SRCSD

Wastewater Treatment

Technology in balance with nature

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June 14, 2010

Mr. Chris Foe
Central Valley Regional Water Quality Control Board
11020 Sun Center Drive, Suite 200
Rancho Cordova, CA 95670-6114

Subject: Sacramento Regional County Sanitation District Comments on Draft "Nutrient Concentration and Biological Effects in the Sacramento-San Joaquin Delta, Central Valley Regional Water Quality Control Board, May 2010."

Dear Mr. Foe:

Sacramento Regional County Sanitation District (SRCSD) appreciates the opportunity to comment on the Draft "Nutrient Concentration and Biological Effects in the Sacramento-San Joaquin Delta, Central Valley Regional Water Quality Control Board, May 2010" report (Nutrient Report). SRCSD has a vested interest in nutrient studies in the San Francisco Bay Delta, as scientific information will be used to make policy decisions regarding the impact, if any, SRCSD's treatment plant has on beneficial uses of the Delta. To date scientific studies that rely on observed data collected in relationship to a specific hypothesis, and not correlation analysis, has not shown any direct impact to the Delta from nutrients in SRCSDs discharge.

This Nutrient Report identifies the primary focus for future research is evaluating nutrient level effects on phytoplankton abundance and species composition in the Delta. SRCSD supports research in the area of determining what is driving phytoplankton biomass and composition, but believes that other environmental factors, such as hydrologic residence time, temperature, benthic grazing, etc., which has changed over time, should be considered in addition to nutrients.

SRCSDs comments provided below are to assist Central Valley Regional Water Quality Control Board staff in generating a final report. The comments are divided into three areas: general comments on the Executive Summary, specific comments on the content of the report, and minor edits. The general comments on the Executive Summary primarily cover language that could easily be misinterpreted, while the specific comments are more technical in nature and are intended to help the scientific understanding of nutrients role in the Bay-Delta.

General Comments on Executive Summary

Risk evaluation methods used in this report are extremely conservative and agree with multiple study findings by Werner et al. (2009a,b) and with National Recommended Water Quality Criteria (EPA 1999, 2009). The ambient concentrations of ammonia were lower than a conservative benchmark where there is no effect – the No Observed Effect Concentration (NOEC) for delta smelt - rather than one that causes threshold effects and would signify the presence of risk. The Executive Summary, Page 3, 2nd paragraph states that "The upper 95 percent confidence limit of these values was 19-times lower than the 7-day no observed effect concentration for smelt survival **suggesting** [emphasis added] that ambient ammonia levels in the Delta were not acutely toxic during the study." We suggest you change this conclusion to be more definite, such as "the data indicate that there is no potential for risk due to the acute toxicity of ambient ammonia to delta smelt within the area studied."

All three purposes of the study (as described on page 4) should be included in the Executive Summary. Currently only collecting nutrient data at key locations in the Delta to characterize concentrations and compare with reported toxic endpoints for sensitive local aquatic organisms is included in the Executive Summary. The following two purposed should also be stated in the Executive Summary:

1) Determining diurnal and tidally induced changes in nutrient concentrations at key locations to ascertain short-term variability,

2) Comparing water quality measurements collected in this study with remote sensing values reported by CDEC to determine the comparability of the two data sets.

The Executive Summary contains some statements that potentially could easily be misinterpreted. One example is the final paragraph of the Executive Summary:

"Other research has now demonstrat[ed] that ammonia concentrations greater than 0.056 mg [N]/L prevent development of algal blooms in Suisun Bay but not in the Sacramento River below the SRWTP. No information presently exists on the effect of this concentration of ammonia on algal production in the Delta."

There are 3 elements of this passage which are potentially misinterpreted:

(1) The first sentence of the passage promotes a common misconception that ammonia concentrations below 4 µM (0.056 mg/L ammonia-N) are a predictor of algal blooms in Suisun Bay. In the ambient time series for Suisun Bay presented in Dugdale et al. 2007[1], algal blooms occurred only twice out of five periods when ammonium concentrations fell below 4 µM (Figure 1). This amply illustrates that other factors frequently prevent blooms in Suisun Bay even when ammonium concentrations are below the "Dugdale" threshold.

