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Delta Nutrient Related-Water Quality Problems

October 14, 2008

Phil Isenberg, Chair
Delta Vision Blue Ribbon Task Force
Members of the Delta Vision Blue Ribbon Task Force:

Please find attached comments on nutrient-related water quality issues in the Delta pursuant to the September 19 Task Force meeting. As discussed herein, this is a topic area that needs greater attention in the Task Force's development of a Strategic Plan for implementing the Delta Vision. If there are questions on our comments, please contact me.

G. Fred Lee, PhD, PE, BCEE

Comments on September 19, 2008 Delta Vision Task Force Meeting Discussion of Nutrient-Related Water Quality Problems in the Delta

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We viewed the recently posted webcast of the September 19, 2008 Task Force meeting and discussion of nutrient-related water quality issues in the Delta, and offer the following comments. An overview of our qualifications to address this topic is provided at the close of these comments.

Need for Greater Task Force Attention

Except for the CALFED-supported study of the low-DO problems in the SJR DWSC (San Joaquin River Deep Water Ship Channel), Delta nutrient-related water quality problems and the importance of nutrients in fish production have received limited attention by CALFED and the regulatory agencies compared to the magnitude and significance of these problems to the beneficial uses of the Delta. Thus far, the staff drafts of the Delta Vision management Strategic Plans have not adequately discussed several of the nutrient-related water quality problems that occur in the Delta. The Delta Vision Strategic Plan for implementation of approaches for control of Delta resource management problems should give greater attention to nutrient-related water quality problems and the role of nutrients in causing them.

Nutrient-Related Water Quality Problems in the Delta

At the September 19, 2008 meeting, Task Force member William Reilly inquired about what water quality problems were being caused in the Delta by aquatic plant nutrients (nitrogen and phosphorus).

There are several significant nutrient-related water quality problems in the Delta. Algal growth contributes to the significant tastes and odors in domestic water supplies that use Delta water as a source. Severe growths of water weeds such as water hyacinth and egeria significantly impair recreational use of Delta waters and deteriorate aquatic life habitat. There are also potential aquatic life toxicity and human health concerns owing to the growth of bluegreen algae in the Delta.

Bacterial decomposition of the excessive growths of algae is a primary cause of the low-DO problem in the SJR DWSC and in some South Delta channels. The low-DO conditions have caused fish kills, have impaired fish and other aquatic life growth, and are likely impeding the ability of Chinook salmon to traverse the SJR DWSC near the Port of Stockton to their home stream waters in the SJR watershed for spawning.

One of the issues of particular importance in developing nutrient management programs for the Delta is the role of nutrients in influencing fish production. There is evidence that fish

production in the Delta is limited by a nutrient-deficient planktonic algal food web. Reducing the nutrient loads to the Delta could further impair fish production in the Delta. The development of a nutrient management program for the Delta will need to balance nutrient control to solve water quality problems with nutrient sufficiency to support desired fish production.

We wish to suggest that those interested in the role of nutrients in causing water quality problems in the Delta review the information presented at the Delta Nutrient Water Quality Modeling Workshop held in March 2008. On behalf of the California Water and Environmental Forum (CWEMF) we organized a one-day workshop to discuss technical issues of nutrient-caused water quality problems in the Delta, with emphasis on the current status of modeling the relationships between nutrient load and aquatic plant growth-related water quality problems. A synopsis of the presentations made by the invited speakers, each an expert in a key aspect of these problems, as well as the PowerPoint slides from the presentations, are on the CWEMF website (<http://cwemf.org>) at <http://www.cwemf.org/workshops/NutrientLoadWrkshp.pdf>. The PowerPoint slides that we will use to summarize the workshop discussion at the CALFED Science conference on October 24, 2008, are attached to these comments.

