

Background

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Delta Stewardship Council

Recommendation WQ R8

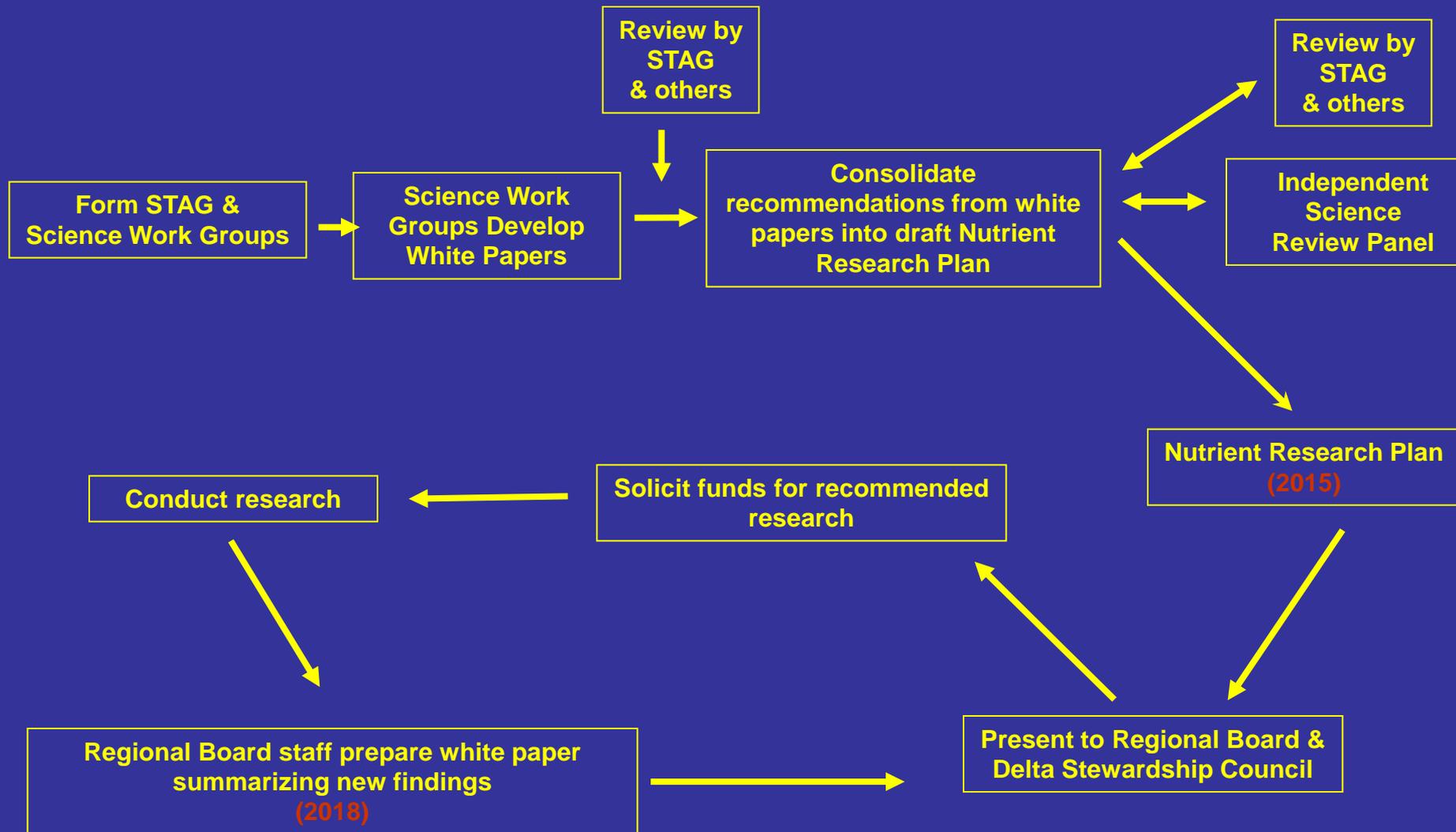
...the Central Valley Regional Water Quality Control Board should prepare and begin implementation of a study plan for the development of objectives for nutrients in the Delta ... by January 1, 2014. Studies needed for development of ... nutrient objectives should be completed by January 1, 2016. The Water Boards should adopt and begin implementation of nutrient objectives, either narrative or numeric, where appropriate... by January 1, 2018

