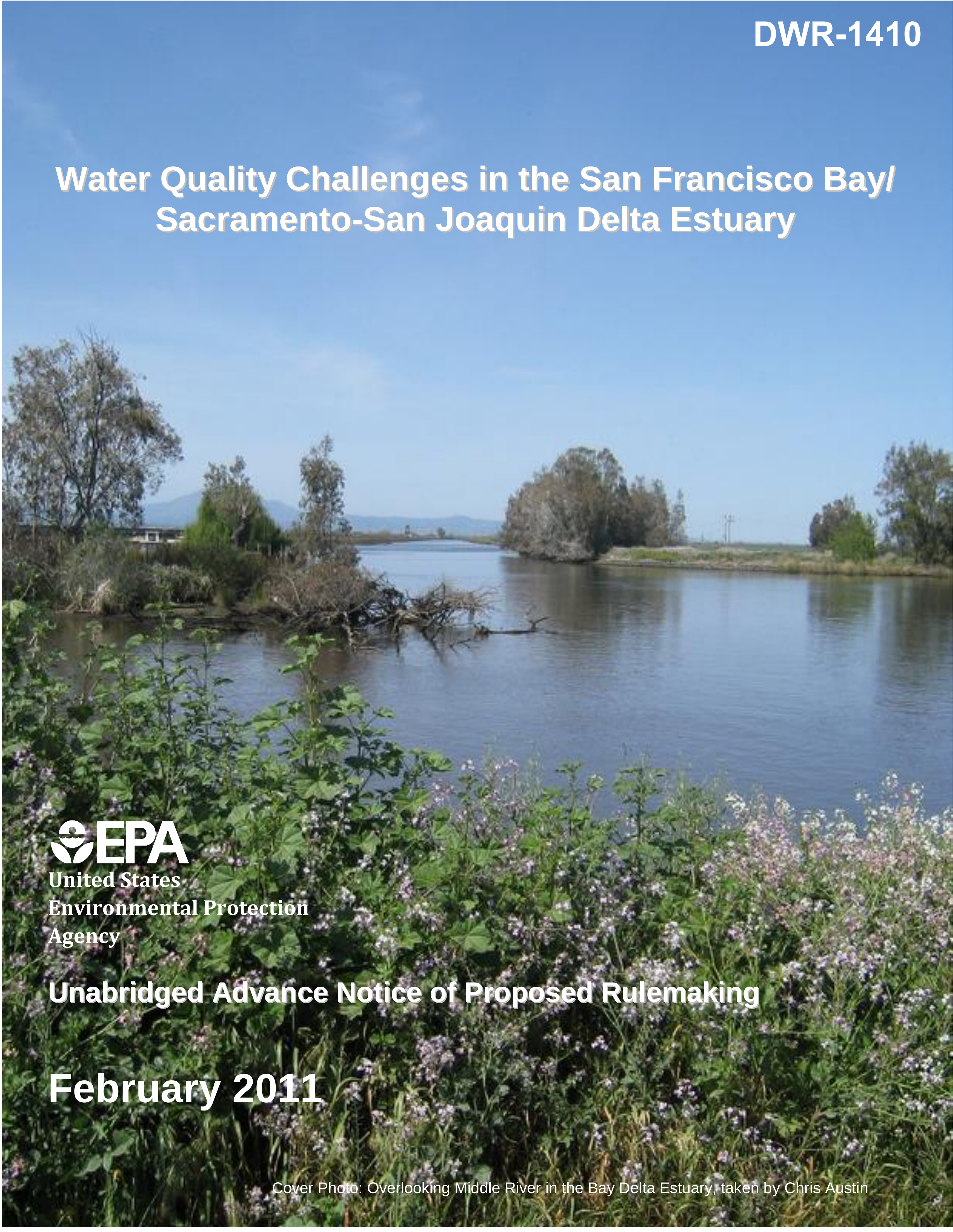
DWR-1410

Water Quality Challenges in the San Francisco Bay/ Sacramento-San Joaquin Delta Estuary



