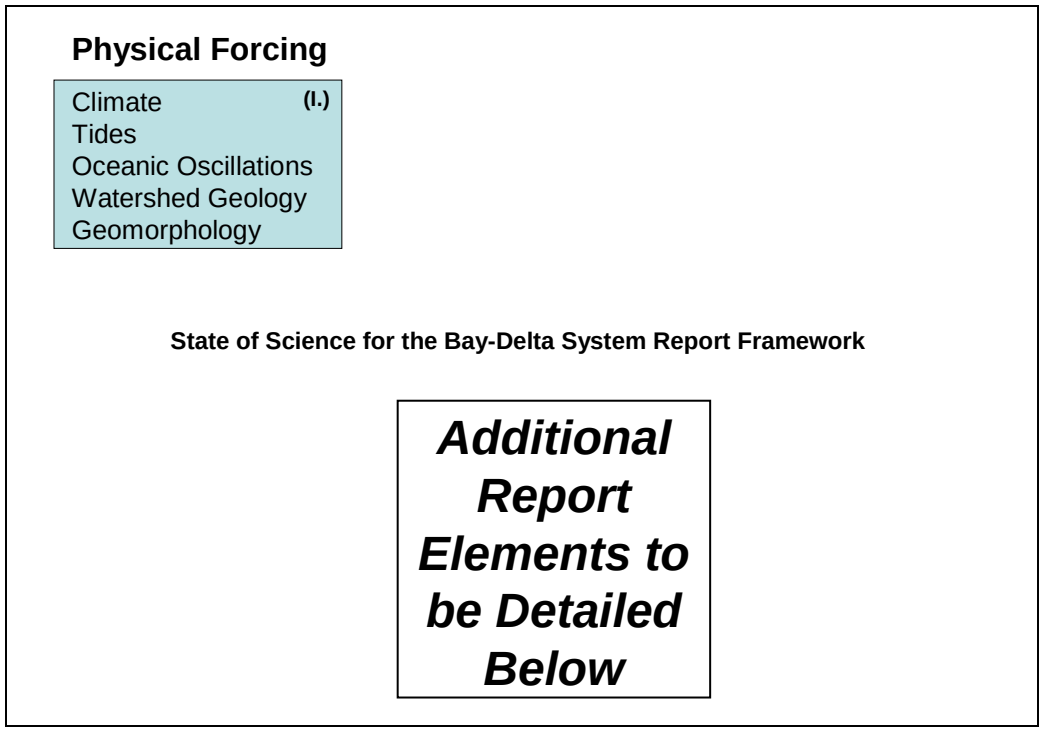
OUTLINE
State of Science for the Bay-Delta System
Edition 1 (2007)

Water Resources Management and Ecosystem Response

What Is 'California Water Resources Management' and How Do Natural and Human Bay-Delta Ecosystems Respond to Such Management?

7 pp.

I. **Forcing Factors: Physical and Climatic Setting** – precipitation patterns, regional hydrographs, surface water storage, conveyance, and distribution of water resources for beneficial use and flood management – *What is the purpose of Water Management in California? What are the key water management features? What are the relevant drivers and resulting impacts to the system from water operations and management actions? What elements of the Water Resources Management system provide opportunities for alternative management manipulation?*



This section will describe the physical and biogeochemical setting for water catchment, storage, conveyance, flood control and the use of managed water resources for drinking water, irrigation water, environmental, municipal, and industrial purposes. This section will briefly contrast the historical natural storage and conveyance system (Delta, rivers, and watersheds) with the constructed and managed system used currently (dams, reservoirs, gates, aqueducts, Delta, channels). The purpose of this section is to illustrate the development (through Project construction) of differences in water quantities, qualities, delivery timing, and hydrodynamics due to water resource manipulation and

management throughout the State which result in ecosystem impacts. [Editor's note: Throughout this document "ecosystem" will refer to both the natural and human systems.] This information will be used in conjunction with information from subsequent sections to illustrate where fundamental conflicts or opportunities exist between competing water resource uses, either natural or human, stemming from conflicts inherent when collecting, storing, conveying, and/or distributing water in alternative ways.

