

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 Modeling 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

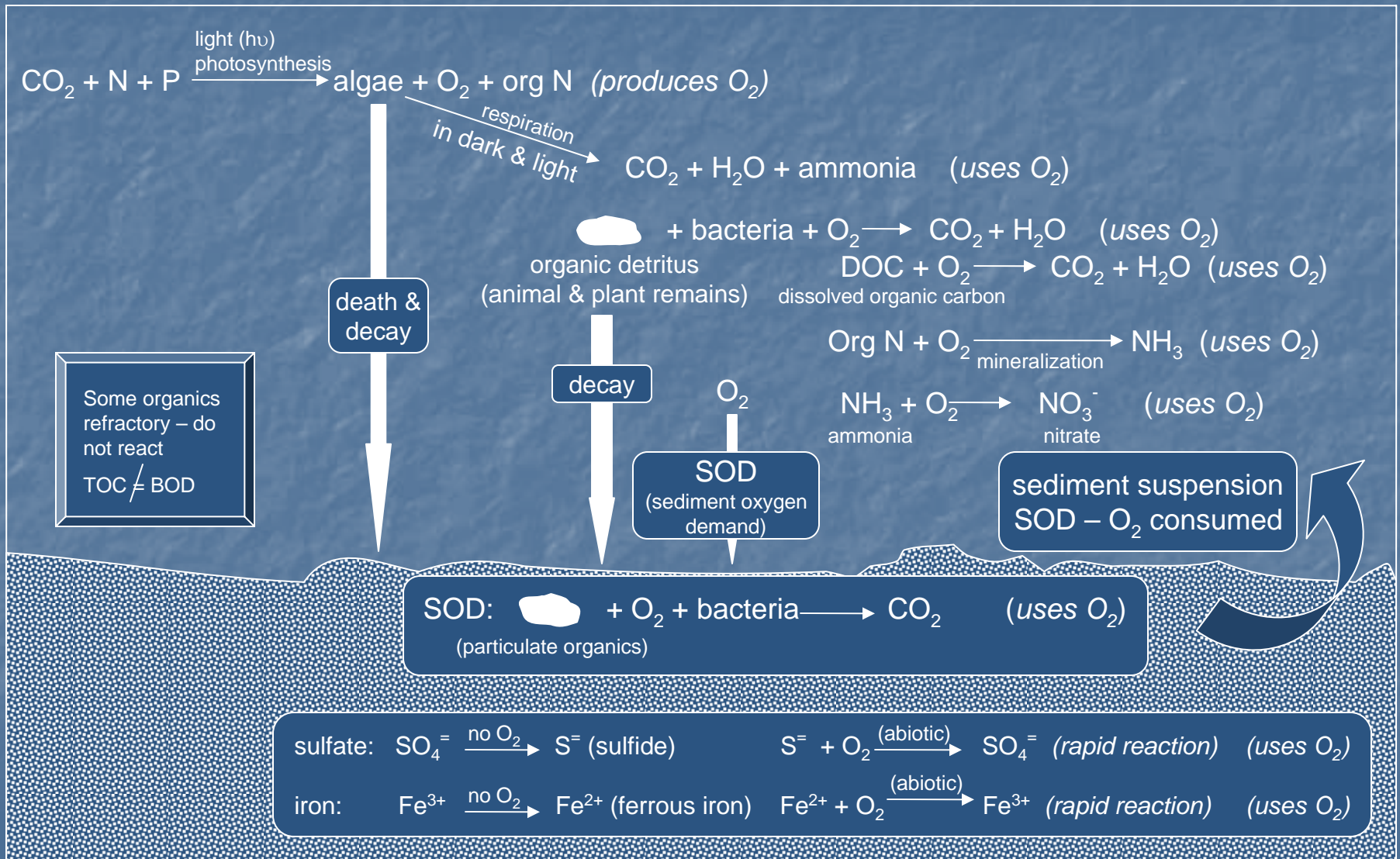
- Quantitative Relationship between Nutrient Loads to Delta & Aquatic Weed Growth in Delta Poorly Understood
 - Difficult to Model
 - Adaptive Management Approach Needed with
 - Adequate Monitoring of Concentrations of Nutrients in Water & Sediments, and Aquatic Weed Biomass