The CWEMF Delta Nutrient Water Quality Modeling Workshop presentation and synopsis included information on major information gaps that need to be filled in order for a reliable management program to be developed for the excessive fertilization problems in the Delta. They also addressed approaches being used by regulatory agencies to begin to address these problems.

Experience in Evaluating Excessive Fertilization-Related Water Quality Problems

Dr. Lee has been involved in teaching, research, public service, and private consulting in the water quality issues associated with excessive fertilization of waterbodies since the early 1960s. He has conducted several-million-dollars in studies of these issues in many parts of the US and in several other countries. Dr. Lee and his graduate students pioneered in developing approaches for relating nutrient loads to planktonic algal growth and associated water quality problems. In the 1970s Dr. Lee was selected to serve as the US representative on the steering committee for the OECD international studies of the impact of nutrients on the development of planktonic algae in waterbodies. Those studies were a \$50-million, five-year effort by 22 countries in North America and Europe, as well as Japan and Australia. Dr. Lee was also selected by the US EPA to develop the synthesis report for the US part of the OCED eutrophication studies. Out of that work Lee and his associates developed empirical relationships between nutrient load and eutrophication response for more than 750 waterbodies worldwide, and demonstrated their predictive capability. Lee and Jones-Lee have published more than 100 papers and reports on excessive fertilization of waterbodies, many of which are available on their website, www.gfredlee.com in the "Excessive Fertilization" section located at <http://www.gfredlee.com/pexfert2.htm>.

Drs. Lee and Jones-Lee became involved in excessive fertilization issues of the Delta in 1989 while he held a Distinguished Professorship and she, an Associate Professorship, in Environmental Engineering at the New Jersey Institute of Technology. As part of a consulting activity devoted to water quality expected in proposed in-Delta water supply reservoirs, they

conducted a comprehensive review of the DWR and USGS nutrient data for the Delta and its tributaries. Based on their review and experience they concluded that the storage of Delta waters in a reservoir would lead to excessive growths of algae that would cause serious water quality problems for domestic water supply utilities. Subsequent studies have confirmed their initial conclusions on this issue.

In the early 1990s Lee and Jones-Lee were selected by the SJR DWSC DO TMDL Steering Committee and CALFED to serve as the Coordinating Principal Investigators for a two-year \$2-million dollar study of the low-DO problems in the SJR DWSC. Those problems are primarily caused by the excessive nutrient discharges in the SJR watershed that support the growth of algae that then die and decompose in the DWSC. The bacterial decomposition of algae leads to low DO in that channel.

Lee and Jones-Lee's papers and reports on issues of nutrients-related water quality issues in the Delta are available on their website in the Watershed Studies – San Joaquin River Delta subsection located at <http://www.gfredlee.com/psjriv2.htm>.

Additional information on Lee and Jones-Lee's qualifications to offer these comments is available at <http://www.gfredlee.com/exfert.htm>. They may be contacted to answer questions on these comments and issues.

Delta Nutrient-Related Water Quality Problems

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Review of Water Quality Problems in Sacramento / San
Joaquin Delta Related to Excessive Fertilization

Review of Ability to Relate Nutrient Loads to Water
Quality Problems

Presented at CALFED Science Conference, Sacramento, CA, October 24, 2008

Severe Water Quality Problems in Delta Caused by Excessive Nutrients

- Aquatic Plant Nutrients – Nitrogen & Phosphorus
- Excessive Discharges of Aquatic Plant Nutrients from
 - Urban Areas
 - Domestic Wastewaters
 - Stormwater Runoff
 - Agriculture
 - Stormwater Runoff
 - Tailwater
 - Subsurface Drain Discharges