United States
Environmental Protection
Agency

Unabridged Advance Notice of Proposed Rulemaking

February 2011

Cover Photo: Overlooking Middle River in the Bay Delta Estuary, taken by Chris Austin

Unabridged Advance Notice of Proposed Rulemaking for Water Quality Challenges in the San Francisco Bay/ Sacramento-San Joaquin Delta Estuary

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Summary

The U.S. Environmental Protection Agency (EPA) is publishing an advance notice of proposed rulemaking (ANPR) to seek comments from interested parties on possible EPA actions to address water quality conditions affecting aquatic resources in the San Francisco Bay/Sacramento-San Joaquin Delta Estuary (Bay Delta Estuary) in California. EPA is asking the public to consider broadly whether EPA should be taking new or different actions under its programs to address recent significant declines in multiple aquatic species in the Bay Delta Estuary. EPA is not limiting its request to actions that would require rulemaking. There may be a range of changes in EPA's activities in the Bay Delta Estuary that would be constructive, including enforcement, research, revisions to water quality standards, etc. EPA will consider all comments before deciding what changes, if any, should be pursued. After reviewing the comments and completing its evaluation, EPA will provide the results of its review and any proposed next steps to the public. This ANPR identifies specific issues on which EPA solicits comment, including potential site-specific water quality standards and site-specific changes to pesticide regulation. In addition to the specific issues on which EPA solicits comments, EPA is interested in comments on any other aspects of EPA's programs affecting Bay Delta Estuary aquatic resources.

This ANPR has no regulatory impact or effect. The ANPR contains descriptions of certain EPA programs relevant to the Bay Delta Estuary and poses questions about how these programs could better protect and improve water quality for the benefit of aquatic resources in the Bay Delta Estuary. This ANPR marks the beginning of a process to consider possible changes to EPA programs in the Bay Delta Estuary.

If EPA decides to pursue regulatory changes as a result of this ANPR, those regulatory changes will be made pursuant to appropriate formal rulemaking procedures. If changes to any regulations, rules, guidance or statutes are proposed and ultimately made final, to the extent such changes would require and/or authorize changes to state or tribal water quality standards or other regulations, states or authorized tribes would be affected. If changes to state or tribal regulations result from any final rule that EPA may promulgate in the future, entities subject to compliance with state or tribal regulations would also potentially be affected. For example, states and tribes authorized to implement the National Pollutant Discharge Elimination System (NPDES) Permit Program would need to ensure that permits they issue include any limitations on discharges necessary to comply with any water quality standards established as a result of any subsequent final rulemaking. Therefore, entities discharging pollutants to waters of the United States under NPDES could be affected by subsequent proposed and final rulemaking.

Submitting Comments

Written comments must be received by EPA within 60 days of publication in the Federal Register.

Written comments may be submitted electronically at the *Federal Rulemaking Portal* (www.regulations.gov), identified by docket number EPA-R09-OW-2010-0976. Hard copy comments should be addressed to Erin Foresman, U.S. Environmental Protection Agency, 75 Hawthorne Street, WTR-3, San Francisco, California 94105.

All comments will be included in the public docket without change and will be made available online at *www.regulations.gov,* including any personal information provided, unless the comment includes Confidential Business Information (CBI) or other information whose disclosure is restricted by statute. Information that you consider CBI or otherwise protected should be clearly identified as such and should not be submitted through *www.regulations.gov* or e-mail. *Regulations.gov* is an ''anonymous access'' system and EPA will not know your identity or contact information unless you provide it in the body of your comment. If you send email directly to EPA, your e-mail address will be automatically captured and included as part of the public comment. If EPA cannot read your comment due to technical difficulties and cannot contact you for clarification, EPA may not be able to consider your comment.