These factors may vary seasonally (temperature, residence time, turbidity, salinity stratification, benthic grazing), but the pattern indicates that it may not be reasonable to expect large dividends in phytoplankton biomass if ammonium concentrations are reduced in the brackish Delta. The fact that low ammonium periods in Dugdale's time series were not always within the April-May spring bloom window does not diminish the significance of non-nutrient-based regulation of phytoplankton biomass.

The large June-September phytoplankton biomass observed in the confluence zone and Suisun Bay prior to the arrival of *Corbula* (Figure 2) illustrates that summer was historically a period of greater algal abundance than spring in Suisun Bay. Spring diatom blooms did not historically dominate annual production in Suisun Bay, and as Dugdale's time series illustrates, ammonium levels are an inadequate explanation for the current dearth of phytoplankton in summer in the brackish Delta.

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[1] The same Suisun Bay time series is included in Wilkerson et al. (2006). Full citations are in the Regional Board report.

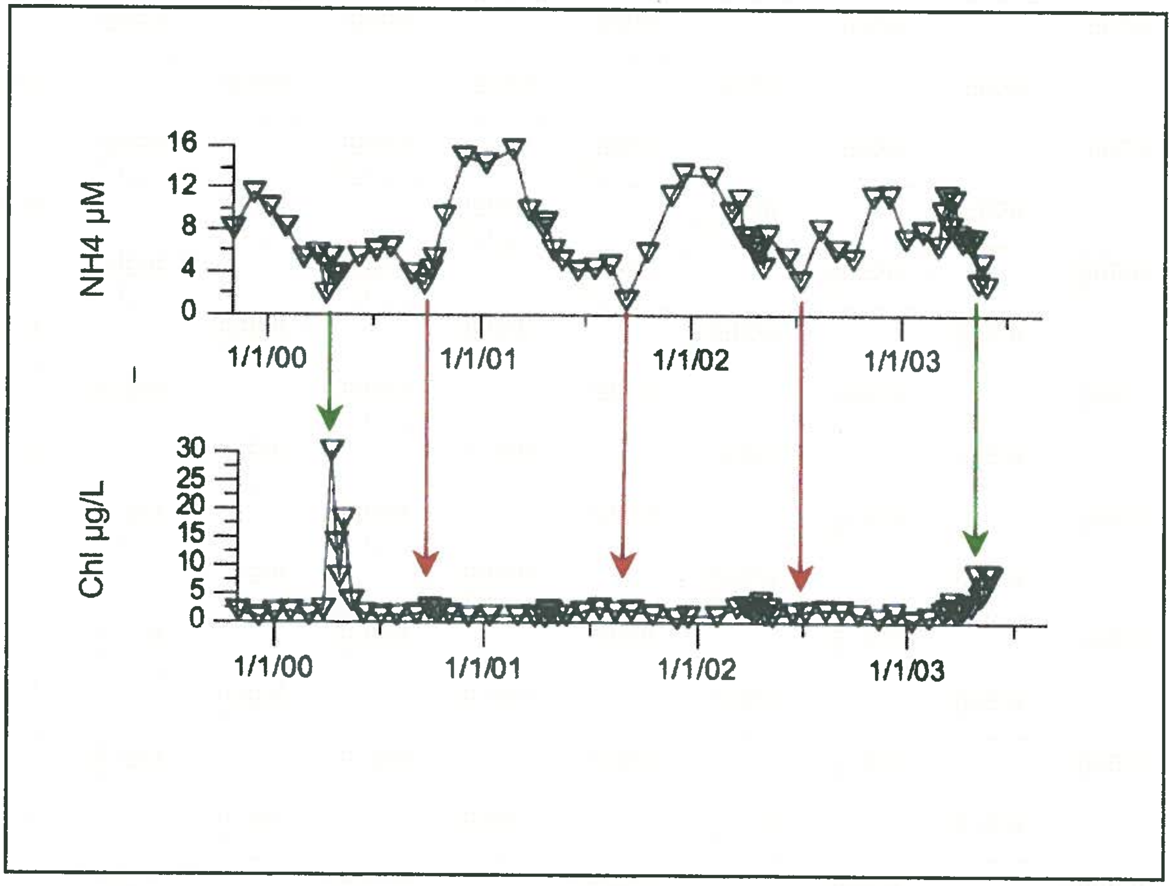

Figure 1. Time series of ammonium and chlorophyll-a from Suisun Bay. Green arrows indicate where ammonium concentrations below a 4 µM threshold were accompanied by increases in chlorophyll-a. Red arrrows show periods when similarly low ammonium concentrations were not accompanied by increases in chlorophyll-a. Panels are from Figure 1 in Dugdale et al. (2007).