Potential Nutrient Related Concerns

- **Increase in the abundance & distribution of macrophytes.**
- **Increase in the frequency & magnitude of cyanobacteria blooms.**
- **Decrease in abundance & shifts in algal species composition**
- **Low dissolved oxygen in back sloughs**

2014 Delta Strategic Plan

Steps & Schedule for Developing & Implementing the Nutrient Research Plan



Questions?

Additional Language for Charter

- To address drinking water and low dissolved oxygen in back sloughs, the following language is proposed to be inserted into the Charter [Section 5.0, 3rd paragraph]

The initial nutrient related work will focus on addressing concerns about ammonia, nutrient ratios, harmful algal blooms, non-native aquatic organisms and the development of robust computer modelling tools. The nutrient work has been restricted to these four topics because of limited Water Board staff resources. After completion of a Nutrient Research Plan for these topics, Water Board staff will organize, with input from the STAG, Science Work Groups for low dissolved oxygen in back sloughs and for the potential effect of nutrients on drinking water supplies. White papers and research recommendations for these two topics will be reviewed by the STAG and Independent Science Review Panel and amended into the Nutrient Research Plan.

Current STAG Roster

| Name | Organization | Representing | Position |
|------------------|--------------------------------------|-----------------------|-----------|
| Terrie Mitchell | Sacramento Regional Sanitation | POTWs | Primary |
| Debbie Webster | Central Valley Clean Water Assoc. | POTWs | Alternate |
| Dalia Fadl | City of Sacramento | MS4 | Primary |
| Kyle Ericson | City of Sacramento | MS4 | Alternate |
| Renee Pinel | Western Plant Health Assoc. | Irrigated Agriculture | Primary |
| Mary Junqueiro | Western Plant Health Assoc. | Irrigated Agriculture | Alternate |
| Kirk Wilbur | California Cattlemen | CAFOs | Primary |
| TBD | | CAFOs | Alternate |
| Lynda Smith | Met. Water District S CA | Water Supply | Primary |
| Rachel Pisor | CA DWR | Water Supply | Alternate |
| Elaine Archibald | CUWA | Drinking Water | Primary |
| TBD | | Drinking Water | Alternate |
| Paul Bedore | Port of Stockton | Waterways | Primary |
| Leandro Ramos | CA State Parks – Boating & Waterways | Waterways | Alternate |
| TBD | | Resource Management | Primary |
| TBD | | Resource Management | Alternate |
| Eddie Lucchesi | Mosquito and Vector Control Assoc. | Mosquito Abatement | Primary |
| David Smith | Mosquito and Vector Control Assoc. | Mosquito Abatement | Alternate |
| Jon Rosenfield | The Bay Institute | Env. Protection | Primary |
| Jennifer Clary | Clean Water Action | Env. Protection | Alternate |

