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Non-Profit Law and Science for Global Resource Solutions

TECHNICAL MEMORANDUM #3

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FROM: JOHN CAIN, NATURAL HERITAGE INSTITUTE

SUBJECT: ANALYSIS OF AN ADAPTIVE MANAGEMENT FRAMEWORK TO THE FLOODED ISLAND PRE-FEASIBILITY STUDY

DATE: REVISED APRIL 24, 2006

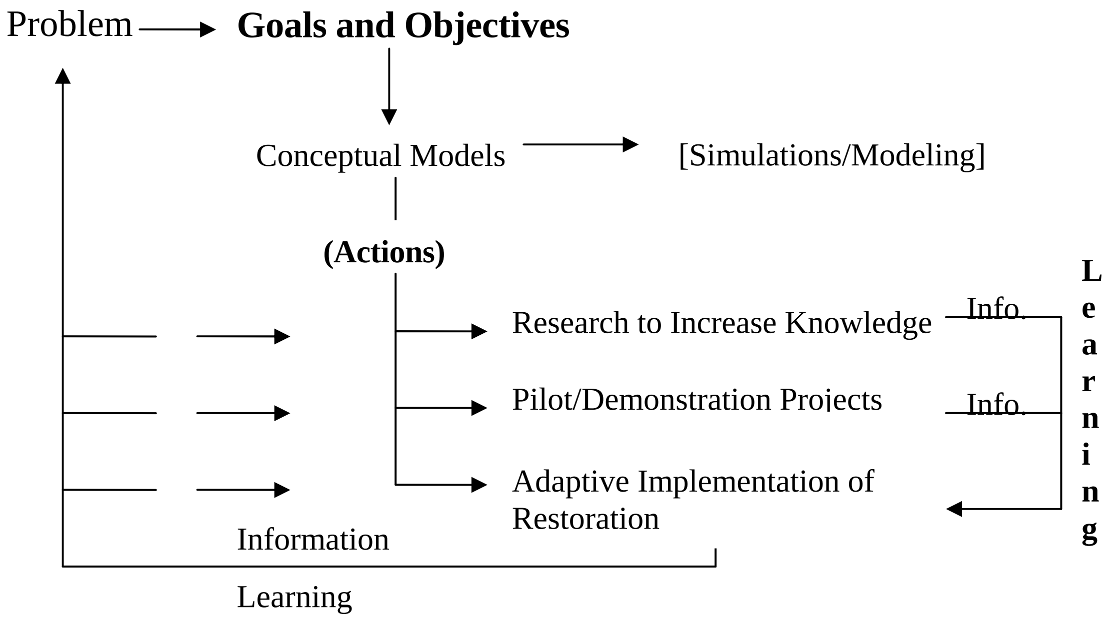
Purpose

This memo is intended to characterize the status of the project relative to the adaptive management framework outlined by the CALFED Science Board. This analysis is intended to provide focus for subsequent phases of the project including additional feasibility analyses as well as design and implementation of a pilot project.

The adaptive management ladder diagram (figure 1) provides a useful framework for clarifying and refocusing project planning and implementation efforts as a project evolves. The diagram illustrates that the adaptive management planning process is necessarily an iterative process. Through development of numerical models, data collection, pilot projects, and monitoring, managers learn more about the nature of the problem they are trying to solve, which often requires fine tuning or revisiting all aspects of their planning and analysis. As depicted in the diagram, this even involves revisiting the problem statement or planning objectives. Revisiting the problem statement or objectives does not mean that they were poorly crafted in the first place. Rather it is an unavoidable result of the considerable uncertainty associated with solving complex environmental problems – precisely the kind of problems adaptive management is designed to address.

Delta hydrodynamics and the flooded islands problem certainly are an example of a complex process that shapes an ecosystem, is continually changing, and insufficiently understood. The Flooded Islands Baseline Report, Pre-Feasibility Study, and technical reviews generated useful information and insights. This memo is an attempt to reexamine the core elements of the Pre-Feasibility Study within the context of the adaptive management framework (figure 1) in the hopes of guiding development of subsequent planning and pilot project implementation.

Figure 1: Framework for Adaptive Management Planning**.**



Summary

Problem Statement: More detail regarding the location and timing of elevated salinity problems at the drinking water diversion is needed to guide design of salinity reduction components. More emphasis should be placed on the ecological and recreation problems associated with the dominance of egeria.