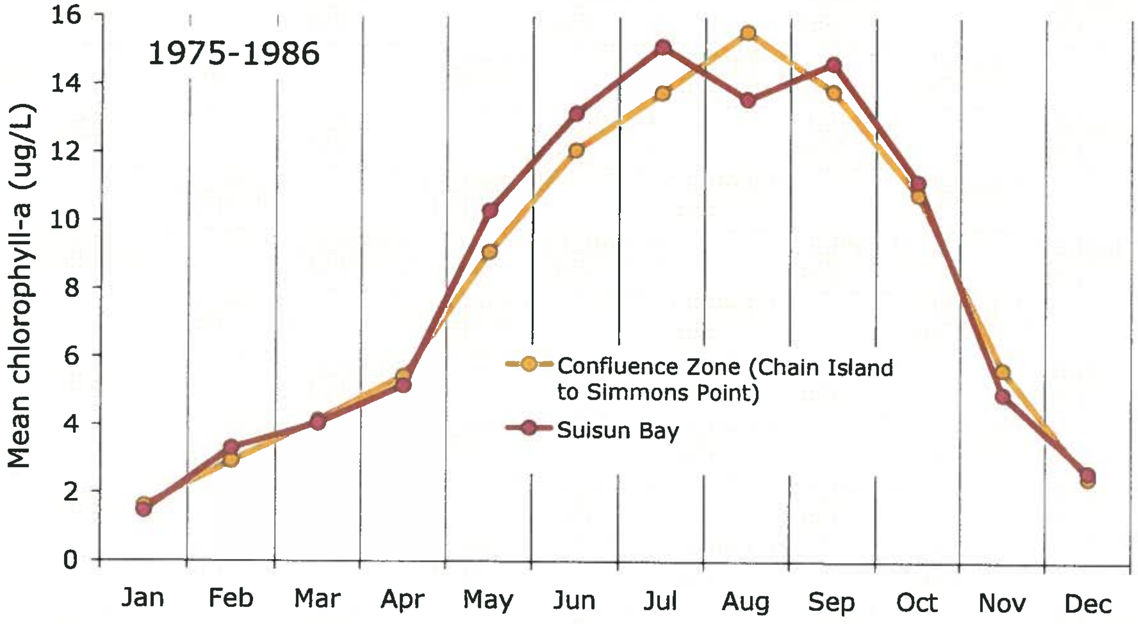

Figure 2. Mean monthly chlorophyll-a concentrations from surface (0-2 m) water samples collected between 1975-1986 at stations used by the IEP, DWR-MWQI, and the USGS.

(2) The first sentence should be modified to say "...but not in the Sacramento River *between the SRWTP and Suisun Bay.*" The sentence as written can incorrectly imply that different growth responses to ammonium in the Sacramento River, compared to Suisun Bay, were only observed immediately downstream of the SRWTP. However, the available datasets (in the Regional Board report and in an SFSU report and 2009 poster)[2] indicate that the relationships between ammonium uptake and phytoplankton biomass and growth rates differ from those in Suisun Bay along the full extent of the Sacramento River within the Delta.

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[2] Although the Parker et al. (2010) draft report for the Central Valley Regional Board only shows transect results between I-80 and Rio Vista, sampling during at least one of the transects extended past Rio Vista well into into Suisun Bay. Results for the longer transect from March 2009 were presented in Parker et al. (2009) *Transport and Fate of Ammonium Supply from a Major Urban Wastewater Treatment Facility in the Sacramento River, CA. 9th Biennial State of the San Francisco Estuary Conference, Oakland, CA, September 29-October 1, 2009.* The poster results show increases in primary production and biomass of several phytoplankton groups (greens, diatoms, and Cryptophytes) starting in the river well upstream from Suisun Bay in a reach where nitrogen uptake was dominated by ammonium.