a. Unrestricted hydrologic geography circa 1840 and historic hydrographic characterization
    i. Precipitation patterns and natural hydrology (northern rainfall abundance, winter timing of snow and rain, spring runoff; flood events and patterns of dispersal and recharge)
    ii. Environmental hydrology and key ecosystem linkages (important ecosystem cues from rainfall, runoff, or flood patterns; life stage integration with natural, variable, hydrograph using as examples spring run salmon, smelt, splittail, clams)
    iii. Constituents and how Delta water quality gets like it is (an estuary where freshwater river flows mix with tidally moving sea water; focus on salinities, temperatures, sediments)
b. Human modifications
    i. Mining and watershed modifications 1850-1880
    ii. Farming and basin modifications 1880-1950
    iii. Description of State and Federal Water Projects, local diversions, storage facilities, levees and levee system, design demands (ca 1950), current demand, projected demand
    iv. Development of "beneficial uses" concept and links to regulatory framework and basin plans (water quality regulations, ESA)
c. Conflicts between ecosystem "needs" and water user "demands" and implications for ecosystem function and resilience (with illustrations using known examples; for example, winter water quality-based drinking water demand and Delta smelt spawning and rearing patterns)
    i. Tools for managing conflicts and balancing resource needs (eg. EWA)
    ii. Ecosystem response to hydrologic manipulation (reallocation of energy resources, abundance reduction, reduced species diversity, increased invasion rates)
d. Future hydrologic characterization and impacts to beneficial use
    i. "Drivers of Change" (critical certainties) and impacts to water use planning
    ii. Environmental impacts beyond management control (floods, droughts, increased demand, disease, climate change-based habitat degradation)

II. **Water Resource Management and Project Operations** – overview using CALVIN/CALSIM II model as template to identify hydrologic underpinning

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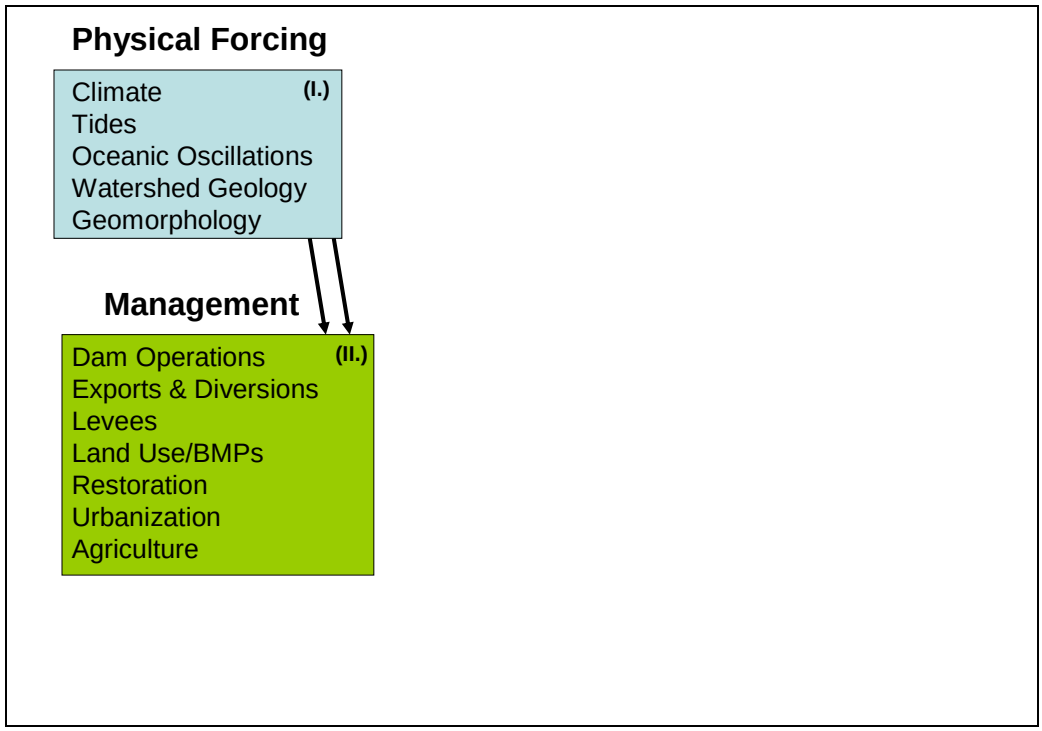
of beneficial uses and the constraints to uses given the hydrologic character of the State and the human activities affecting the management of these uses – *How are the Water Projects and associated facilities operated to meet end user needs?*