Measurable Objectives: Specific quantifiable measures of salinity reduction are necessary to guide alternative design and cost benefit analysis. There are many potential measures, but end users need to help identify the measures most important to them. These measures should specify constituent, timing, location, and statistical metric (eg. average, peak, total). Egeria control or reduction should be identified as a discrete ecosystem and recreation objective.

Conceptual Models: More explanation is necessary for justifying the focus on constraining tidal excursion at Franks Tract with gates rather than using passive approaches to manipulate hydrodynamic processes at Franks Tract or Big Break in a manner that reduces salinity at the drinking water diversions.

Numerical Modeling: Additional fine-tuning and data collection is necessary to better calibrate the model at several specific but important locations. Improving calibration for multiple year classes under a range of water management operations would improve confidence in the models ability to predict salinity reduction benefits under a broader range of conditions.

Field Research: Additional hydrodynamic data from several stations around Franks Tract is needed to better calibrate the numerical model. Data regarding the depth and character of the Franks Tract bottom is needed to evaluate recreation and restoration options.

Pilot Projects: Improved model calibration and modeling of multiple year classes under varying water year types is necessary to better identify a preferred alternative and pilot project. A pilot project should be designed to test the model results as well as provide some incremental level of benefit.

Problem Statement

The problem statement and corresponding study consists of four components – water quality, ecosystem function, recreational deficiencies, and flooding concerns. These components are summarized below:

- *Water Quality:* Flooded islands alter delta hydrodynamics, which either increases salinity levels in delta water diversion facilities or requires increased delta outflows to meet water quality regulations.

- *Ecosystem:* Like most of the Delta, flooded islands were once tidal marsh habitat for a variety of now declining native species and now are artificial, homogenous environments that harbor exotic species at the expense of native species.

- *Recreation:* Flooded islands are important recreational resources for boaters and anglers, but these areas have not been adequately developed or managed to meet recreational needs.

- *Flood Control:* The large wind fetch across flooded islands generates wind waves action that disrupts docks and marinas and threatens to erode levee banks of nearby islands.

With information and insights derived from the pre-feasibility study effort we can now add, or realize that we need to add, quite a bit of detail to these components and in some cases may need to totally rearticulate the problem.

<u>Water Quality</u>

The general water quality problem has not changed, but a more specific definition of the problem is necessary to design a solution. In particular, more information is needed about where and when salinity is a problem for water diversions.

- Are elevated salinity levels a problem in all summer and fall months in all years, or mostly just a problem during the fall months of dry years?
- Are elevated salinity levels a similar problem at all intake locations or does the magnitude and timing vary significantly at different locations?

- Are elevated salinity problems a significant problem for all end users or is it mostly a problem for end users that have no other drinking water alternatives (for blending or substitution)?
- Is salinity the problem or is are water supply carriage losses associated with meeting delta outflow or water quality criteria the larger problem?

<u>Ecosystem</u>

Understanding of the ecosystem problem has evolved considerably since the pre-feasibility project was initially proposed. Research has shed new light on the ecological processes shaping flooded islands and this has resulted in both the identification of new problems as well as skepticism that previously identified solution strategies were likely to succeed. Research on the foodweb and nutrient dynamics of flooded islands (Lucas, 2002) suggests that flooded islands could significantly affect food resources for pelagic fish species, either positively or negatively depending on the configuration, hydrodynamic, and community ecology of the particular flooded island. Furthermore, research of vestigal or restored tidal marshes suggest that exotic species, particularly egeria, dominate those environments casting doubt that marsh restoration would cost effectively reverse the decline of native species (Simenstad et al, 2000). Finally, the feasibility study revealed that it would be prohibitively expensive to restore entire flooded islands to tidal marsh and that such an effort may not have any salinity reduction benefit.

Simply creating small patches of marsh or multiple marsh islands would probably not improve conditions for native fish species, particularly if those restored areas were surrounded by egeria or if the increased primary productivity generated by these areas were consumed by Asian clams. A lack of habitat heterogeneity may still be the problem, but not because of the lack of island marshes but rather due to the dominance of a few exotic species. This change in emphasis could profoundly reshape the solution space.

New information on marsh remnants suggest that it is no longer reasonable to assume that construction of marsh islands to increase habitat diversity would control or limit the dominance of exotics (Brown, 2003). Yet, restoration of small marsh islands would probably benefit birds and other native species, may boost ecological productivity for all species, and large scale restorations may recreate processes and conditions where native species have a competitive advantage. Irregardless of the effectiveness of marsh restoration, it is clear that marsh restoration alone will not control dominant exotics such as egeria densa.