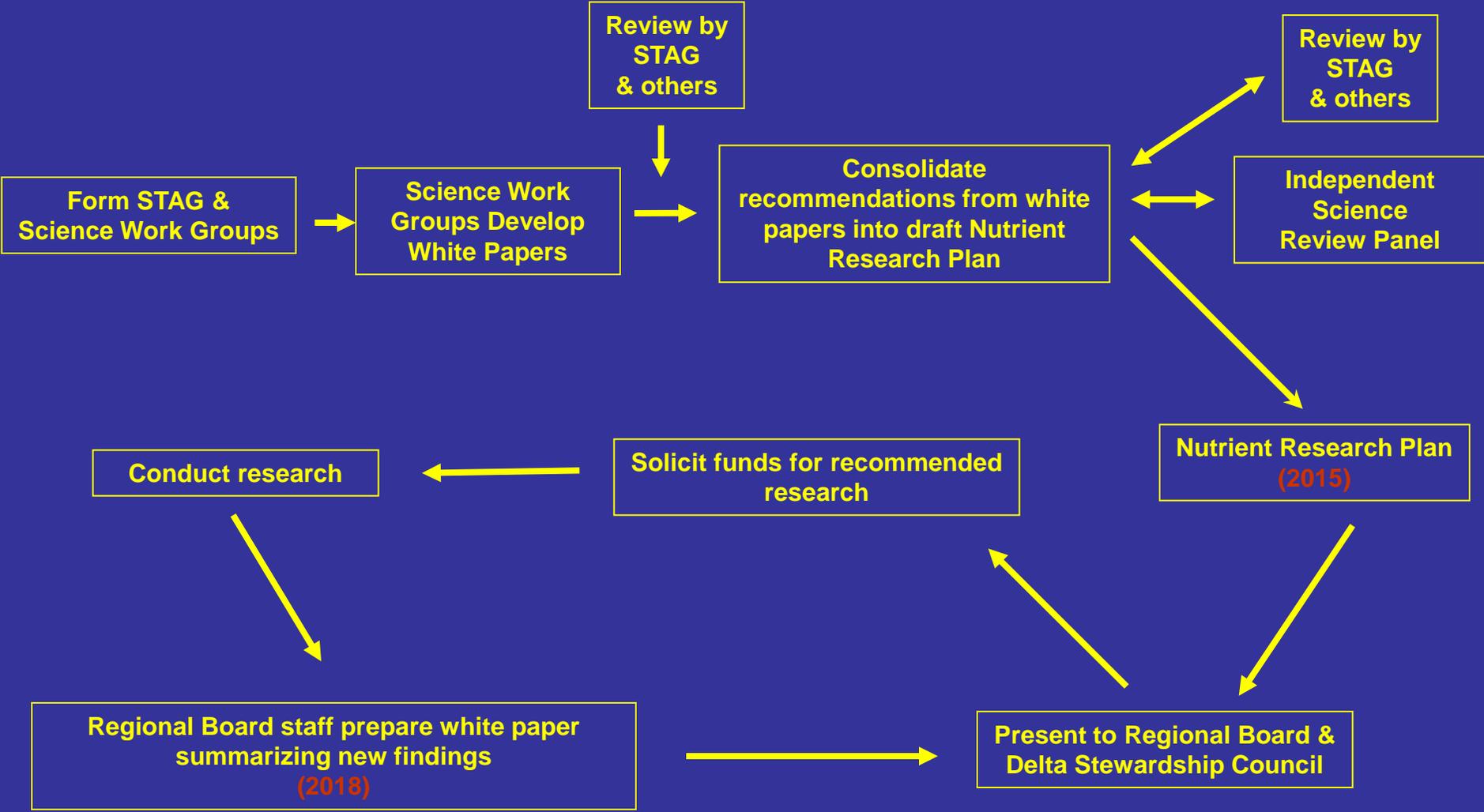
Science Work Groups

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Steps & Schedule for Developing & Implementing the Nutrient Research Plan



Potential Nutrient Related Concerns

Delta Stewardship Council

- Increase in the abundance & distribution of macrophytes.
- Increase in the frequency & magnitude of cyanobacteria blooms.
- Decrease in abundance & shifts in algal species composition
- Low dissolved oxygen in back sloughs

STAG

- Effect of nutrients on drinking water supplies.

Proposed Science Work Groups

Now

- Macrophyte Science Work Group
- Cyanobacteria Science Work Group
- Concentrations, forms and Ratios Science Work Group
- Modelling Science Work Group

Later

- Dissolved Oxygen in Back Sloughs
- Drinking Water Reservoir Issues

Questions for STAG

**Do you agree with the general approach that the Regional Board is taking?
How might it be improved?**

Do you agree with the approach of Phasing the research?