This section is intended to describe the day-to-day and season-to-season operation of the State and Central Valley Water Projects (and any other coordinated operations in support of the Projects) that have the potential to affect other aspects of the Bay-Delta ecosystem as a consequence of such operation. This section will briefly outline operational guidelines for meeting various regulatory and contractual targets for water quality, water quantity, or other explicit measures that govern Project operation. This section will use one or more of the following constructs as a framework for presentation and discussion, and will qualitatively present linkages to ecosystem impacts (which are described in more detail in subsequent sections). We include State, federal, local infrastructure, levees and levee maintenance, and flood control operations as appropriate.

a. CALVIN/CALSIM II approach for managing water in California
    i. Impoundments
    ii. Gates and control structures
    iii. Conveyance facilities
    iv. Operational representation within modeling environment and consequences for decision-support
b. Performance measures approach for managing water in California
    i. Conceptual Models
    ii. Indicators and rationale for their use
    iii. Evaluation of management actions

c. Levee system
    i. Levee construction and maintenance
    ii. Subvention programs and emergency response
    iii. Subsidence
    iv. Risk assessment
    v. Levees as habitat
d. Water Management System constraints
    i. Climatic constraints
    ii. Infrastructural constraints
    iii. Contractual obligations
    iv. Regulatory obligations
    v. Operational criteria (X2, WR Decision 1641)

III. **System Response to Water Resource Management** – system-level characterization of selected ecosystems and components with regard to Water Resources Management and issues of public health and safety – *What are the consequences of water resource management operations on water and related resources? Are there specific systems experiencing unusual trends or deserving enhanced focus? What role does water resource management play when considering broad-spectrum stressors to human health and natural ecosystems, including species of concern? What are the key drinking water issues? What role do levees and water conveyance play in the overall water management system and how will this role change through time?*