<u>Recreation</u>

The dominant role of egeria has also reshaped the nature of the recreation problem. Huge masses of egeria densa limit nearly all aspects of boating, fishing, and shoreline access. Creation of amenities, such as islands and beaches, could enhance recreational opportunities, but only if they are not surrounded by beds of egeria densa.

MEASUREABLE OBJECTIVES

Project objectives are often only generally stated during the feasibility analysis phase, but as the analysis unfolds planners are increasingly able to provide more specific detail about the problem they are attempting to rectify and the objectives they are trying to achieve. Technical memorandum #2 describes the objectives and how they were revised during the planning process to incorporate new information. These objectives and the associated revisions are listed below.

1. Evaluate the feasibility of habitat diversification approaches for Lower Sherman Lake, Big Break, and Franks Tract and adjacent areas with the objectives of restoring ecosystem values, improving water quality conditions for water supply, and enhancing recreation and other social values at one or more of the flooded islands.

2. Develop and evaluate innovative and cost-effective Delta tidal marsh restoration concepts that re-create the dendritic channels or other desirable environmental conditions and provide ecological benefits for native plants, fish, and wildlife, and impede the success of undesirable invasive, nonnative fish and aquatic plants.

3. Evaluate cost-effective restoration and modification of shoreline levees and adjacent channels ~~with strategically located openings,~~ ~~to beneficially alter the salt-trapping and mixing characteristics of~~ to one or more of the flooded islands to improve water quality in the central and south Delta. ~~while retaining tidal flow to the island interiors~~.

4. Achieve ~~concurrent~~ resource benefits ~~for the three flooded islands~~, ~~including~~ or maintain existing, desirable characteristics related to recreation, aesthetics, and flood control at the three flooded islands.

These objectives were suitable for guiding the first phase of pre-feasibility analysis, but specifying more detailed objectives is necessary to guide subsequent feasibility analyses and planning. These specifics are needed to:

1. Design alternatives targeted at specific objectives.
2. Evaluate the merits of one alternative over another.
3. Evaluate the cost benefit of each alternative
4. Identify the primary beneficiaries of each alternative.

Water Quality Objectives

What measures should we use to define water quality objectives? Which types of salinity reduction benefits have the highest economic value? Based on modeling analysis, it appears likely that modifications to Franks Tract will reduce salinity at the Delta drinking water diversions, but it is unclear whether the benefits of modifying Franks Tract warrants the considerable costs involved. The value of salinity reductions presumably varies depending on the diversion location, the season and year type, and the ultimate end use. Simply aiming for a reduction in EC at various drinking water diversion points is not focused enough to promise high value benefits.

It will be difficult to adequately characterize the benefits of modifying Franks Tract until we have better characterized the relative and absolute value of various salinity reduction parameters (season, location, year type, etc.). It will be similarly difficult to determine the best alternative for reconfiguring Franks Tract without a rough understanding of the relative value of different salinity reduction parameters and how various alternatives perform in each parameter category. For example,

- Is it economically more valuable to reduce salinity in the late fall of dry years at Cliffton Court than it is to reduce salinity during all summer and fall months of normal years at Rock Slough?
- Is it more important to craft an alternative that maximizes salinity reduction in dry years than one that performs better in normal years?
- Is it more important to reduce total salt loads than to reduce peak salinity levels? Is total pounds of salt exported during the water year a more effective measure than peak EC.
- Are salinity levels the problem or is the problem water supply "carriage losses" associated with delta outflow requirements? If both, perhaps maximizing ratio of total water exported to pounds of salt exported is the most decisive measure.
- What are the water quality benefits under various operation scenarios for the Delta Cross Channel, South Delta Barriers, Environmental Water Account, etc. The Pre-Feasibility Study only modeled the relative various alternatives under the assumption that water management operations are identical to 2002 conditions. Before spending millions of dollars, water users and planners would want to determine the relative benefits of different alternatives under more likely future water management scenarios.

<u>Ecosystem Objectives</u>
The ecosystem objectives may need to be revised to reflect new information on flooded islands, their role in the primary productivity of the Delta, and the dominant role that exotic species (egeria densa and asian clams) plays in flooded island ecology. Perhaps the objective should be to eliminate or minimize egeria densa, but there are no proven methods for doing so. If it was possible to greatly limit egeria, how would that change the ecology of flooded islands and their value for native species? Modifying the flooded islands to increase the food supply available to the Delta's pelagic fish would be a very significant benefit, but the suite of processes that control primary and secondary productivity on flooded islands are not adequately understood to inform the alternative design process.