CWEMF Delta Nutrient Water Quality Workshop

- CWEMF – California Water & Environmental Modeling Forum
 - Develops Workshops on Issues Related to Modeling Water Quality and Water Management
 - Drs. Lee and Jones-Lee Organized CWEMF Workshop to Highlight Water Quality Problems in Delta Caused by Excessive Nutrients
 - Lee Involved in Investigating & Developing Management Programs for Excessively Fertile Waterbodies in Many Parts of US & Other Countries since Early 1960s
 - Involved in Nutrient-Related Water Quality Issues in Delta since 1989
 - Workshop Held March 2008 in Sacramento
 - Program & PowerPoint Slides Available at:
<http://www.cwemf.org/workshops/NutrientLoadWrkshp.pdf>

Nutrient-Related Water Quality Problems in Delta



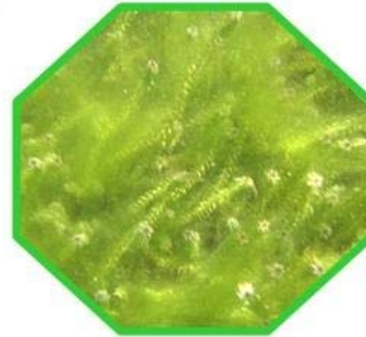
*Water Hyacinth
on Channel*



Tastes & Odors



*Algae-Caused Low
DO — Fish Kills*



Attached Algae

Domestic Water Supply Tastes & Odors

- Algae Release Chemicals That Impart Strong, Unpleasant Odors in Water Supply
 - Geosmin (Earthy Smell), and Others
 - Indicate Potential Public Health Concern for Consumers
 - Cause Public to Complain or Reject Water Supply as “Polluted”
 - Cause Water Utilities to Spend Money to Try to Remove Tastes & Odors

Need for Models to Develop Management Approaches

- Some Models Can Reliably Describe Relationships between Nutrient Discharges and the Algal Growth That Causes Water Quality Problems
- Demonstrated Predictive Capability of Model Crucial
- Reliable Models Can Help Evaluate
 - Type and Amount of Nutrient Control Needed to Manage Water Quality Problems
 - Water Quality Improvements That May Be Expected from Various Control Options

Modeling of Taste & Odor Production by Algae

- Can Effectively Quantitatively Relate (Model) Nutrient Loads to Planktonic Algal Biomass
- Studies by MWD of Southern CA Showed That Algae-Related Tastes & Odors in Waters from Delta Are Associated with Benthic Algae
 - Limited Ability to Reliably Model Relationships between Nutrient Concentrations/Loads and Growth of Benthic Algae-Caused Tastes & Odors

Need to Use Adaptive Management Approach

- Trial & Error to Evaluate Impact of Nutrient Control on Taste & Odor Problems

Toxicity of Bluegreen Algae

- Some Bluegreen Algae, at Some Times, Contain or Release Chemicals to Water That Are Toxic to Animals, Aquatic Life, People
- DWR Studies: Bluegreen Algae in Delta Release Chemicals That Cause Toxicity
 - Concentrations of Toxins < Those Known to Be Toxic to People & Aquatic Life
 - Needs Further Study & Monitoring

Aquatic Weed Problem in Delta

- Several Types of Aquatic Weeds Causing Water Quality Impairment
 - Water Hyacinth, Egeria, Others
 - Adversely Impact Recreation & Aquatic Habitat
 - CA Boating & Waterways Spends \$6-million/yr for Chemicals to Control Water Hyacinth & Egeria in Delta
- Excessive Water Weeds Caused by Excessive Nutrient Discharges to Tributaries & within Delta
 - Water Column & in Sediments