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 and Habitat
 - Adverse to Home-Stream Migration of Chinook Salmon to SJR Watershed
 - Fish Kills in Some South Delta Channels

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

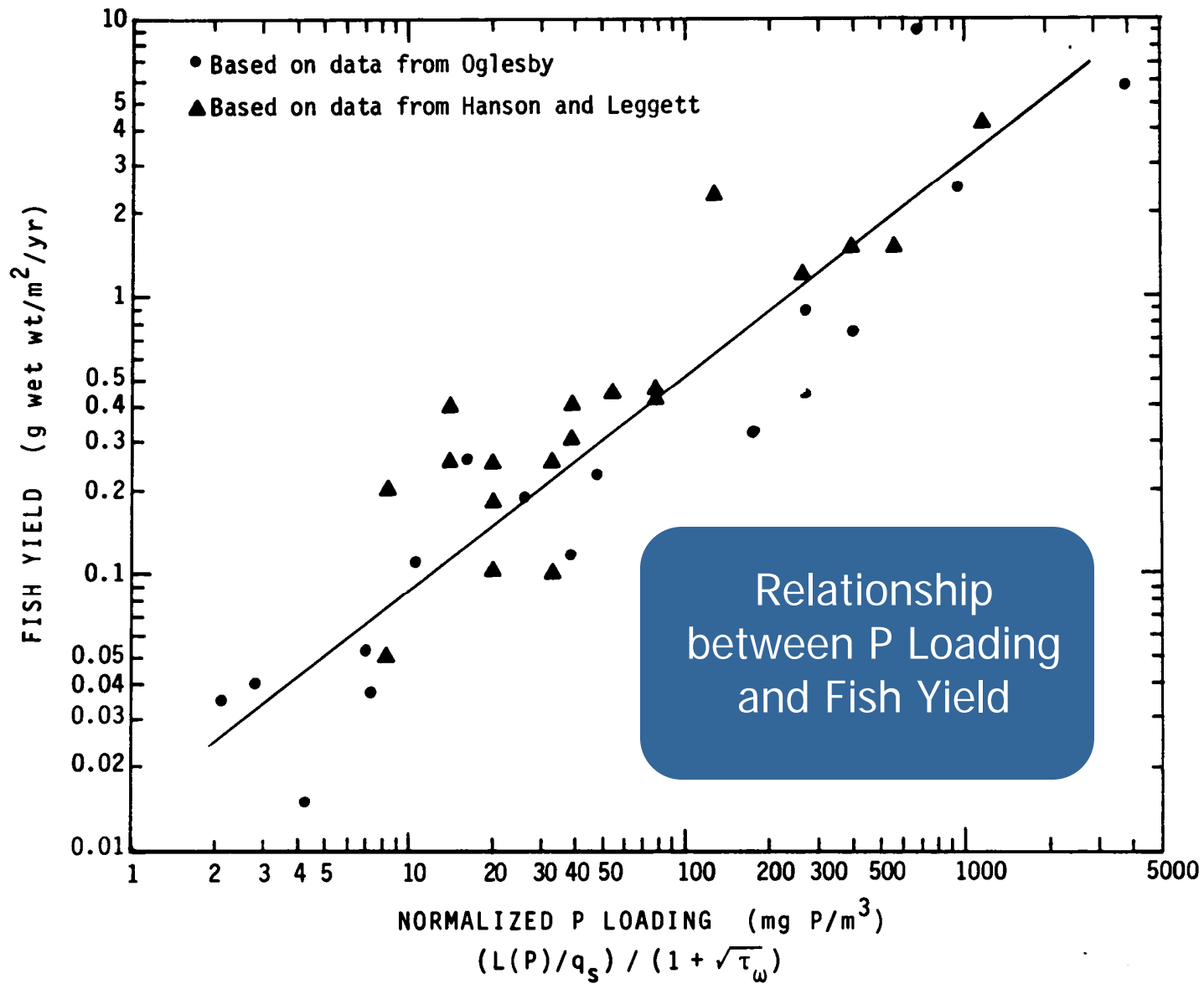


Control of Low DO

- 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>