred numbers show values that should be used in that scenario (added by me); Ecology does not list them. The shaded row is Ecology's "no dam" baseline scenario with which the others are compared.

4-6d. Figure 4-7; Grid Maps of the Dam/No Dam Simulations.

The outcomes of my effort to compare “dam” vs “no dam” effects on Budd Inlet are shown in Figure 4. The four grid maps are juxtaposed such that the upper row shows Budd Inlet with the dam present over a lower row that shows Budd Inlet with the dam absent. The left column shows the dam/no dam effects isolated by themselves, the right column shows the dam/ /no dam effects in company with all other nitrogen source inputs operating.

Figures 4-7a, -b, and –d are from the SM Report, Figure 4-7c is derived by me.

Figure 4-7d – Budd Inlet with no dam but all other anthropogenic sources present – implies almost no DO standards violations at all. However recall that grid maps formed by comparing the modern situation with the “natural” situation show *how much worse* the modern situation is than the natural situation. Figure 4-7d shows that whatever the modelers did to remove the dam from the model didn’t change the “natural” background picture very much. That is not surprising; the “no dam” simulation uses the same gusher of Deschutes River nitrogen nutrients as was used in the “natural” simulation (Fig. 4-4a). If the

(a)

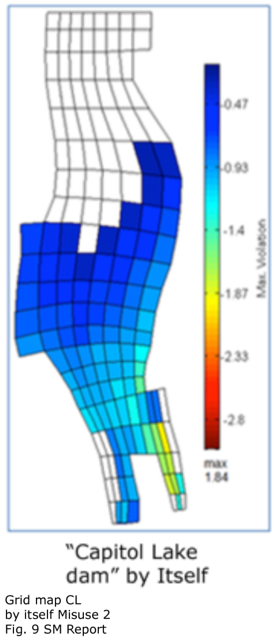

Figure 4-7a. Budd Inlet DO violations; dam present but no other anthropogenic nutrient sources. Source: Fig 9 p. 34 SM Report.

(b)

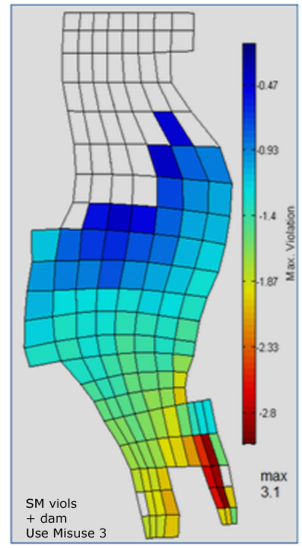

Figure 4-7b. Budd Inlet DO violations; dam present with all other anthropogenic nutrient sources. Source: Fig. 8 p. 33 SM Report.

(c) ??

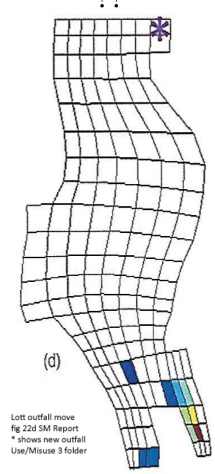

*Figure 4-7c. Budd Inlet DO violations; no dam, no LOTT (outfall moved to *), all other anthropogenic nutrient sources present at 100%. Source: derived by me, see text. (SM Report Figure 22d.)*

(d)

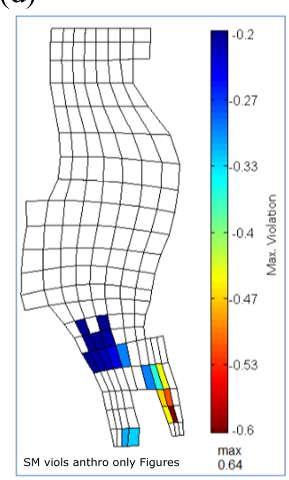

Figure 4-7d. Budd Inlet DO violations; no dam but all other anthropogenic nutrient sources present. Source: Fig. 17, p. 40 SM Report.

violations themselves were shown, the grid map of Budd Inlet with no dam would be as "blue" as Figure 4-4a with much more color in East Bay.