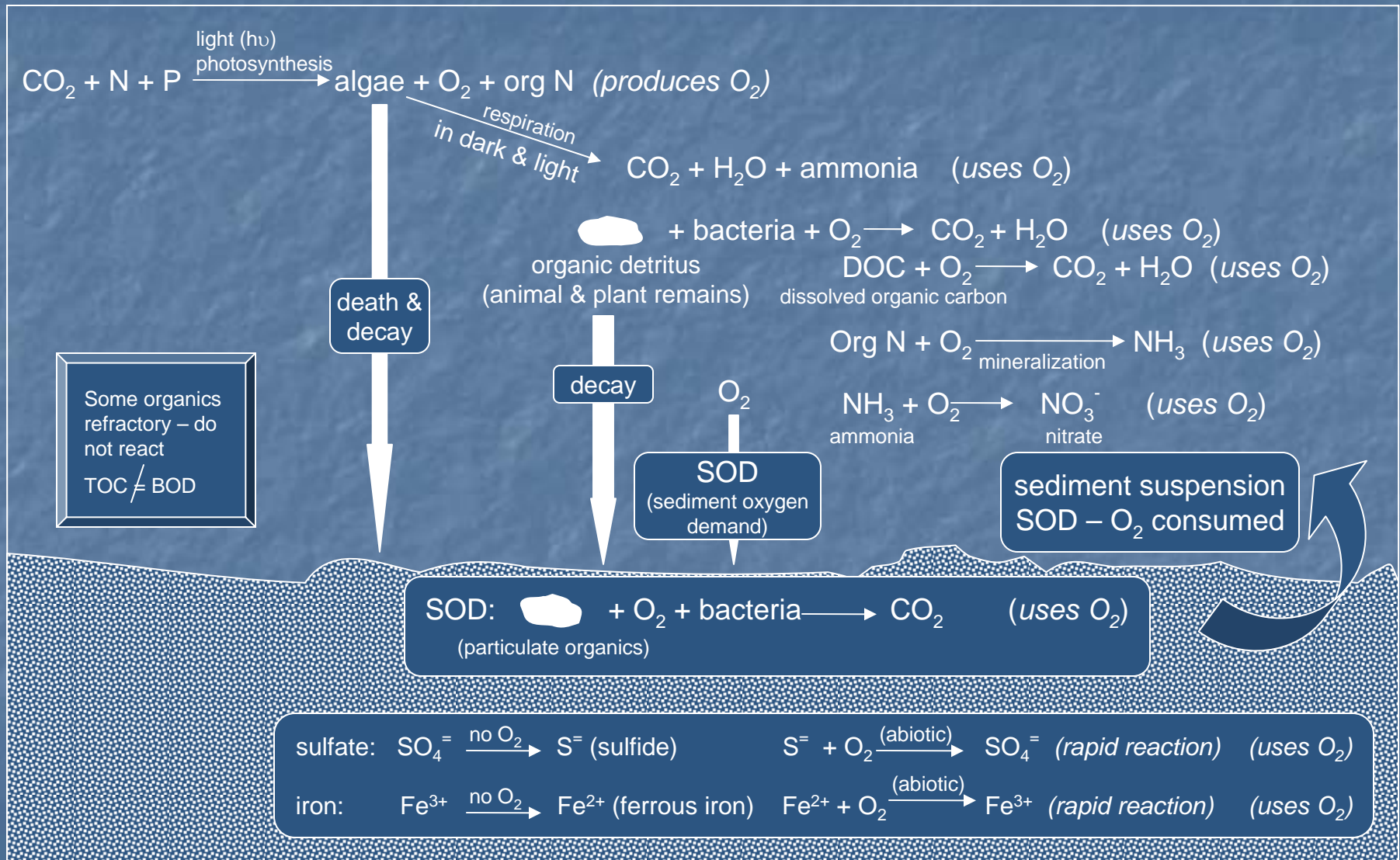
Modeling of Aquatic Weed Growth in Delta

- Quantitative Relationship between Nutrient Loads to Delta & Aquatic Weed Growth in Delta Poorly Understood
 - Difficult to Model
 - Adaptive Management Approach Needed with
 - Adequate Monitoring of Concentrations of Nutrients in Water & Sediments, and Aquatic Weed Biomass