Due to the significant cost of creating large areas of tidal marsh and the level of uncertainty regarding how tidal marsh may affect water quality, it may be worthwhile to refine this goal. The size of the restored marsh area included in the feasibility alternatives study was largely dictated by fill and cost constraints. If creation and configuration of tidal marsh in flooded islands were sufficient to create large water quality benefits, then it would be easier to justify the expense of creating large areas of tidal marsh. Based on the assumption, perhaps incorrect, that configuration of tidal marsh in Franks Tract would not reduce EC at the drinking water diversions, tidal marsh was configured primarily along the deep-water channels of False River to minimize egeria impacts and maximize fish access.

Conceptual Model

The conceptual model, described in figure 1-7 of the pre-feasibility report, assumes that an integrated package of actions will provide water quality, ecosystem, and recreational benefits. Ideally, each action furthers each objective. The pre-feasibility report alternatives strive for this integration, but do not always achieve it. For example, in many cases marsh elements do not serve water quality objectives and water quality gates are unrelated to ecosystem restoration elements. The project was initially conceived with the belief that it might be possible to reconfigure the flooded islands (eg. create marsh, levee and island habitat) in a manner that would advance recreation and water quality objectives. Due to assumptions about what hydrodynamic processes drive water quality concerns, however, the project ended up focusing on gates to control tidal excursion and then added in ecosystem and recreational amenities.

A number of different processes that control salinity patterns in the Delta are described in the Conceptual Alternatives Report, but the final alternatives are primarily focused on constraining the tidal excursion to prevent salt water from being pushed into the freshwater corridor of the Delta. The focus on tidal excursion into the fresh water corridor resulted in a focus on Franks Tract, since it is located between the freshwater corridor (Old River/Middle River) and the easternmost extent of salt transport by tidal excursion. Focus on tidal excursion into the fresh water corridor also resulted in dismissing the potential to reconfigure Big Break and Sherman Lake for water quality benefits. A more thorough conceptual model of the processes controlling net salinity transport from west to east might have resulted in a different set of alternatives – ones designed to reduce mixing, attenuate tidal energy, or otherwise reduce the net transport of salt from west to east. Constraining tidal excursion is the most obvious approach, and probably the most promising, but other approaches have not been adequately fleshed out conceptually or operationally.

Lastly, the potential to reduce salinity at the drinking water diversions by reconfiguring flooded islands, must be viewed within the context of all the other opportunities to reduce salinity at the diversions such as modifying operations of the Delta Cross Channel, reducing salinity emanating from the San Joaquin, the South Delta Barriers, and moving diversion intakes. Which strategy will be most effective? Will the water quality benefits of modifying Franks Tract still be worthwhile if these other projects or programs are implemented? In short, ultimate project implementation must be informed by a conceptual model that explains the interconnection between all of these different efforts.

<u>Water Quality</u>

Several hydrodynamic processes associated with flooded islands appear to control salinity levels at the drinking water diversions, but the Pre-Feasibility Study alternatives focus on altering only one process, tidal excursion, and utilizing gates and levees to constrain it. Each of the alternatives, attempts to block saline water from either entering Franks Tract on flood tides or from ever being transported across tides. This may very well be the best way to reconfigure Franks Tract to reduce salinities, but it is probably worthwhile to further evaluate, at least conceptually, the possibility of altering other mechanisms such as mixing, to achieve the same result.

More subtle changes in island reconfigurations carefully designed to reduce dispersion (mixing) were generally not evaluated. A tidal marsh restoration element involving large-scale restoration of Jersey Island and Dutch Slough was run to test the hypothesis that increasing tidal prism in the vicinity of Big Break would reduce tidal excursion to Franks Tract. The model run resulted in increased salinities east of Franks Tract suggesting that perhaps some other mechanism, such as dispersion, are playing a role.

Clearly, the feasibility study would benefit from a clearer understanding and explanation of the hydrodynamic processes controlling salinity patterns. USGS investigators have posed several questions, which if answered, would improve understanding of hydrodynamic processes in the Central Delta and the impact of water project operations on them.

- What are the mechanisms that control the intrusion of salinity into the central Delta from the Bay and from the San Joaquin River? How can we use this understanding to better manage the system?