The effect of removing the dam by itself *and with no other sources complicating the picture* is not shown in the SM Report (see Row B, Table 1). I created that Figure (4-7c) from the information in Table 1. The result -- Figure 4-7c -- shows almost no negative effects at all attributable to removing the dam. By dramatic contrast, its counterpart Figure 4-7a shows (small) negative effects attributable to the dam by itself almost everywhere. To an ecologist's eye, the "no dam by itself" outcome is just plain "too good to be true."

For readers interested in how I arrived at Figure 4-7c ("no dam and no other nutrient sources"), that derivation is shown in detail in the Optional sections at the end of this Chapter. Briefly I examined Table 1 for a simulation that approaches most closely the "Budd Inlet without dam" scenario in Row B of the Table; full blast 100% Deschutes River input, zero, zero and zero for Other creeks, LOTT, and External sources. The closest example was that of Row F (LOTT outfall out of the picture, Other creek effects small even at 100%, and almost no measurable external effects when all other sources are at zero (Row D).

4-7. "With Dam" Scenarios Compared; Ecology's vs. This Review's Versions.

Is it possible to check up on Ecology's "Budd Inlet with dam by itself" (with no other anthropogenic sources) claim (Fig.4-7a)? To do that, one would need to find the scenario in Table 1 that most closely approaches the conditions shown in Row A; that is Deschutes River with 90% of both anthropogenic and natural nutrient loads reduced by Capitol Lake and the three other input sources at zero, zero, and zero.

The closest approach to a "dam by itself" scenario in Table 1 is Row H. The Deschutes River anthropogenic nitrogen input is reduced by 50% (mimicking the effect of Capitol Lake), the LOTT input is reduced to zero, and the very small and localized "Other creek" sources are reduced by half. The huge external input is left intact at 100%; there's nothing we can do about that. The grid map resulting from that simulation is shown in Figure 4-8b. For our grand finale, the "natural Budd Inlet estuary" is also repeated for comparison in Figure 4-8a.

Recall that the two portrayals of "Budd Inlet with dam" do not show the whole story. Each shows the additional violations that would be "piled on" the natural estuary; that is, how much worse off Budd Inlet is with the dam than it would be without it. The complete grid map of violations would be "blue all over" (the natural estuary map) with even more blue (and other colors) added by the two scenarios to the right. Even piled on, the additional violations caused by "the dam" in either case (Fig. 4-8b and 4-8c) are so tiny (blue) that composite violations map shows "no real problem here."

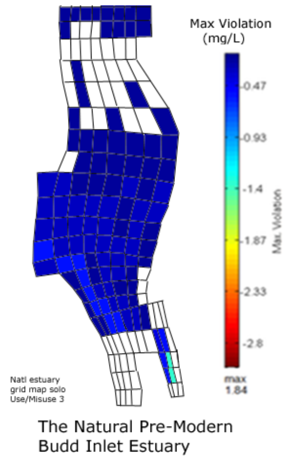

Figure 4-8a. Dissolved Oxygen standards violations in the Budd Inlet "Natural" (Pre-Modern) Estuary. Source: Derived from Ecology's Figure 7, SM Report.

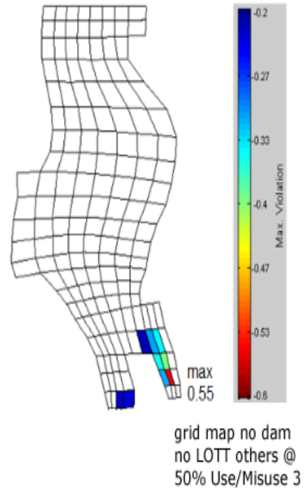

Figure 4-8b. Budd Inlet <u>with dam</u> and no other human-caused inputs. Source: ID'd by author as closest to Ecology's "with dam" scenario Fig. 24c, SM Report.

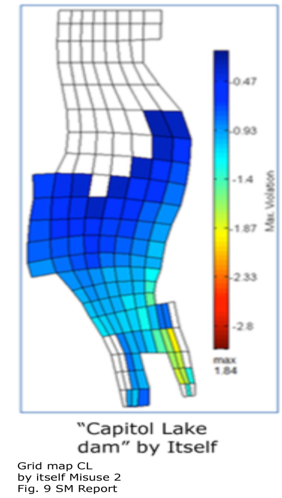

Figure 4-8c. Budd Inlet <u>with dam</u> and no other human-caused inputs. Source: Figure 9 p. 34 SM Report. Ecology's version.