(3) The sentence *"No information presently exists on the effect of this concentration of ammonia on algal production in the Delta"* could easily be misinterpreted or taken out of context. The Sacramento River between the American River and Suisun Bay is an important part of the Delta, and as indicated above, the SFSU study now provides information about algal production in the Sacramento River throughout its course within the Delta. Given that Sacramento River water is diverted into the central and south Delta by export operations, it is not unreasonable to hypothesize that relationships between phytoplankton and ammonium observed downstream of SRWTP within the main Sacramento River channel may also apply to riverine phytoplankton that are transported out of the main channel into the interior Delta.

In the Executive Summary and on page 9, it is stated "*Microbial transformation of ammonia to nitrite and nitrate appears to be the major biological process at work in the Delta.*" This is a gross overstatement that could be used out of context by readers less familiar with the available research. Aquatic nitrogen transformations include (at minimum) nitrogen fixation, nitrification, denitrification, dissimilatory nitrate reduction to ammonia (DNRA), anaerobic ammonia oxidation (annamox), assimilation by phytoplankton, aquatic plants, *and* bacteria, excretion by pelagic and benthic biota, and microbial remineralization. Except for the N uptake rates measured in one study by Parker et al. (2010) along the Sacramento River, genuine rate measurements (such as direct measurements of transfer of ^{15}N between compartments) have not been reported from the freshwater Delta for the myriad routine pathways by which nitrogen is used and re-used in aquatic systems - *including nitrification*. In many settings, rapid recyling of nitrogen between grazers and microbes in the water column (nutrient regeneration) means that patterns in bulk concentrations of nutrients (such as observed by grab sample surveys) do not reflect underlying turnover rates. Although stable isotope analyses of bulk N pools (currently underway by C. Kendall, USGS, and colleagues) can reveal information about sources and transformations, they do not result in rate measurements. Almost nothing is known about the use and cycling of dissolved organic nitrogen in this system, although there is growing evidence that marine and freshwater phytoplankton utilize amino acids, amides, urea, humic substances, and other dissolved organic nitrogen compounds as sources of nitrogen (recently reviewed in Bronk et al. 2007)[3].

The cross comparison between grab sample and CDEC data was useful information and will hopefully spur additional cross comparisons.

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[3] Bronk, D. A., J. H. See, P. Bradley, and L. Killberg. 2007. DON as a source of bioavailable nitrogen for phytoplankton. Biogeosciences 4: 283-296.

Specific Comments on Content

Page 7, Results and Discussion: It would be helpful to identify or report the river flows during this study and how they compare with long-term averages. This information will help place the monitoring conditions in context of a wet vs. dry year. Measurements made in a dry year (lower than average flows) would represent conservative estimates of the potential for risks while wet weather measurements would likely be less conservative. This is relevant because the report makes risk estimates based on the measured concentrations of ammonia.

Page 14, Results and Discussion, first paragraph: It would be helpful to add that the 7-day NOEC concentrations reported by Werner et al. (2009a,b) range from 0.087 – 0.177 mg/L NH3, although only the NOEC value reported here (0.091 mg/L) represents a bounded NOEC where there was an effect observed at a higher tested concentration. The other NOECs reported were unbounded, because there were no effects at the highest tested concentrations.

Page 10: The possibility that current speed and/or residence time are directly affecting the biomass of phytoplankton which remains in suspension in the Sacramento River is investigated by correlating the percent decline in chlorophyll concentrations between Tower Bridge and Isleton with (a) Sacramento River flow at Freeport and (b) minimum velocity at Freeport (for 2 days prior). This type of analysis is welcome, because the roles of residence time, turbulence, and other physical processes in shaping riverine phytoplankton communities deserve more attention than they have received in Delta food web discussions.

Freeport flow and current speed are probably reasonable proxies for these two parameters between Freeport and Walnut Grove. However, depending on season and year, between 15-60% of Sacramento River flow exits the main channel near Walnut Grove on a monthly basis through Georgiana Slough and the Delta Cross Channel (Figure 3). Especially during months when high percentages of river flow exit the main river channel at Walnut Grove, it might be better to compare Freeport flow and current speed to chlorophyll decline between Tower Bridge and Walnut Grove only, rather than chlorophyll decline between Tower Bridge and Isleton.