Macrophyte Science Work Group

Macrophyte Science Work Group

Problem: Increase in the abundance & distribution of Brazilian Waterweed & Water Hyacinth in Delta.

Question: Whether increase in macrophytes is the result of a long term change in nutrient loads and whether nutrient management might reduce their proliferation.

Contractor: Contract with Katharyn Boyer, San Francisco State University, to write white paper.

Science Work Group: Charge is to review the conclusions of white paper & prepare a prioritized list of recommendations for future research.

Potential list of individuals for Macrophyte Science Work Group

| Individual | Agency | Macrophyte Work Group |
|--------------------|--|-----------------------|
| Louise Conrad | Department of Water Resources | ? |
| Shruti Khanna | U C Davis | ? |
| Raymond Carruthers | USDA, Agricultural Research Service | ? |
| John Madsen | U C Davis/USDA, Agricultural Research Service | ? |
| Kathy Boyer | San Francisco State University | X |
| Martha Sutula | Southern California Coastal Water Research Project | X |
| Judy Drexler | U.S. Geological Survey | ? |
| John Durand | U C Davis | ? |
| Diana Engle | Larry Walker Associates | ? |

Key: X= Individual has agreed to participate in the work group. ?=individual has been identified as a potential candidate but has not yet been contacted.

Goals for first meeting

- **Introduce project, insure members understand commitment, time involved & final products**
- **Ask members whether they can recommend additional experts who might make significant contribution**
- **Dr. Boyer review white paper outline, including conceptual model, & ask for preliminary comments**

Goals for Second Meeting

Review and provide comments on white paper.

In particular determine:

- Whether the principal physical & biological factors that influence the abundance & distribution of invasive aquatic weeds been identified.
- Whether all peer reviewed & grey literature studies that evaluate the efficacy of nutrient management for decreasing the abundance & distribution of macrophytes have been reviewed.
- Whether the importance of nutrients versus other factors in promoting macrophyte abundance have been correctly evaluated.
- Whether the white paper findings are fully supported by the literature discussed in the paper & whether additional information exists that either supports or refutes the findings.
- Whether the prioritized list of recommendations to resolve outstanding nutrient management questions is appropriate & consistent with present information gaps in the Delta & elsewhere

Goals for third and final meeting

- Review changes that primary author has made to the white paper & to the prioritized list of recommendations for future research after receiving comments from the Science Work Group, STAG & State Board Independent Science Review Panel.
- Ascertain whether Science Work Group agrees with the overall conclusions & recommendations in white paper. Document disagreements.

Questions for the STAG

- Do you agree with the general approach & schedule being proposed to determine whether nutrient management might reduce the abundance and distribution of macrophytes?
- Do you agree with the proposed membership of the Macrophyte Science Work Group?
- Do you agree with the questions being asked of the Macrophyte Science Work Group?
- Do you think we are ready to convene the work group and move forward developing the white paper?
- Other?

Cyanobacteria Science Work Group

Cyanobacteria Science Work Group

Problem: Increase in the magnitude and frequency of cyanobacterial blooms in Delta.

Question: Whether increase in cyanobacteria is the result of a long term change in nutrient loads & whether nutrient management might reduce problem.

Contractor: Contract with Dr. Mine Berg, Applied Marine Science, to write white paper.

Science Work Group: Charge is to review the conclusions of white paper & prepare a prioritized list of recommendations for future research.

Potential list of individuals for Cyanobacteria Science Work Group

| Individual | Agency/Institution | Cyanobacteria Work Group |
|----------------|--|--------------------------|
| David Senn | San Francisco Estuary Institute | X |
| Thomas Jabusch | San Francisco Estuary Institute | X |
| Lisa Thompson | Sacramento Regional Combined Sanitation District | X |
| Tim Mussen | Sacramento Regional Combined Sanitation District | X |
| Alex Parker | California Maritime Academy | X |
| Stephanie Fong | State and Federal Contractors Water Authority | X |
| Peggy Lehman | Department of Water Resources | X |
| Rafael Kudela | U.C. Santa Cruz | ? |
| Mine Berg | Applied Marine Sciences | X |
| Martha Sutula | Southern California Coastal Water Research Project | X |

Key: X= Individual has agreed to participate in the work group. ?=individual has been identified as a potential candidate but has not yet been contacted.