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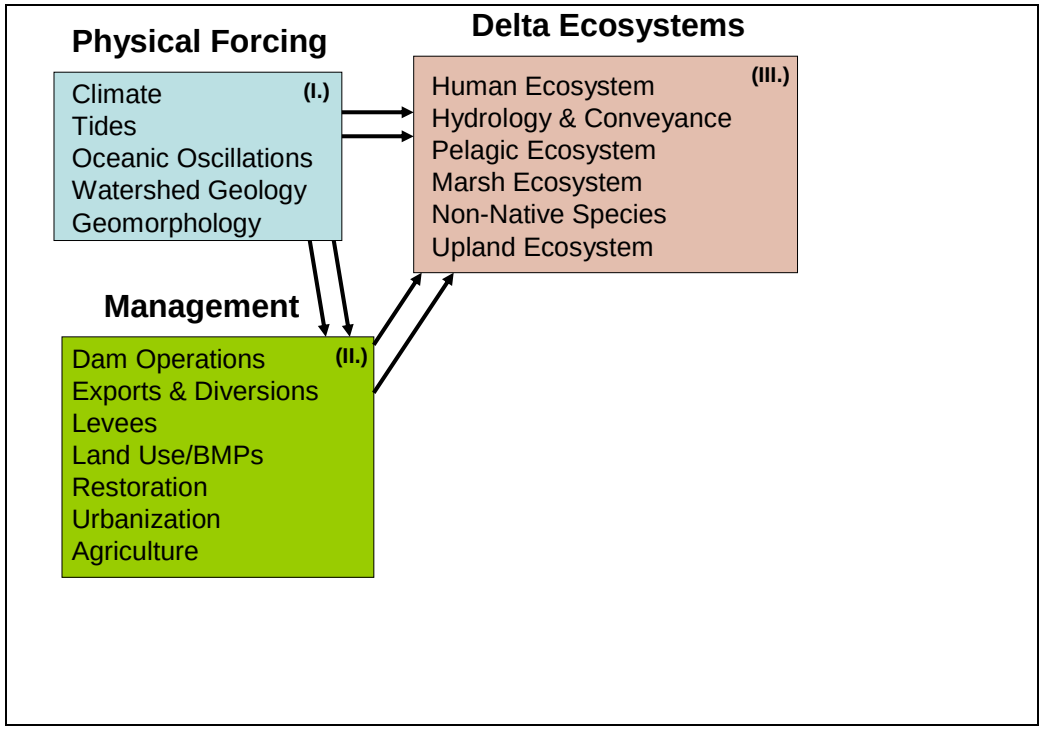

This section is intended to take a broad, system-level approach to describing how water resource management creates impacts to the water resources it attempts to manage, or

how end users are impacted as the result of such management. This section will therefore expand on material originally presented in Section I. Here we will also examine in some detail impacts to drinking water and environmental water quality and/or quantity that are of principal concern to State-wide water supply planning efforts. Impacts to agricultural water supply in light of potential future climate change scenarios are also presented. We subdivide our narrative into human and wildlife portions for organizational purposes only – the two water management elements are, of course, inextricably linked.

a. Human needs and Delta water management
    i. Drinking Water
        1. Background: upstream dependencies and challenges resulting from choosing the Delta as a source for drinking water
        2. Constituents of primary concern
            a. Salinity/Bromide
            b. Organic Carbon/Disinfection Byproduct Precursors
            c. Nutrients
            d. Pathogens
            e. Taste and Odor
        3. Conveyance and water quality south of the Delta
    ii. Agricultural Water & Agroeconomy
        1. Background: downstream dependencies and challenges resulting from choosing the Delta as a source for irrigation water
        2. Salinity (including source water salts and extra-tidal sea water intrusion events)
        3. Conveyance to point of use challenges
        4. Agricultural return water
        5. State Water Project and Central Valley Project management implications for agricultural use
b. Ecosystem needs and Delta water management
    i. Water temperature, quantity, timing, and constituents
    ii. Habitats and relationships to water resource management
        1. Wetlands
        2. Pelagic
        3. Shallow water
        4. Benthic
        5. Floodplain
        6. Riparian
        7. Levee breaches
    iii. Key species and relationships to water resource management
        1. At risk species
        2. Anadromous species
        3. Non-native invasive species
    iv. Issues for enhanced focus
        1. Pelagic Organism Decline

2. Bioaccumulation of contaminants and pesticides – Delta as urban and agricultural sump
3. Low dissolved oxygen events
4. Mercury
5. Selenium
6. Sediments

c. Flood Control
   i. Ecosystem considerations
   ii. Maintenance
   iii. Human health and safety issues

