

# 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



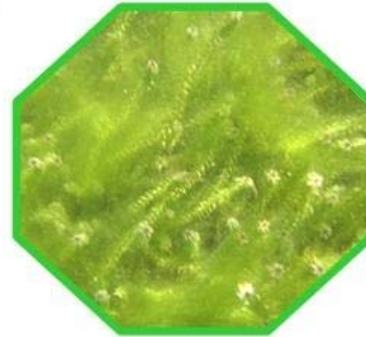
*Water Hyacinth  
on Channel*



*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

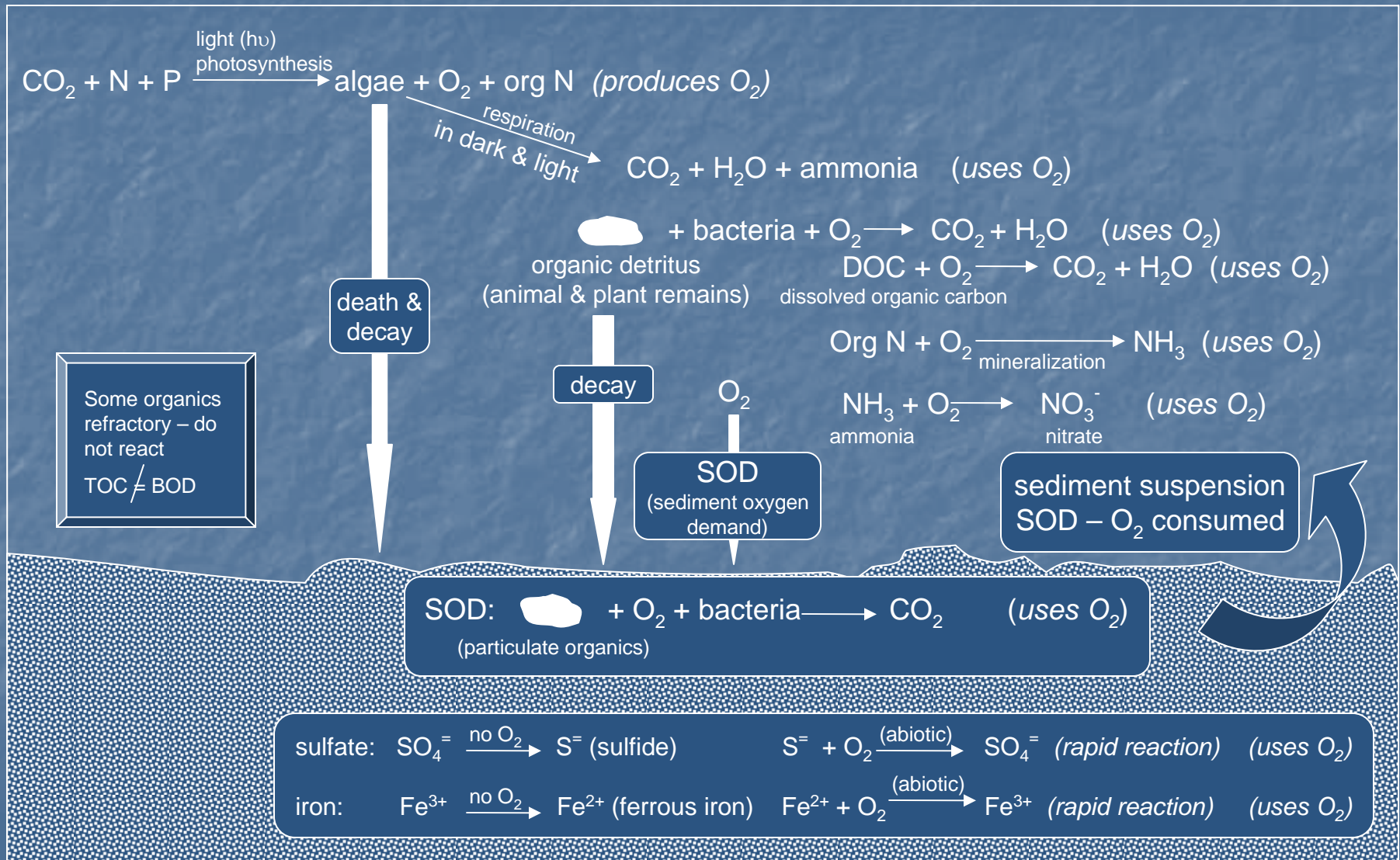
# Modeling of Aquatic Weed Growth in Delta