Goals for first meeting

- **Introduce project, insure members understand commitment, time involved & final products**
- **Ask members whether they can recommend additional experts who might make significant contribution**
- **Dr. Mine Berg review white paper outline, including conceptual model, & ask for preliminary comments**

Goals for Second Meeting

Review and provide comments on white paper.

In particular determine:

- Whether the principal physical & biological factors promoting cyanobacteria blooms & toxin production in the Delta have been identified.
- Whether all peer reviewed & grey literature studies that evaluate the efficacy of nutrient management for decreasing the magnitude & frequency of cyanobacteria blooms & toxin formation have been reviewed & summarized.
- Whether the relative importance of nutrients versus other factors in promoting cyanobacteria abundance & toxin production have been correctly evaluated.
- Whether white paper findings are fully supported by the literature discussed in the paper & whether additional information exists that either supports or refutes the findings.
- Whether the prioritized list of recommendations to resolve outstanding nutrient management questions is appropriate & consistent with present information gaps in the Delta & elsewhere

Goals for third and final meeting

- Review changes that primary author has made to the white paper & to the prioritized list of recommendations for future research after receiving comments from the Science Work Group, STAG & State Board Independent Science Review Panel.
- Ascertain whether Science Work Group agrees with the overall conclusions & recommendations in white paper. Document disagreements.

Questions for the STAG

- **Do you agree with the general approach & schedule being proposed to determine whether nutrient management might reduce the frequency & abundance of cyanobacterial blooms?**
- **Do you agree with the proposed membership of the Cyanobacterial Science Work Group?**
- **Do you agree with the questions being asked of the Cyanobacterial Science Work Group?**
- **Do you think we are ready to convene the work group and move forward developing the white paper?**
- **Other???**

Concentration, Forms & Ratios Science Work Group

Concentration, Forms & Ratios Science Work Group

Problem: Whether long-term changes in nutrient concentrations, forms & ratios contribute to the observed decrease in algal abundance & shifts in algal species composition in the Delta.

Question: *Ammonia Paradox:* Whether elevated concentrations of ammonia are responsible for reducing phytoplankton biomass & shifting algal community composition.

Ecological Stoichiometry: Whether increases in the proportion of ammonia to nitrate & nitrogen to phosphorus reduces the competitive advantage of larger, fast growing algal forms, like diatoms, & selects for smaller, slower growing groups like flagellates, greens & cyanobacteria

Contractor: Regional Board staff will facilitate meetings & summarize discussions for white paper.

Science Work Group: Charge is to review the literature & presentations by research groups & determine which hypotheses are not supported & what additional studies need to be done to reconcile differences between research results.

Concentrations, Forms and Ratios Science Work Group members for evaluating Ammonia Paradox

| Individual | Agency | Work Group |
|------------------------|---|------------|
| David Senn | San Francisco Estuary Institute | X |
| Lisa Thompson | Sac Regional County Sanitation District | X |
| Tim Mussen | Sac Regional County Sanitation District | X |
| Stephanie Fong | State and Federal Contractors Water Authority | X |
| Frances Brewster | Santa Clara Valley Water District | X |
| Peggy Lehman | Department of Water Resources | X |
| Randy Dahlgren | U.C. Davis | X |
| Richard Connon | U.C. Davis | X |
| Erwin Van Nieuwenhuyse | U.S. Bureau of Reclamation | X |

Key: X = Individual agreed to participate in work group.