Low-DO Problems in Delta

- Low-DO (Dissolved Oxygen) Problems in San Joaquin River (SJR) Deep Water Ship Channel (DWSC) near Port of Stockton
 - Adverse to Aquatic Life
 - Adverse to Home-Stream Migration of Chinook Salmon to SJR Watershed
 - Fish Kills in Some South Delta Channels
 - Adverse to Aquatic Life Habitat
- Low DO Caused by Bacterial Decomposition of Dead Algae That Develop in SJR & Delta
- Algal Growth Stimulated by Nutrients in Delta Tributaries & Delta

Algae & Organic Detritus as Sources of Oxygen Demand

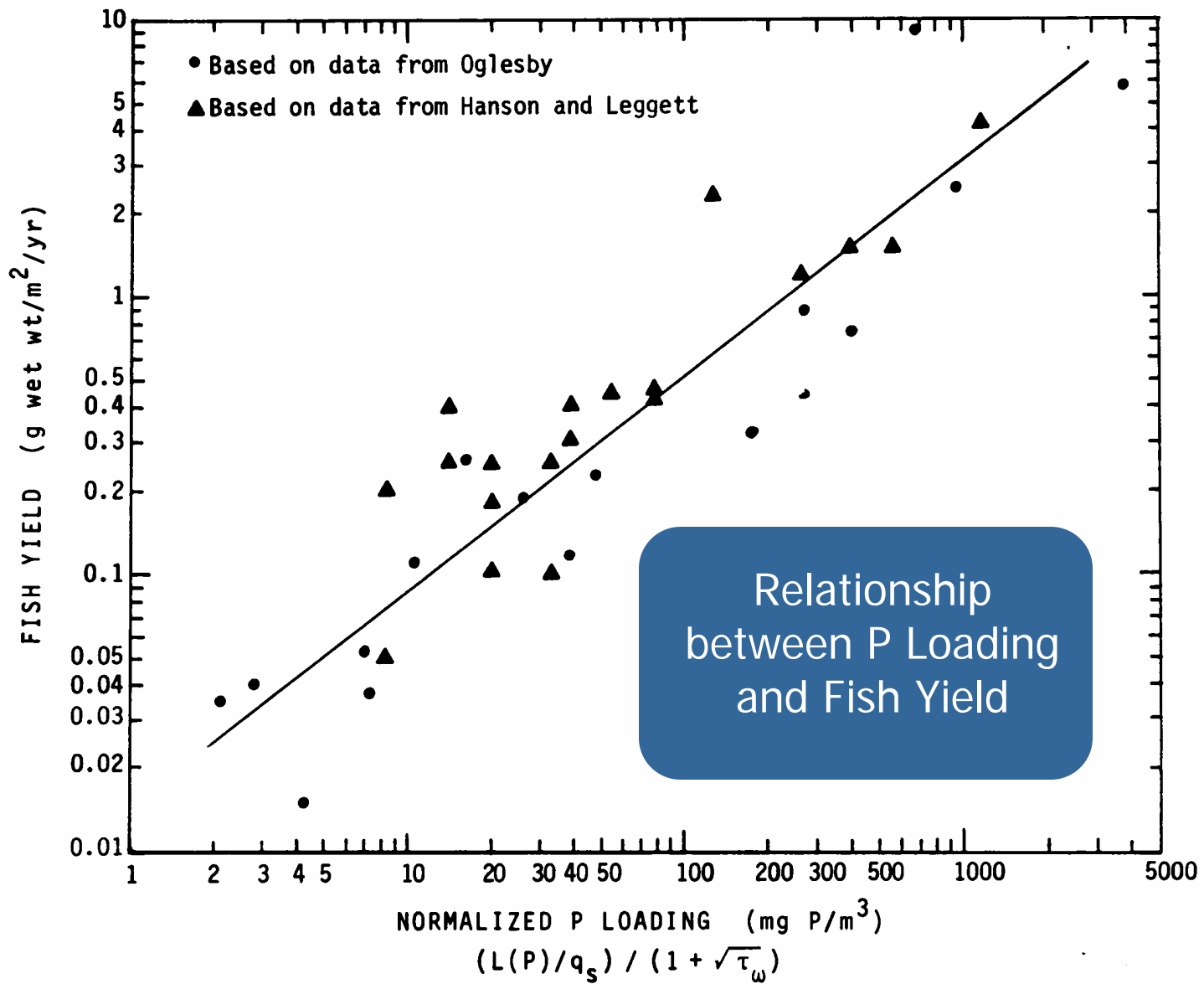


Control of Low DO

- Legislature Made \$35-million Available to Begin to Address Low-DO Problem in SJR DWSC
- Aeration of SJR DWSC to Control DO below Water Quality Objectives
 - Evaluated by DWR & CVRWQCB
- Control of Nutrients in SJR DWSC Watershed Not Likely Effective for Controlling Load to Algae to SJR DWSC That Leads to Low-DO Problem
 - Large Surplus of N & P in SJR Compared with Algal Needs
- Selective P Control May Help Reduce Algal Growth & Reduce Need for Aeration
 - Focus on Sources of Available P That Stimulate Algal Growth Leading to Low-DO in SJR DWSC
 - Don't Focus on Annual P Load
 - Much of Total P Load to SJR Doesn't Lead to Algal Growth Important to Low-DO Problem

Impact of Nutrients on Fish Production in Delta

- Amount of Fish That Develops in Waterbody Depends on Overall Trophic Status (Nutrient Concentrations) of Waterbody
 - More Nutrients → Greater Fish Production



Sacramento Regional Wastewater Treatment Plant Discharges of P

- In 1992 Sacramento Regional WWTP Reduced P Concentrations in Discharge to Sacramento River
- Van Nieuwenhuyse Found Subsequent Reduction in Planktonic Algae in North & Central Delta

Fish Production vs Nutrient-Caused Water Quality Problems

- Fish Production in Delta Limited by Available Nutrients for Planktonic Algal Food Web