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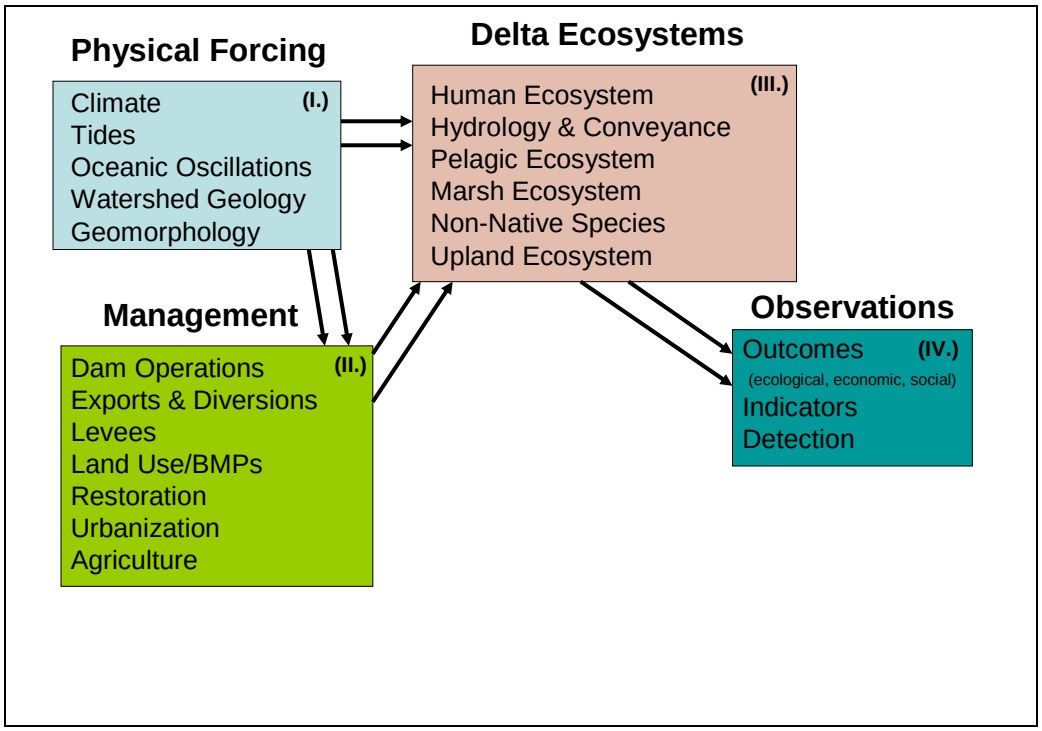
IV. **Action, Observation, and System Response Detection** – selected potential options for water quality protection and resource enhancement or restoration for impacts due to water resource management and likely outcomes – *Are water resource management/protection efforts effective and can we quantify the results? Will an examination of the EWA efforts lead us to increasing the effectiveness of management actions vis-à-vis protecting drinking water quality, water supply reliability, or ecosystem services?*