Potential presenters for evaluating the Ammonia Paradox hypothesis.

| Individual | Agency/Institution | Research Area of Interest | Participation |
|--------------------------------|-----------------------------|--|---------------|
| Jeff Miller | AquaScience | Laboratory NH4 algal dosing experiments | ? |
| Pat Glibbert | U. Maryland | Laboratory/mesocosm/field experiments with nutrients and algae | X |
| Dick Dugdale/Frances Wilkerson | Romberg Tiburon Center | Field N uptake experiments | X |
| Mine Berg | Applied Marine Sciences | Laboratory NH4 algal dosing experiments | X |
| Tamara Kraus | U.S. Geological Survey | Sacramento River Lagrangian study | ? |
| Alex Parker | California Maritime Academy | Mesocosm/Field Experiments | X |
| Richard Connon | U.C. Davis | NH4 Paradox Review paper | X |

Key: X= Individual has agreed to participate in the work group. ?=individual has been identified as a potential candidate but has not yet been contacted.

Goals for first meeting

- **Introduce project, insure members understand commitment, time involved & final products**
- **Ask members whether they can recommend additional experts who should be included in the Science Work Group**
- **Determine whether we have an inclusive list of all research groups evaluating the ammonia paradox hypothesis.**
- **Formulate a series of questions for each presenter to address as part of their presentations. The Science Work Group along with the other presenters would be asked to submit questions. These questions will be designed to elucidate the likely sources of differences in study results & further the group's goal of identifying additional needed research.**
- **Presenters will also be asked to submit in PDF format several weeks before the second meeting all papers that they intend to cite during their presentations. This library will be uploaded to the Regional Board web site and made available for all to review before the meeting.**

Goals for Second Meeting

- The purpose for the second session is to evaluate the evidence for and against the NH₄ paradox.
- Each presenter would make a presentation summarizing their findings & discussing how their findings support or refute those in the published literature. Presenters will also answer specific questions previously forwarded to them by the work group & by each other.
- The Science Work Group, other presenters & the STAG may question each presenter to try and determine the reason for the differing ammonia paradox results.
- The Science Work Group would then meet to review & discuss the presentations & papers. The group will determine whether there is sufficient information to conclude that the ammonia paradox is or is not occurring in the Delta. The group will also recommend studies to help reconcile the different ammonia paradox study results and, if needed, to provide more conclusive evidence for and against the ammonia paradox hypothesis.
- Board staff will summarize the discussion & conclusions of the work group and forward them to the presenters and Science Work Group to insure we have correctly captured the presentations and discussions. These would then be made available for review by the STAG

Ecological Stoichiometry

Do not propose to hold the Ecological Stoichiometry meetings at this time.

Questions for the STAG

- Do you agree with the general approach for conducting the ammonia paradox meetings?
- Do you agree with the proposed membership for the ammonia paradox Science Work Group?
- Do you know other researchers working on the ammonia paradox hypothesis that should be invited to make a presentation?
- How should we handle Richard Connon? Allow him to make a presentation and serve on the Science Work Group?
- Do you agree with the proposal to hold off on evaluating the Ecological Stoichiometry hypothesis until after March?
- Do you think we are ready to convene the work group and move forward developing the ammonia paradox white paper?
- Other???

Modelling Science Work Group

Modelling Science Work Group

Problem: White papers & associated research will provide valuable information on whether ambient nutrient concentrations in the Delta contribute to present problems & whether nutrient management might remedy them.

Issue: However, these one dimensional nutrient centric results cannot provide a holistic understanding of the effect of nutrient loads acting in combination with other physical & environmental factors on water quality & food webs in the Delta. Only a robust hydrodynamic model that is linked to a suite of environmental modules can accomplish this.

Science Work Group: Charge is to provide advice on model selection criteria & on the characteristics of the institution(s) where the model & water quality modules would be housed. The Group will not recommend the preferred suite of models nor the institution responsible for maintaining the model.

Contractor: San Francisco Estuary Institute & Regional Board staff will summarize deliberations & recommendations of Science Work Group for the white paper.