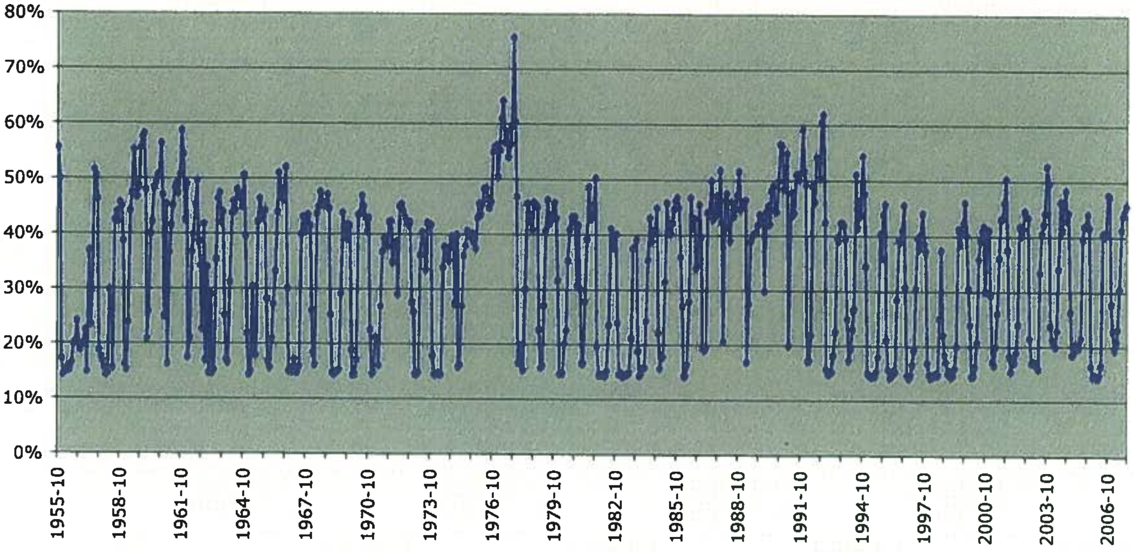

Figure 3. Percent of Sacramento River flow which exits the river per month via combined flow through Georgiana Slough and the Delta Cross Channel for water years 1956-2007. Percents were calculated using monthly means of daily Dayflow output for QSAC (measured flow at Freeport) and QXGEO (estimated combined flow through the Georgiana Slough and the Delta Cross Channel).

Page 14: Werner's 2006-2008 survey of un-ionized ammonia concentrations is referenced to provide context for the results of the Regional Board survey. In doing so, attention is called to un-ionized ammonia concentrations in the Werner dataset that approached 0.02 mg N/L. Additional context could be provided by referencing the multi-agency dataset analyzed by Engle & Lau (2009, 2010)[4], which provides un-ionized ammonia concentrations for the period 2000-2010 for stations spanning the brackish (18 stations) and freshwater Delta (30 stations)[5]. In this larger dataset (which includes Werner's 2006-2008 survey data), un-ionized ammonia was ≥ 0.02 mg N/L in only 4 water samples, and the 99th percentile concentrations for un-ionized ammonia at freshwater sites and brackish sites were 0.014 and 0.0063 mg N/L, respectively.

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[4] Engle, D.L., & G. Lau (2009) *Total and Un-ionized Ammonia Concentrations in the Upper San Francisco Estuary: A Comparison of Ambient Data and Toxicity Thresholds.* 9th Biennial State of the San Francisco Estuary Conference, Oakland, CA, September 29-October 1, 2009

Engle, D.L., & G. Lau (2010) *Does Ammonia Exceed Toxicity Thresholds in the Upper San Francisco Estuary? A Comparison of Ambient Data and Toxicity Thresholds for 1974-2010.* Interagency Ecological Program (IEP) Annual Workshop, Sacramento, CA, May 25-26, 2010.