- Nutrient Control in Delta Watershed from Ag & Urban Sources for Control of Nutrient-Caused Water Quality Problems in Delta
 - Will Adversely Affect Fish Production
- Must Balance Fish Production with Magnitude of Nutrient Related Water Quality Problems
- Need Reliable Models to Relate These Issues to Develop Appropriate Nutrient Management Programs

Control of Nutrient Sources in Delta

- Good Information Available on Cost of Controlling Nutrients in Domestic WWTP Discharges
- Limited Information on
 - Sources of Nutrients for and within the Delta
 - Ability to Control Nutrients at Ag Sources & Urban Stormwater Runoff
- Need Study of Nutrient Sources in Delta Areas
 - On Monthly Basis
 - To Relate Nutrient Loads to Water Quality Problems & Fish Production

Current Regulatory Agency Actions for Nutrient Control

- SWRCB Developing Water Quality Criteria for Nutrients
 - Based on Site-Specific Evaluation of Sources, Impact & Potential for Control
- CVRWQCB Developing Central Valley Drinking Water Policy
 - Includes Drinking Water Quality Problems Caused by Nutrients
 - Should Consider Cost-Effectiveness of Control of Nutrients at Sources (Ag & Urban) vs Cost for Control of Tastes & Odors at Drinking Water Treatment Plant

Overall

- Nutrients – Major Cause of Water Quality Problems in Delta
- Limited Understanding of Relationship between Nutrient Loads to Delta & Magnitude of Nutrient-Related Water Quality Problems in Delta
 - Needs Attention to Begin to Develop Effective Control Programs
 - Likely Require Adaptive Management Approach
 - Must Include Evaluation of Impact of Nutrient Control on Aquatic Food Web in Delta
 - Balance Nutrient Needs of Food Web with Control of Nutrient-Related Water Quality Problems

Further Information
Consult Website of
Drs. G. Fred Lee and Anne Jones-Lee



<http://www.gfredlee.com>