Potential list of Individuals for the Modeling Science Work Group

| Individual | Agency | Modeling Work Group |
|-----------------|--|---------------------|
| David Senn | San Francisco Estuary Institute | X |
| Joe Domagalski | US Geological Survey | X |
| Chris Enright | Delta Stewardship Council | X |
| Lisa Thompson | Sacramento Regional County Sanitation District | X |
| Bill Fleenor | UC Davis | ? |
| Phil Trowbridge | San Francisco Estuary Institute | X |
| Edward Gross | Resource Management Associates | ? |
| Michael Deas | Watercourse Engineering, Inc | ? |
| Frances Chung | Department of Water Resources | ? |
| Lisa Lucas | U.S. Geological Survey | ? |

Key: X= Individual has agreed to participate in the work group. ?=individual has been identified as a potential candidate but has not yet been contacted.

Modelling Science Work Group Leader

Role of Group Leader would be to help structure subsequent meeting(s) to provide advice on model selection criteria, characteristics of the institution likely to host the model and phasing of model development.

Goals for first meeting

- **Introduce project, insure members understand commitment, time involved & final products**
- **Ask members whether they can recommend additional experts who might make significant contributions**
- **Review questions submitted by other Science Work Groups, STAG & Modelling Work Group. The intent is that these questions will help inform the suite of models needed.**
- **SFEI and Regional Board staff will develop and present a preliminary conceptual model of the hydrodynamic platform, water quality modules and how they might interact. Solicit input from Work Group on how to revise conceptual model.**

Preliminary Modelling Questions

Short-Term Nutrient Related Questions

- 1 What are the main sources and loads of nutrients to the Delta now? How are they transformed seasonally and spatially in the system?
- 2 What will be the main source of nutrients in the Delta after all permitted NPDES upgrades have been implemented? What will be the new concentrations seasonally and spatially in the system?
- 3 How will permitted reductions in nutrient loads from NPDES & agriculture change algal biomass and algal species composition seasonally in different areas of the Delta?
- 4 How will permitted reductions in nutrient loads from NPDES & agriculture change the distribution and abundance of macrophytes in different areas of the Delta?
- 5 How will permitted reduction in nutrient loads from NPDES & agriculture change the magnitude and frequency of cyanobacterial blooms in different areas of the Delta?

Long-Term Nutrient Related Questions

- 1 How will warmer water temperatures and increasing residence time affect the magnitude and frequency of summer cyanobacterial blooms?
- 2 How will changes in Delta hydrology (new diversion points, changes in the timing and magnitude of river flow, changing residence time) alter nutrient processing, algal biomass and algal species composition in the Delta?
- 3 What is the relative importance of nutrient loads, grazing, light limitation and river flow on algal biomass and algal species composition in the Delta? What affect would a range of nutrient load management options have on algal biomass and species composition?
4. What are the main factors affecting the abundance and distribution of macrophytes in the Delta. How is macrophyte abundance predicted to change in the future as a results of changes in various factors?

Goals for Second Meeting

- **Advice on model selection criteria**
- **Characteristics of the institution likely to host the model**
- **Phasing of model development.**

Desirable criteria for the linked hydrodynamic water quality modules.

- **Public domain, peer reviewed, open source**
- **Model successfully employed elsewhere**
- **Compatible with Cascade II and other water quality modules selected by the San Francisco Regional Board for use in Suisun and San Pablo Bays.**
- **Calibrated hydrodynamic and water quality model for the Delta**
- **Model training available locally for end users**
- **Water quality models include modules for nutrients, water temperature, multiple algal species (including diatom and cyanobacteria), sediment transport, light penetration, vertical mixing, macrophyte production and zooplankton and clam grazing**
- **Spatial scalability—model can be started at a simple, coarse grained, large-cell version, with finer scale resolution and complexity added as the need arises and data allow.**
- **Temporal scalability—model can accommodate time scales from hourly to decadal.**

Questions for the STAG

- Do you agree with the charge to the modelling work group?
- Do you agree with the proposed membership of the Group?
- Do you have suggestions on a group leader?
- Do you agree with the questions being asked of the modelling group? Do you have additional questions?
- Can you recommend other important criteria for the final group of models to have?
- Do you think we are ready to convene the group and move forward developing the white paper?
- Other???

Thanks!