[5] USGS, IEP, DWR, SRCSD, and UC Davis ATL POD monitoring programs

Page 14, paragraph 3: The method for calculating ACRs is incorrect. USEPA does not calculate ACRs for ammonia by dividing 96-h LC50s by "lowest chronic NOEC values". USEPA calculates ACRs for ammonia by dividing the 96-h LC50 from acute tests by the EC20 from comparable chronic tests. The USEPA uses specific criteria for determining which LC50s and EC20s are suitable for pairing for purposes of ACR calculation.[6]

The footnote on page 14 incorrectly describes how an ACR of 20.7 was calculated by USEPA from the life cycle test of Thurston et al. (1986). The ACR was calculated using an EC20 based on an endpoint of *percent hatch* (not a NOEC related to histopathologic effects)[7]. The USEPA does not use chronic values obtained using histopathologic endpoints to calculate criteria or ACRs for a host of reasons which are detailed in USEPA (1999).

Additionally while it is a positive result that the Regional Board did not find evidence for chronic toxicity after applying an ACR of 21 to the LC50 for Delta smelt, this particular ACR is a biased screening tool. USEPA (1999) provides three ACR's for fathead minnow: 20.7, 9.7, 6.5[8]. There is no justification for singling out the highest of 3 independently determined ACRs for fathead minnow to derive a hypothetical chronic threshold for Delta smelt.

As is customary, the USEPA uses a Genus Mean ACR (GMACR) to characterize the acute:chronic sensitivity of fathead minnow, not the highest of the available ACRs. Following USEPA procedures, the GMACR for fathead minnow is calculated in the 1999 criterion

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[6] USEPA (1985) *Guidelines for Deriving Numerical National Water Quality Criteria for the Protection of Aquatic Organisms and Their Uses*, outlines the following steps for producing an ACR from a chronic value:

1. The numerator for the ACR should be the geometric mean of the acute values for that species from all acceptable flow-through acute tests in the same dilution water.
2. For fish, the acute tests should have been conducted with juveniles.
3. The acute tests should have been (a) a part of the same study as the chronic tests, (b) from different studies but from the same laboratory and dilution water, or (c) from studies at different laboratories using the same dilution water.
4. If no such acute tests are available, an ACR should not be calculated.

[7] See Table 5 and text on page 53, in USEPA (1999).

[8] See Table 7, p. 136, in USEPA (1999).

document as the *geometric mean* of the three available ACRs (see p. 136 in 1999 criterion document). The resulting GMACR of 10.9 is one of five GMACRs for fish genera that have survived vetting by the USEPA and which were published in both the 1999 and 2009 USEPA ammonia criteria documents (the latter being a draft update):

Pimephales	10.86
Catostomus	<8.33
Ictaluris	2.712
Lepomis	7.671
Micropterus	7.688

Singling out the 20.7 ACR for fathead minnow to derive a screening threshold is especially inappropriate considering that it is derived from a chronic test that the USEPA considers problematic, as indicated by the following passage from the "Review and Analysis of Chronic Data" in the 1999 criteria document:

> *"Thurston et al. (1986) reported similar results from two life-cycle tests that started with 3 to 5-day-old fry and ended with 60-day-old offspring....However, there are concerns about this test:*
> *1. Effects on survival and weight of F1 fry were uncertain due to high mortality attributed to handling during cleaning.*
> *2. The eggs were dipped in malachite green daily.*
> *3. Hatchability of the controls was about 50 percent.*
> *4. There was a large difference between the replicate test chambers in the control-adjusted percent hatch at 0.09 mg NH3/L."* (USEPA 1999, p. 53)

The other two ACRs for fathead minnow were derived from tests which did not raise any concerns (Swigert & Spacie 1983, Mayes et al. 1986)[9]. In fact, USEPA purposely averaged the chronic values from the latter two tests with the chronic value from Thurston et al. (1986) to derive the species mean chronic value (SMCV) for fathead minnow owing to concerns about the validity of the Thurston et al. test:

> *"In the present case, however, because of the concerns about the life-cycle test* [Thurston et al. 1986], *the SMCV for the fathead minnow at pH=8 is set equal to 3.09 mg N/L, which is the geometric mean of the three EC20s from Thurston et al. (1986), Swigert and Spacie (1983), and Mayes et al. (1986).." (USEPA 1999, p. 54)*

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[9] Full citations are available in USEPA (1999).