- 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

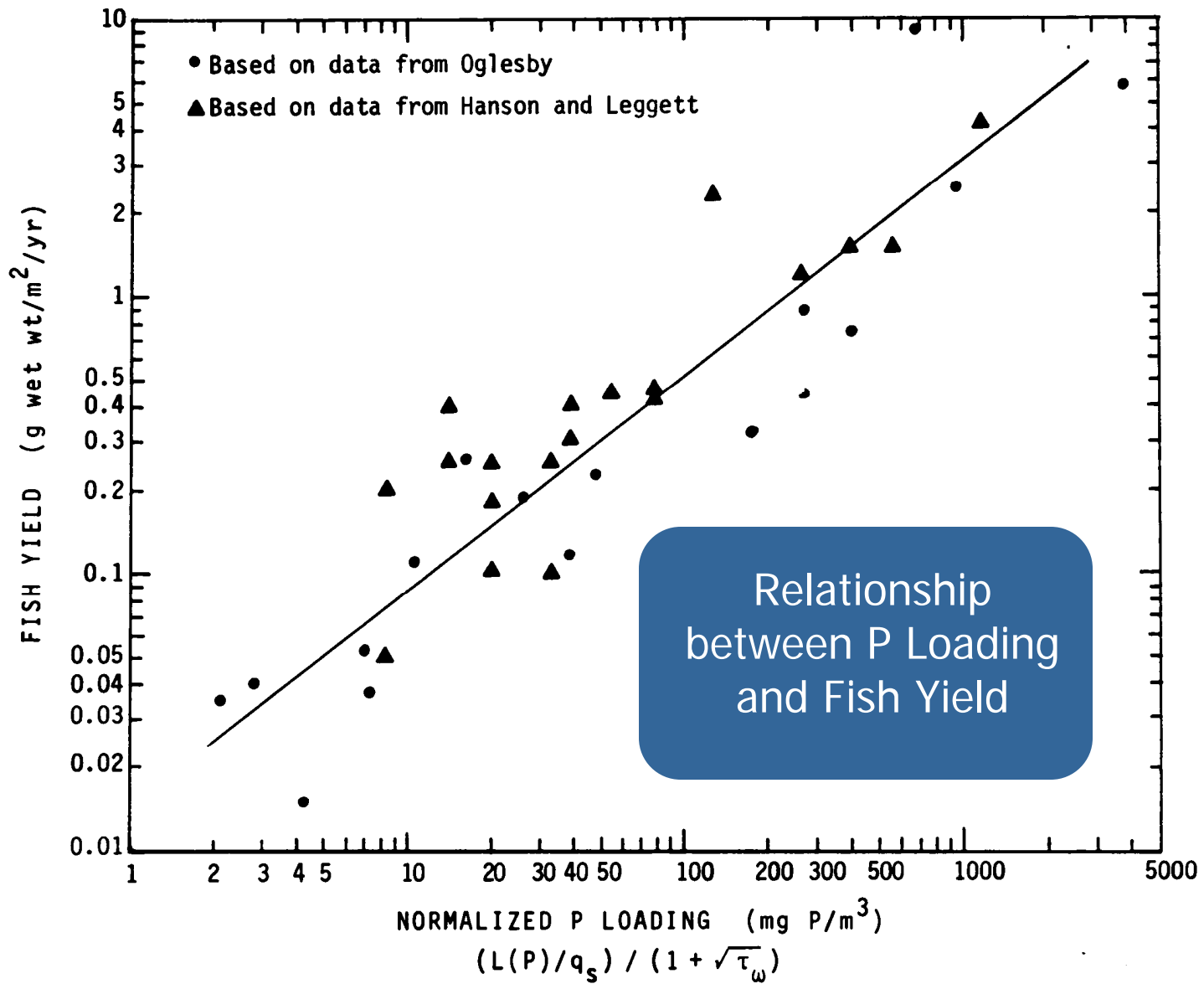


# Control of Low DO

- 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>**