<u>4-8. Summary of With/Without Dam Scenario Outcomes.</u>

1) The "natural" estuary with current levels of natural nitrogen inputs (and none from non-human sources) is loaded with water quality standards violations (Figure 4-8a);

2) "The dam by itself" is claimed by Ecology to make the Inlet even worse than it was in its natural state almost everywhere (Figures 4-8c);

3) The effect on Budd Inlet of "no dam by itself" as shown by Ecology is actually "no dam but with all other sources operative" (Figure 4-7d);

4) One of the scenarios (Row F, Table 1) gives a rough estimate of what "no dam by itself" really looks like (Figure 4-7c);

5) The scenario in Row H, Table 1, allows an estimate of what "with dam by itself" would look like (Figure 4-8b), which is almost certainly better than that shown in this Figure. (Better, because Capitol Lake would capture more than 50% of the anthropogenic nitrogen and because any effects of the other watersheds and external source would be eliminated.)

The simple bottom line is that Budd Inlet with Capitol Lake in place is almost certainly better off than it would be if the Lake were removed, but the Department of Ecology shows the opposite.

<u>4-9. Budd Inlet is Better Off With the Dam than Without it.</u>

Unscrambling the scrambled tangle of scenarios and assertions made in the SM Report has been one of the most difficult intellectual challenges I've faced in years. By their nature, computer simulations are complex beyond measure and fully capable of revealing phenomena that are, on the face of it, anti-intuitive. In this case, it is ecologically unthinkable that a Lake capturing almost all of the nutrients – *of both natural and anthropogenic origin* that the Deschutes River would otherwise pour directly into Budd Inlet -- has a negative effect on the Inlet whereas removing the Lake would somehow make water quality out there dramatically improved. Yet this is what Ecology tries to use its computer model to prove.

The un-edited, un-peer-reviewed scramble of verbiage, numbers and maps that is the SM Report makes analyzing their claim even more difficult. Nowhere do they provide a detailed description (in the form of data) of what they mean by "no dam." What was actually changed in the model to make those simulations? Nowhere do they summarize the numerical values that the computer used in the scenarios they tested. (Some numbers are mentioned tangentially in some brief scenario descriptions.) Nowhere is there a Table resembling my Table 1 above summarizing the scenarios for readers, or a Figure resembling my Figure 4-6 reporting the sizes of the nutrient inputs to Budd Inlet. Analyzing all this to try to see if their presentations support their claims is a near-impossible task.

My conclusion is that the Ecology modelers, perhaps confused themselves by the complexity of the task,[3] have mistakenly claimed that "no dam" is better than "with dam" for Budd Inlet. My own conclusion, from their own publications and real-world ecological intuition, is that the opposite is true:

Budd Inlet is better off with the dam than without it.

4-10. Optional. Figuring Out the Data Used by Ecology in the Scenarios.

The modelers do not list the anthropogenic nitrogen input values used in the Table 4-1 scenarios for each of the four sources of inputs to Budd Inlet, but some of them can be inferred as shown in Table 4-2.

1	Total anthropogenic load	1980 kg N/day	mentioned on SM page 40
2	External source	1488 kg N/day	mentioned on SM page 41
3	Deschutes, other, & LOTT	492 kg N/day	line 1 above minus line 2
4	Deschutes and other	296 kg N/day	from 50% reduction x2 SM p. 42
5	LOTT	196 kg N/day	line 3 above minus line 4
6	Deschutes by itself	--	no way of determining this value
7	Other (including Moxlie Cr)	--	no way of determining this value

Table 4-2. Anthropogenic Nitrogen Inputs used in the SM Scenarios of Table 4-1. (Natural Inputs not shown (all at 100%, all scenarios).

[3] See Chapter 6, discussing likely model confusion attributing external source effects to Capitol Lake.