- What is the influence of river flows, DCC gate operations, export rates, and barrier placements on the net flows, salt field and salt fluxes in the central Delta? Can the distribution of salt fluxes among the central Delta channels be manipulated in some way to reduce salinities at the export facilities? In other words, can we exploit water project induced changes in the central Delta salt fluxes to "blend" salty and fresh water sources to minimize salinities at the export facilities?

- How do the flows in Turner Cut, Columbia Cut, and Old River influence entrainment of San Joaquin River salmon outmigrants into the central Delta? How are the flows and salmon outmigrant entrainment rates influenced by the placement of the south Delta temporary barriers? How well do the numerical models mimic this behavior?

- Does the exchange of Mokelumne River water across the San Joaquin into the central Delta increase the net flows in Old (station ODR, Figure 1) and Middle river (station MDR, Figure 1). If so, does this increase the entrainment of San Joaquin River salmon outmigrants into the south Delta?

- Can operations in Franks Tract be used to increase water supply and/or improve water quality during a prolonged drought?

- Will modifications in Franks Tract decrease the response time of the salt field in the central Delta to water project operations? If so, could this translate into greater operational flexibility leading to (1) increased supplies, and/or (2) decreased salinities at the export facilities?

- Could operations in Franks Tract hasten the reduction of salinities in the central and south Delta that occur as a result of a series of catastrophic levee failures?

Interaction between projects

- Can operations in Franks Tract be used to ameliorate increases in salinities in the central Delta due to DCC gate closures for fish protection in the fall?

- Can operations in Franks Tract be used to ameliorate the effects (increased salinities and salvage) of increased south Delta pumping rates (e.g. 8500 cfs)?

<u>Ecosystem</u>

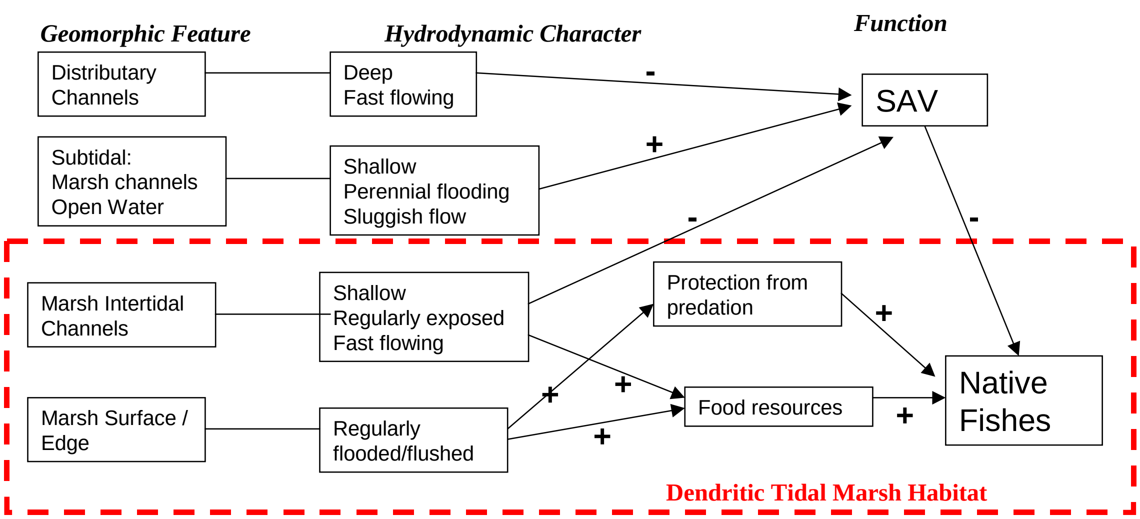
The purpose of restoring tidal marsh is to reduce and reverse the decline of native fishes in the Delta. The reduction in quantity, quality, and diversity of habitat for native fishes has likely contributed to the listing of several species that are found in the Delta during parts of their life cycles. The ecosystem approach to species conservation adopted by CALFED calls for sustaining and enhancing the fundamental ecological structures and processes that support the species. Thus, the objective of this element is to provide dendritic tidal marsh habitat with attributes that will benefit native, at-risk species, and discourage attributes (i.e., non-native SAV) that do not.

The conceptual model underlying this restoration element is the link between the decline in natural dendritic intertidal marsh habitat, which historically dominated the Delta (Atwater, 1982), and the decline in native, at-risk species, including delta smelt, splittail, chinook salmon, and steelhead rainbow trout utilizing the Bay-Delta. The presence of extensive dendritic intertidal marsh habitat at a time when native, at-risk species maintained healthy populations implies that habitat restoration will likely benefit the native species that coevolved over the development of the historic Delta.