Page 14: It is suggested that CDEC pH values above 8.0 might be used as a potential indicator of chronic toxicity for Delta smelt at Hood and Rio Vista. There is large risk for this remark to be misconstrued as an endorsement of the use of pH as a screening tool in the Delta, generally. Because total ammonia concentrations and water temperature vary widely within pH strata across the estuary, ambient pH is a terrible generalized basis for gauging whether un-ionized ammonia concentrations are of concern. Data for 2000-2010 illustrate the wide range of un-ionized ammonia concentrations that occur when pH is greater than 8.0 at stations in the brackish Delta (Figure 4) and the freshwater Delta (Figure 5).

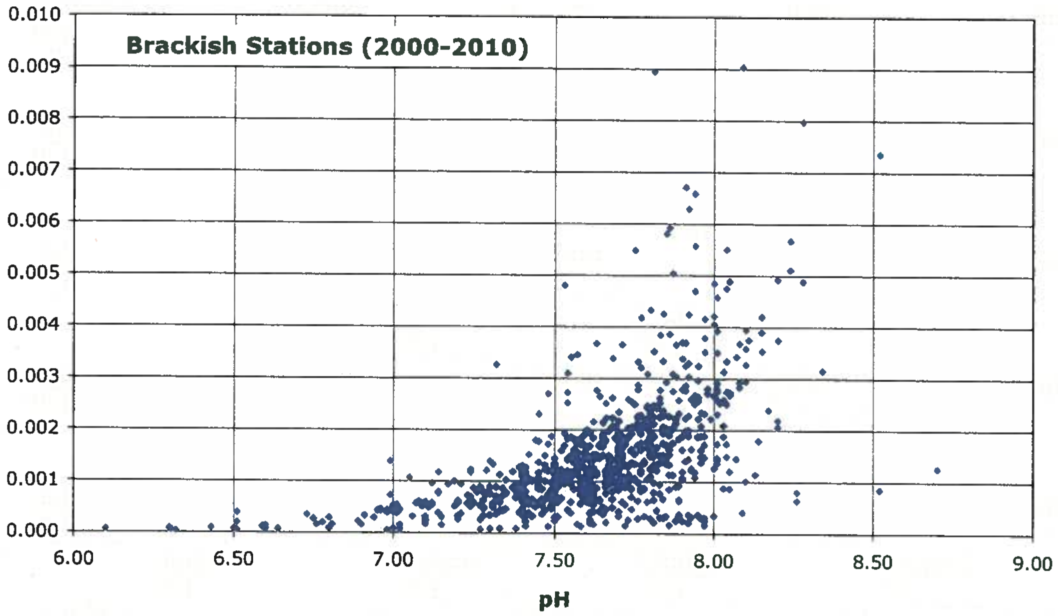

Figure 4. Relationship between field pH and un-ionized ammonia (mg N/L) at brackish stations in the upper San Francisco Estuary (Sherman Island to San Pablo Bay) during 2000-2010. Dataset is described in Engle & Lau (2010). Data from eighteen stations used by the IEP, DWR-MWQI, and UC Davis ATL POD project are represented.