These anthropogenic input values compare with those shown in Figure 4-6 above as follows (underlined values are from Figure 4-6); external 1488 and 1488 same; LOTT 196 vs 92; Deschutes + Other 296 vs. 167. For the SM scenarios the modelers have used much larger values for the LOTT input and for the (Deschutes River + Other) sources than are named in the main data tables that the modelers cite in their TMDL Report.

4-11. Optional. Transforming the Natural Estuary Grid Map.

How was Ecology's portrayal of the natural estuary (Figure 4-3b) converted to the one shown in conventional grid map format (Figure 4-4a)? My procedure is described in this section for readers who care to follow it or try it for themselves.

I examined a full screen image of Ecology's 'natural' estuary map (Fig. 4-3b), obtained from an on-line ecology website ("SM Report on line," References) using Photoshop software (Photoshop Elements 12 Expert Level).

First I constructed a black-and-yellow scale bar and scaled it to fit the modelers' erratic color scale gradation (shown in Figure 4-9a). I then used the "polygonal lasso" selection tool to carefully select the interior color of one square on the image in Figure 4-3b, taking care not to include any parts of the grid lines. I then clicked "Similar" under Photoshop's Selection Menu. This highlights ("selects") every grid square in the Figure that has a "similar" color *and also that color on the modelers' scale bar.*

The selected similar color on the modelers' scale always spanned a small range whose upper and lower limits could be measured with my own calibrated scale. I hand-annotated all selected grid squares on a printed copy of the grid, noted the DO range indicated on the scale, and repeated the process by deselecting the image and selecting another grid square. (Notation by hand was easier than storing all of the values in computer memory at this stage.) I continued this until every grid square on the printed map was filled. Later in the procedure I transferred the key colors of the violations to a preliminary computer-generated grid map – Figure 4-9b – as described below.

Table 4-3 summarizes these measurements. These could be grouped into three partially overlapping categories in the central inlet (the "green zone," Figure 4-3a) and three additional partially overlapping categories in the southernmost inlet (the "orange zone, Figure 4-3a). Columns A and B (Table 4-3) show the upper and lower limits of these categories. Mean values of the categories are shown in Col-

Sizes of Water Quality Violations in Natural Estuary.				
A	B	C	D	E
upper DO (mg/L)	lower DO (mg/L)	Mean (mg/L)	Max. Violation (mg/L)	Key Color (preliminary for Fig. 5-5b)
(Central Inlet)				Central Inlet std = 6 mg/L
5.90	5.70	5.80	0.30	blue
5.83	5.60	5.72	0.40	green
5.70	5.40	5.55	0.60	orange
(Lower Inlet)				Lower Inlet std = 5 mg/L
4.90	4.50	4.70	0.50	orange

umn C.

4.60	4.20	4.40	0.80	yellow
4.30	< 3.00	3.65	>2.00	red

Table 4-3. Conversion of the scale of Figure 4-3b (amount of oxygen in the water, mg /L) to the scale of Figure 4-4a (size of DO violation, mg/L). Size of the 'violation' (Column D) is the difference between the lowest DO value of each selected batch of similar grid squares (Column B) and the size of the standard; 6.0 for the central inlet, 5.0 for the lower inlet.

Water quality violations occur when values fall 0.20 mg/L or more below the standard. Column D shows the size of the violation at the lowest value of each category.

Early in this work it was not possible to use the same colors for violations as those used by the modelers. I assigned colors to the violation categories as shown in Column E and created a preliminary grid map using those colors (Figure 4-9b). Subsequently I created the finished natural estuary grid map (Figure 4-4a) by converting the preliminary colors to those used by the modelers.[4]

4-12. Optional (continued). Details and Reliability of the Selection Process.

The Photoshop "similar selection" process clearly identifies the squares with similar colors in, say, 90% of cases while leaving some doubt about others. (In the doubtful squares, the selection lines may follow only three of the four grid square sides, or wander across some grid square boundaries, or appear as small shimmering "islands" in the centers of some otherwise unselected squares, etc.) I resolved doubt in most cases by selecting the doubtful squares themselves and clicking "Similar" on the Selection Menu. Where doubt was not completely resolved, if any part of a grid square was selected I considered the whole square to be selected.