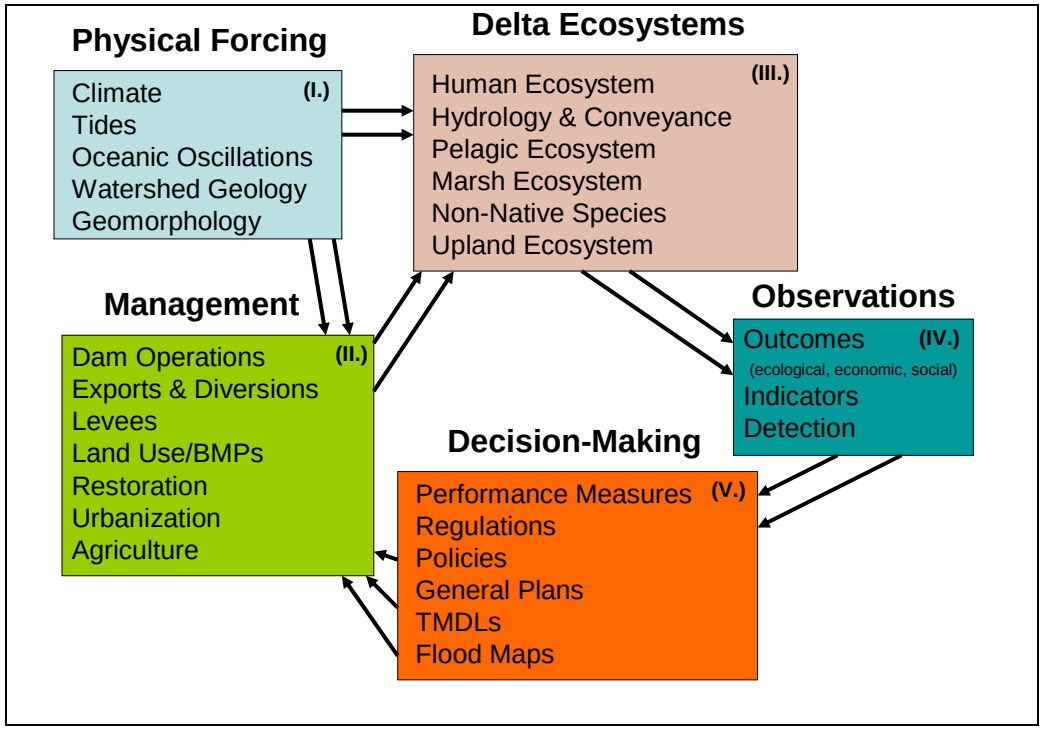
This section will focus on proposed analyses of integrated water management programs within the Bay-Delta ecosystem, with an explicit discussion of whether management activities are likely to have an intended (or desired) effect. It will also revisit in further detail previously introduced notions of environmental variability and the likelihood of detecting environmental effects of management actions given changing ecosystem character and regional climate change. This first edition Report will examine the role and

effectiveness of the Environmental Water Account; future Reports may treat ERP Project activities, VAMP, B2, or other environmental protection or restoration actions.

a. The issue of detectablility within a complex, self-regulating system
b. Environmental Water Account
c. The changing Delta and ecosystem predictability
d. Restoration actions and subsequent evaluation

10 p.

V. **Water Management Tools and Decision-Making, Management System Integration, and Water System Integrity** – What are the important pending water management decisions; where are the important overlaps between traditionally dissected elements or management entities; how does integration serve system understanding; and what contributes to ecosystem and water management vulnerability in spite of best management efforts – *How can management tools (including indicators and performance measures) best be integrated into water management decision-making and adaptive management with regard to water resources? What are the important emergent properties of Delta ecosystems in light of management actions and why is it insufficient to use a piecemeal approach to characterize them or evaluate their management? How can we reduce vulnerability of project infrastructure and delivery systems?*



Here the Report will examine the role of science (and the Science Program) within the water resources management decision-making process (including elements such as DSRAM, IWOFF, and WOMT). This section of the report will also be used to illustrate the necessity of evaluating the State of the Science of the Bay-Delta System using an

integrative perspective. This section will also consider water supply system integrity in light of the Delta Science Panel's six "critical certainties" likely to dominate the nature and function of water supply and delivery within the Bay-Delta region within the current planning horizon.

a. Science and information generation, and moving information dependably to policy arenas and agency decision-makers
b. The critical role of indicators and performance measures
c. Grasping the forest and the trees – interagency program coordination can improve integrated management, monitoring, and information development
d. Successful long-term mandates will have to overcome shorter-term imperatives
e. The tangled web – how changes to one part of management within the Bay-Delta region results in impacts to other parts of the system, and how meeting multiple stakeholder objectives may be irreconcilable.

Special Topics on Integration – where is the issue primarily one of linkages across traditionally separated disciplines or topic areas – *What topics need an extensive approach to address or have solutions demanding extra-Delta primary focus?*

a. Organic carbon production and transport
b. Management actions as ecosystem experiments – are we ready?
c. Mercury source, fate, and transport
d. Connecting the Delta to its watersheds
e. Water supply, water reuse, water quality
f. Levee construction and Delta plan form geometry
g. Delta geometry and hydrodynamic mixing
h. Ecological water quality and contaminants

These "call out" boxes will be used to focus on integrated issues of special concern or illustrative value. They may appear in various places within the final report.