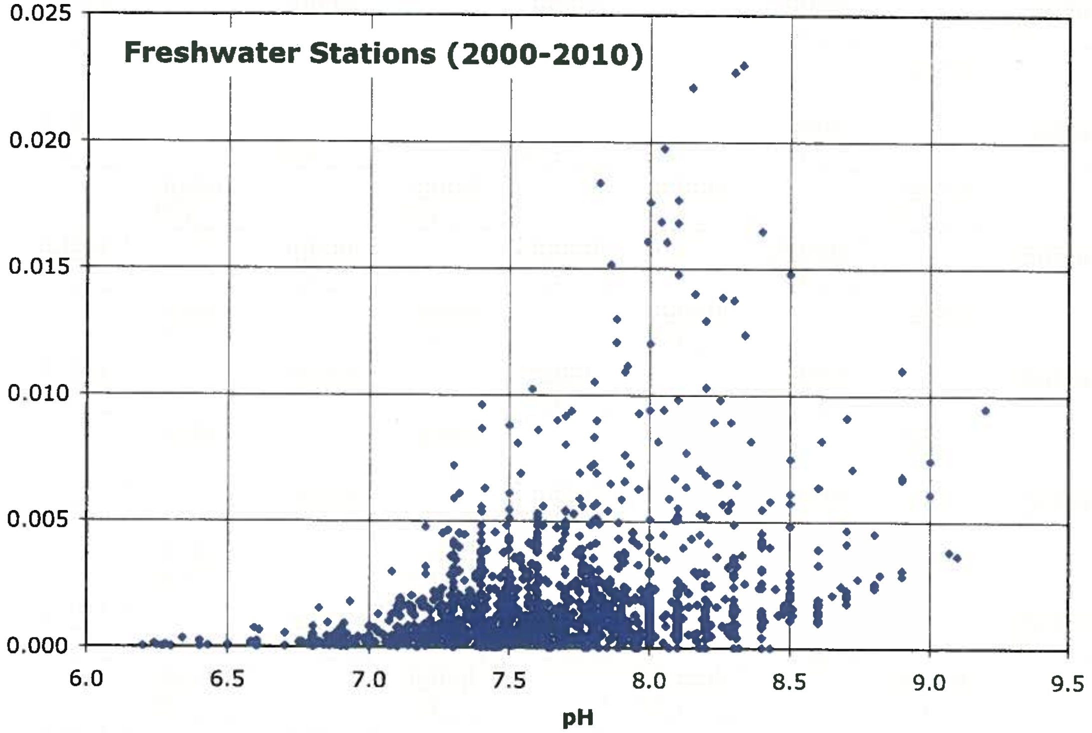

Figure 5. Relationship between field pH and un-ionized ammonia (mg N/L) at freshwater stations in the Delta during 2000-2010. Dataset is described in Engle & Lau (2010). Data from thirty stations used by the USGS, IEP, DWR-MWQI, SRCSD, and UC Davis ATL POD project are represented.

On page 16, paragraph 2, it is stated "*The impact of elevated ammonia concentrations on the algal community downstream of Rio Vista is not known.*" This remark is somewhat misleading, as there has been research on the effects of ammonia on the algal community in the Sacramento River downstream of Rio Vista. As explained above (see footnote 2), longitudinal transects by the Parker/Dugdale team during their 2008-2009 project included descriptive sampling and rate measurements at 11 stations extending from Rio Vista well into Suisun Bay. This work, which was not included in the Parker et al. (2010) draft report, indicates that increases in primary production and biomass of several phytoplankton groups (greens, diatoms, and Cryptophytes) can occur in the Sacramento River between Rio Vista and Suisun Bay even when nitrogen uptake is dominated by ammonium. These results are particularly important to reference because the lower reach of the Sacramento River is more important habitat for pelagic fish than the reach between the SRWTP and Isleton.

Minor Edits

The following bullets are some minor editorial suggestions to make the report consistent and figures easier to read.

- Ammonia and nitrate concentrations are referred to throughout the report and on graph axes using "mg/L" which can be interpreted by readers as mg NH4/L and mg NO3/L, rather than mg/L ammonia-N or mg/L nitrate-N. The units should be consistently labeled mg N/L, if that is what is meant.
- Figure 2. No units are provided for the y axis.
- X axis labels are missing or only partially visible in most of the figures.
- Y axis units are jumbled in Figures 10 and 11.
- Figure 7B. The yellow masking obscures the daytime values in Figure 7B. The y axes should be labeled (which y axis is chl? which is river stage?)

Conclusions

Overall the Nutrient Report is fairly balanced. The recommendations for changes to the Executive Summary will help readers that only read the Executive Summary have a comprehensive understanding of the information in the report, without misinterpretation. The changes requested for the acute to chronic ratio, will correct the way in which this ratio should be derived in accordance with USEPA guidance. We hope the minor editorial changes enhance the thoroughness of this report.

Should you have any questions please contact me at 916-876-6030, or dornl@sacsewer.com.

Sincerely,

Linda Dorn
Environmental Program Manager

Cc: Terrie Mitchell
Stan Dean
Mitch Maidrand
Stephanie Fong