There was little overlap of the grid squares selected in this way. Perhaps five of all of the grid squares ultimately selected by all of the similarity searches were highlighted more than once throughout this process. In those cases, I assigned the lower of Photoshop's two "DO readings" to such squares. Groups of squares that were never matched with DO scale values of 4.8 – or 5.8 mg/L or lower (orange or green violation thresholds in

[4] The preliminary grid map was presented in the first draft of this report posted on the CLIPA website.

Figure 4-4a), or whose mean DO's exceeded these limits were judged to be in compliance with water quality standards and were left uncolored in Figure 4-9b, the intermediate step in this process. The sizes of the violations thus estimated were assigned colors; these were "painted" into the appropriate grid squares to create the preliminary violations map with its own color coded violations scale (Figure 4-9b). (The grid map to be painted was created by tracing all of the grid lines in Ecology's map with Photoshop's line tool, finally merging all of the lines into a single layer and coloring each grid square with the paint tool.)

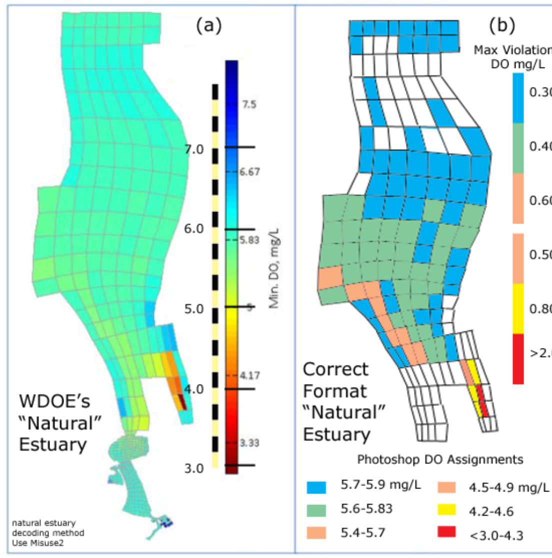

Figure 4-9. Conversion of Ecology's "natural" estuary DO levels to Ecology's conventional format for displaying water quality violations. Left: Ecology's "natural" estuary DO's with my readable scale. Right: Preliminary grid map of Budd Inlet in Ecology's conventional format obtained via Photoshop from the leftmost Figure. See text.

Because of the labor-intensive time-consuming nature of this process, I stopped there and showed the preliminary map in the first draft of this report. Continuing recently, I converted the violations colors to those used by Ecology and painted the grid map with those colors, obtaining the final corrected natural estuary grid map (Figure 4-4a, above).

<u>4-13. Optional. The Derivation of "Budd Inlet With No Dam" (Figure 4-7c).</u>

A scenario that shows the effect of "no dam" by itself should include the Deschutes River source at 100% of its "natural" nitrogen content and zero for every other source (as in Row B, Table 1). (Any lesser Deschutes River input with "no dam" would be secretly giving "no dam" credit for removing both natural and anthropogenic nitrogen, something that only happens when the Lake is in place.) Deciding which of the four scenarios actually shown by Ecology approaches the Row B combination most closely is based on the following.

First, I disregarded the "Other Watersheds" category of nitrogen inputs; that total is very small (see Figure 4-6) and mostly confined to East Bay.

Second, the huge External source by itself (Row D, Table 1) shows almost no effect whatsoever on Ecology's simulated Budd Inlet; the grid map of that scenario (not shown here) is clear of violations everywhere except for a few small ones in East Bay.[5]

[5] See Chapter 6. I believe that the external source is responsible for a lot more DO depletion in Budd Inlet than the modelers recognize.

Third, scenarios that reduce or eliminate the LOTT plant effect (Rows D, F and H, Table 1) wipe out most of the “big blue patch” of violations that is the dominant feature of the baseline scenario (Figure 4-7d).

All things considered, Row F shows the closest approach to a “no dam by itself” scenario. The Deschutes watershed input and Other watersheds are at 100%, the crucial LOTT input is moved to the mouth of Budd Inlet (and is effectively 0), and the External source left at 100%, as claimed by the modelers, has almost no effect on violations in the simulations.

Figure 4-7c shows the map from the scenario in Row F. That map (SM Report’s Figure 22d) is the closest thing to a “no dam by itself” scenario to be found in the SM Report.