The Delta has changed dramatically from pre-historic conditions. Physical changes such as the creation of large shallow open water areas associated with flooded islands have created a large habitat type that did not formerly exist. Biological changes such as the invasion of numerous exotic species have also altered conditions for native species. Many of these species, particularly submerged aquatic vegetation (SAV), thrive in the shallow water areas characteristic of flooded Islands. Recent studies (Brown 2003B) note an association between subtidal areas, frequently dominated by SAV, and non-native fishes that consume native fishes, or may displace or out-compete them.

The project proposes to convert the shallow water areas associated with flooded islands into dendritic, intertidal marsh. The conceptual basis for this proposal is outlined in Figure 3.1. Tule vegetation characteristic of fresh water tidal marsh readily colonizes marsh areas between –2 and +3 MLLW and thus preempts establishment of noxious SAV. The intertidal marsh plain drains and floods on daily cycles discourages the establishment of territorial non-native species, but still provides habitat for transitory native species who have evolved to use the marsh during high water periods. Dendritic channel networks carry water and nutrients to and from the site and provide native fish with access to the marsh. These habitats prove beneficial only if they are directly accessible to native fish via SAV free water. If native fish must traverse dense beds of SAV in order to access the marsh, they are likely to succumb to predation or otherwise fail to beneficially utilize the marsh. Thus, an important landscape component of the conceptual model is that active distributary or slough channels also exhibit conditions that are unsuitable (too deep or too turbid) for SAV growth. Furthermore, we assume that relatively large restoration patch sizes of approximately 100-200 acres are preferable for native fish species and are necessary to support a high order dendritic channel network.

Figure 2: Conceptual Model for Tidal Marsh Restoration (Reed and Digenero, 2002)



Limitations of the Ecosystem Conceptual Model
The ecosystem conceptual model may over emphasize the importance of tidal marsh and under emphasize other factors such as egeria or primary productivity. Although egeria plays a central role in the conceptual model, control is predicated on creating relatively high velocity dendritic channels in tidal marsh. Although dendritic tidal marsh may significantly preempt and exclude egeria and other native species, it is not realistic to assume that we can convert all of Franks Tract to dendritic tidal marsh. There is simply not enough fill material in the Delta and even if there was the costs of building would be extremely high. The impact on boating would be unacceptable to Franks Tract's recreational stakeholder community. Therefore, the conceptual model must address some other method of managing egeria and the large open water areas of Franks Tract that will persist irregardless of the project.

- Will the Department of Boating and Waterways newly instituted egeria program succeed in reducing the egeria infestation?
- In the absence of egeria, will small marsh islands (30 acres or less) provide significant benefits for native fish species?
- Will shallow open water free of egeria provide good habitat for native fish species?
- In addition to creating marsh and islands or removing egeria, are there other ways to manage flooded islands to improve conditions for native species?

- Is it possible to manage flooded islands to enhance food supply available to zooplankton and would this entail controlling exotic asian clams? Although, such an outcome could be very significant for native fish, there are too many uncertainties about the hydrodynamics and ecological processes that control primary productivity in flooded islands (Lucas, 2002).

Recreation

The conceptual model for recreation is also influenced if not dominated by egeria. Initially, the conceptual model for recreation was that reconfiguration of flooded islands for water quality and ecosystem could provide or be designed to provide a number of recreational amenities such as improved fishing, beaches, recreation islands, aesthetic viewscapes, etc. This is partly true, but these amenities are of little value if Franks Tract remains overrun with egeria. Therefore, a clearer understanding of egeria, the processes that sustain it as well as the potential for effective control, is necessary to develop worthwhile recreational enhancements on the flooded islands.

Numerical Modeling

Additional fine-tuning and data collection is necessary to better calibrate the model at several specific but important locations. Improving calibration for multiple year classes under a range of water management operations would improve confidence in the model's ability to predict salinity reduction benefits under a broader range of conditions. RMA has identified the following locations where the model requires additional calibration.

- Old River between Franks Tract and the San Joaquin River
- Franks Tract main jet
- Three mile slough
- Junction of Georgiana Slough, Mokelumne River, and Little Potato Slough
- Mixing of Old River, Middle River, and San Joaquin River
- Delta Cross Channel and Snodgrass Slough

Field Research

Additional field research for the Flooded Islands study is necessary to collect data regarding hydrodynamic processes, the depth and character of the bottom of Franks Tract, and boat traffic in and around Franks Tract. This data is necessary to calibrate the model, design and evaluate the cost of restoration and recreation enhancements (marshes, beaches, boating channels, etc.), and evaluate the effects of the project on boating traffic.

