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STATE OF WASHINGTON

DEPARTMENT OF ECOLOGY

7272 Cleanwater Lane, LU-11 • Olympia, Washington 98504 • (206) 753-2353

MEMORANDUM

December 22, 1981

To: Dick Cunningham

From: Bill Yake

Subject: Seasonal Nutrient Depletion at Ambient Marine Stations in Puget Sound; Implications for Discharge of Nutrients to Embayments like Budd Inlet

In reviewing the WY 1981 marine ambient data, a pattern of seasonal NO_3-N depletion in surface waters during the algal growing season became apparent at 50 to 60 percent of our stations. This observation led to further analysis and consideration of two questions: (1) are algae nutrient-limited in Puget Sound water (a supposition ~~often voiced~~ questioned); and (2) when considering impacts of municipal plants on marine primary productivity, what precautions should be exercised in analyzing the data.

Further data review revealed that at many stations, surface NO_3-N concentrations typically fell to less than .01 mg/L for two to three months during the summer. Simultaneously, at most of these same stations dissolved orthophosphate concentrations fell to fairly low levels (in some cases less than .01 mg P/L). The table below notes patterns found in specific areas of the Sound and adjacent waters.

It is apparent that nutrient depletion is observed most clearly in waters which stratify and experience poor mixing during the summer. These are areas most susceptible to heavy planktonic algae blooms. Seasonal nutrient depletion is not seen in areas strongly influenced by "new" oceanic waters coming in from the Strait (the San Juans) or in areas of strong vertical mixing during tidal exchanges (Admiralty Inlet; Tacoma Narrows).

The implication of this pattern is that planktonic algae blooms in many areas of the Sound can be (and often are) nutrient-limited. The limiting nutrient appears to generally be NO_3 (and by extension, inorganic nitrogen). Therefore, problems associated with excessive algal blooms -- extreme swings in dissolved oxygen concentration, poor visability, and possibly toxic algae effects -- may be aggravated by substantial nutrient sources (including municipal plant discharges).

Nutrient depletion patterns (marine ambient monitoring network).

Nutrient Depletion (2 to 3 months, NO_3-N < .01 mg/L in surface) waters)	Intermediate (Decrease in NO_3-N concentrations noted in surface waters during summer)	No Nutrient Depletion (No significant NO_3-N increase noted during summer)
Drayton Harbor	Port Townsend Harbor	Haro Strait
Bellingham Bay	Port Angeles Harbor	San Juans
Port Susan	Upper Hood Canal	Admiralty Inlet
Port Gardner	Skagit Bay	Tacoma Narrows
Possession Sound	West Point	
Penn Cove	Commencement Bay	
Holmes Harbor	Nisqually Reach	
Saratoga Passage	Pickering Passage	
Hood Canal (lower 3/4)		
Sequim Bay		
Port Orchard		
Dyes Inlet		
Sinclair Inlet		
Liberty Bay		
Carr Inlet		
Case Inlet		
Budd Inlet		
Eld Inlet		
Totten Inlet		
Oakland Bay		
Willapa Bay		

Such affects would probably be most noticeable in very poorly flushed embayments with major nutrient sources. Budd Inlet and the LOTT plant may provide the strongest example of this phenomenon. Total phosphorus concentations in Budd Inlet are approximately 2-1/2 times the concentrations at other locations in the Sound. This strongly suggests (a) major nutrient source(s) in this system. Dissolved orthophosphate concentrations remain well above .01 mg PO_4-P/L; therefore, productivity is not phosphate-limited. A WDOE study (Kruger, 1979) concluded that "the Olympia STP contributed 82 percent of the orthophosphate-phosphorus loading" to Budd Inlet. (This study considered only freshwater sources; the contribution of PO_4-P from incoming saltwater was not quantified.) Based on this information, this study concluded that: "Puget Sound waters are naturally abundant in nutrients throughout the year. Therefore, it is evident that tertiary treatment (nutrient removal) is not necessary at the new Olympia treatment facility."

This conclusion appears questionable. As noted, NO_3-N depletion does occur in Budd Inlet. Municipal effluents typically contain approximately three to four times as much inorganic nitrogen-N as orthophosphate-P. Unfortunately, this contribution was not documented in the above-referenced report because only NO_3-N was analyzed and most inorganic nitrogen in primary effluent is in the ammonia (NH_3-N) form. A rough estimate is that LOTT inorganic nitrogen loadings may double or triple available inorganic nitrogen in inner Budd Inlet. The implications are self-evident.

Investigators should keep in mind the potential of municipal discharges to aggravate marine algal blooms and address all inorganic nitrogen forms when assessing the potential impacts of discharges on primary productivity in susceptible marine waters.

BY:cp

Attachment

cc: Jim Krull
Tim Determan
Lynn Singleton
Art Johnson
John Bernhardt
Dale Norton
Marc Heffner
Anne Haines