Franks Tract Depth and Substrate

Precise depth measurements and core samples are necessary to determine the depth of Franks Tract, the siltation rate, the type of soils, and the depth of organic soils. Uncertainty regarding the soil characteristics of Franks Tract as well as the depth of water and soil type is a constraint on design and analysis. Local boaters and some scientists have casually observed that Franks Tract appears to be silting in, in large part due to the sediment trapping capability of egeria. Bathymetric surveys, however, show no difference in depth between the years1992 and 2000. It is possible that the 2000 survey did not measure a change in depth because 1) it was a low-resolution survey designed for another purpose and 2) it was conducted before the full scale invasion of egeria. If egeria is causing relatively rapid siltation of the track, it could have profound implications for the future of Franks Tract and the rationale of the entire project.

Data on the soil character and depth of the bottom of Franks Tract and Little Franks Tract is critical for evaluating restoration and recreational design elements. Design and construction options will vary greatly if the bottom consists of deep peats (<20 feet) rather than mineral soils. It will be difficult to dredge peats or inefficient to place fill material on top of deep peat.

<u>Hydrodynamics</u>
USGS has proposed an expanded Delta flow monitoring program to collect data necessary to calibrate the model and evaluate water quality and hydrodynamics responses at a number of key locations under a range of water management operations.

To better characterize flow and transport conditions in and around Franks Tract, the USGS has proposed eight additional flow stations for the central Delta (yellow dots in Figure 3), six of which will include temperature (T) and conductivity (C) probes (black circles, in Figure 3). USGS also recommends that all of the existing flow stations south of the San Joaquin record temperature and conductivity measurements (many of these stations already have this capability). These new central Delta stations, coupled with the recent addition of three new stations in the South Delta (CCF, VIC, TRN, installed in 2005) would create, for the first time, a complete flow monitoring network in the Delta, where all of the major flow paths in the Delta would be monitored.

<u>Fish Biology</u>
In order to obtain permits to construct a project that modifies Franks Tract, it may be necessary to conduct fish surveys to better characterize the fish species that use Franks Tract and how hydrodynamic changes or infrastructure constructed to induce hydrodynamic changes would affect those fish species. Studies should include surveys of fish species that migrate through Franks Tract during different seasons and life stages including Chinook salmon, stripped bass, and Delta smelt. Studies should be designed to determine how different operational patterns of tidal gates could effect upstream and downstream movement of larval, juvenile, and adult fish as well as predation of larval and juvenile fish.

Pilot Projects

The Flooded Island Feasibility Study proposes several options for implementing a pilot project as a step toward full implementation of a preferred alternative. These pilot projects generally entail partial or temporary implementation of the preferred alternative to test its efficacy before full-scale implementation. This would allow for water managers to test drive the preferred alternative before committing very large sums of money to its permanent or complete construction.

However, there are two main reasons why it is not practical to move forward with design or implementation of a pilot project at this point in time:

1. The existing alternatives have not been adequately modeled under a variety of operational and hydrologic scenarios, which is key to defining the preferred alternative. It is premature to partially construct an alternative before selecting the preferred alternative. More detailed descriptions of the problem and objectives are required (discussed above) before selecting a preferred alternative or defining a pilot project. Specifically, we need to know what water quality measures (metrics, location, timing) are most important to achieve before we can identify the preferred alternative or design a pilot project that will test the management strategy embedded in the preferred alternative.
2. The permitting and design costs of implementing the pilot projects described in the feasibility study are large. Normally, a pilot project can be implemented inexpensively and relatively quickly to demonstrate the merits of a geographically broader program. In this case, the footprint of the pilot project is almost as large as the full-scale project.

Theoretically, the objective of a pilot project is to:

1. Field-test a management strategy.
2. Provide incremental benefits while demonstrating the value of a management strategy.

There may be other methods to achieve these objectives short of partially or temporarily building a preferred alternative. Better calibrating and utilizing the model may be the most cost effective method for testing the management strategy embedded in the preferred alternative. While modeling runs do not constitute a field test, runs can be conducted to model a variety of real field conditions and field data can then be evaluated to determine if the model was correct. Such an expanded model calibration effort would increase confidence in the model its ability to predict efficacy of the management strategy a pilot project would otherwise be needed to test.

A clearly defined set of performance criteria must be identified to measure the effectiveness of the pilot project whether the pilot project focuses on the ground implementation or expanded model calibration under a wider range of management scenarios. The RMA model output (RMA 2005) includes a number of different measures that could be used as performance criteria, but it is premature to select these criteria until the problem statement and objectives have been more clearly articulated as discussed previously in this memorandum.

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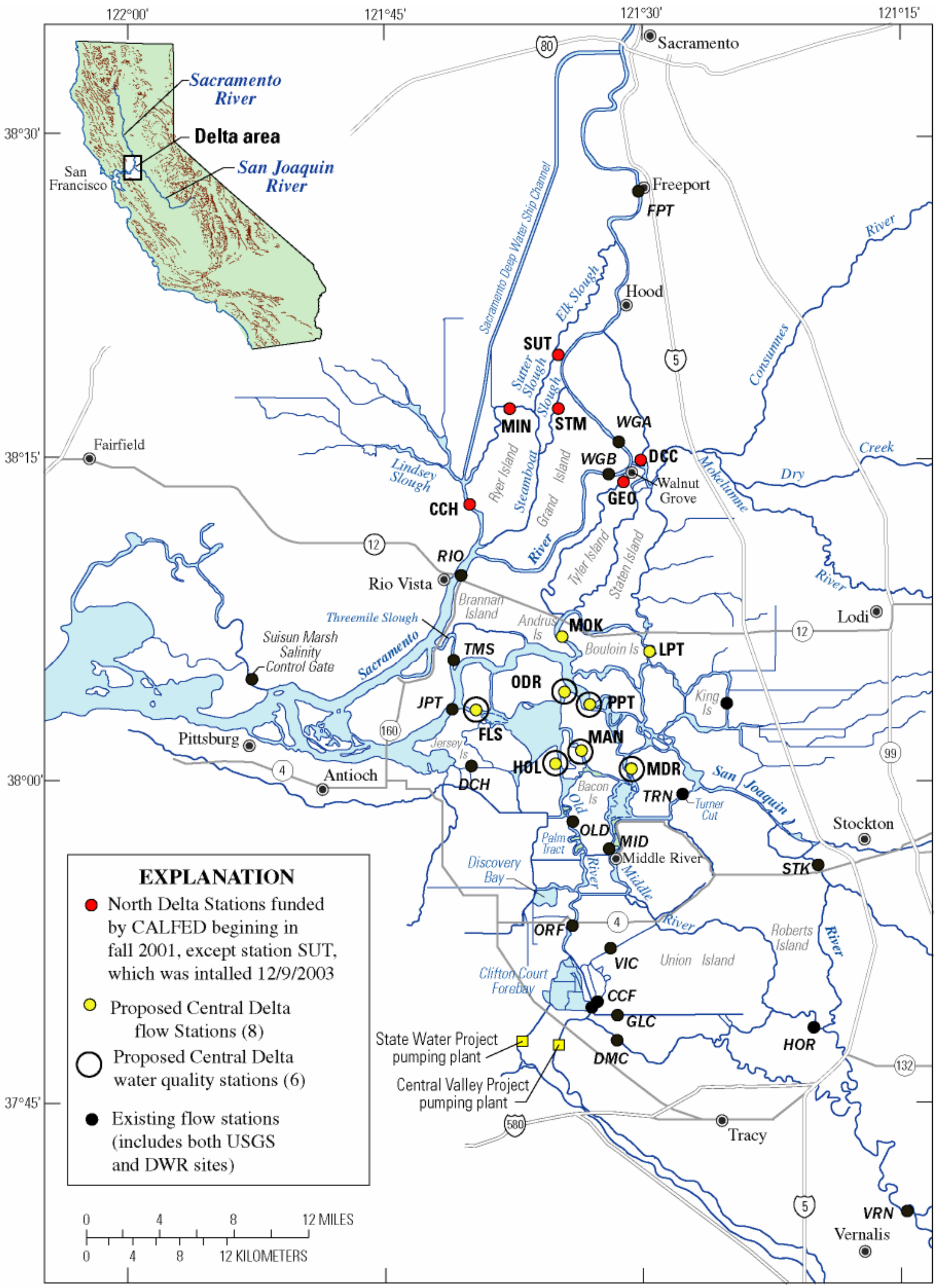

Location of flow station sites in the Delta Area of California.

Figure 3 – Existing and proposed flow and water quality monitoring stations (Prepared by Bureau and Ruhl).