Docket: The index to the docket for this action is available electronically at *www.regulations.gov* and in hard copy at EPA Region 9, 75 Hawthorne Street, San Francisco, California. While all documents in the docket are listed in the index, some information may be publicly available only at the hard copy location (*e.g.,* copyrighted material), and some may not be publicly available in either location (*e.g.,* confidential business information). To inspect the hard copy materials, please schedule an appointment during normal business hours with Erin Foresman, foresman.erin@epa.gov; (916)557-5253.

For further information contact: Erin Foresman at U.S. Environmental Protection Agency, Region 9, Water Division, 75 Hawthorne Street, San Francisco, California 94105; foresman.erin@epa.gov; (916)557-5253.

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List of Selected Acronyms

ANPR	Advance Notice of Proposed Rulemaking
AWQC	Ambient Water Quality Criteria
BDCP	Bay Delta Conservation Plan
C&D ELG	Construction & Development Effluent Limitations Guideline and Standards
CA CGP	California Construction General Permit
CA IGP	California Industrial Stormwater General Permit
CBI	Confidential Business Information
CCC	California Coastal Commission
CDFG	California Department of Fish and Game
CECs	Contaminants of Emerging Concern
Corps	U.S. Army Corps of Engineers
CVP	Central Valley Project
CZARA	Coastal Zone Act Reauthorization Amendments of 1990
DSC	Delta Stewardship Council
DDT	Dichlorodiphenyltrichloroethane
EDC	Endocrine Disrupting Chemicals
EPA	U.S. Environmental Protection Agency
ESA	Endangered Species Act
FERC	Federal Energy Regulatory Commission
FIFRA	Federal Insecticide, Fungicide and Rodenticide Act
IEP	Interagency Ecological Program
ILRP	Irrigated Lands Regulatory Program
MAF	Million Acre-Feet
MS4s	Municipal Separate Storm Sewer Systems
NAS	National Academy of Sciences
NCCP	California Natural Community Conservation Plan Act
NMFS	National Marine Fisheries Service
NPDES	National Pollutant Discharge Elimination System
NTR	National Toxics Rule
NOAA	National Oceanic and Atmospheric Administration
PGP	Pesticides General Permit
POD	Pelagic Organism Decline
POTW	Publicly Owned Treatment Work
PPIC	Public Policy Institute of California
RWQCB	Regional Water Quality Control Board
SCCWRP	Southern California Coastal Water Research Program
SDWA	Safe Drinking Water Act
SFEP	San Francisco Estuary Partnership
State Board	California State Water Resources Control Board
SWP	State Water Project
TMDL	Total Maximum Daily Load
USBR	U.S. Bureau of Reclamation
USFWS	U.S. Fish and Wildlife Service
USGS	U.S. Geological Survey
VAMP	Vernalis Adaptive Management Plan
WQS	Water Quality Standards
WPCF	Water Pollution Control Facility
WWCF	Wastewater Control Facility
WWTP	Wastewater Treatment Plant
X2	Low Salinity Zone

I. PURPOSE OF THIS ANPR

The Bay Delta Estuary is a complex web of waterways, islands, and levees at the junction of the San Francisco Bay and the Sacramento and San Joaquin Rivers (see Figure A.)[1] The Bay Delta Estuary is the hub of California's water distribution system, supplying some or all of the drinking water to 25 million people and irrigation water to 4 million acres of farmland.

Water quality and aquatic resources in the Bay Delta Estuary are under serious stress. All of the waters of the Bay Delta Estuary and most of its tributaries are listed as impaired for one or more parameters under the federal Clean Water Act.[2] Populations of many formerly abundant open-water (i.e., pelagic) fish species, including delta smelt, longfin smelt, and threadfin shad, have collapsed in recent decades. Anadromous[3] fishes, including the winter run chinook salmon, have suffered a similar decline. The decline of these aquatic resources has generated debate over water resource management in the Bay Delta Estuary. Delta interests, including state and federal agencies, environmental groups, urban and agricultural water users, commercial and recreational fishermen, and others have spent many years grappling with Bay Delta Estuary resource issues.

Concerns regarding Bay Delta Estuary water resource management increased during the 2009 water year[4] as water users and resource managers struggled with the effects of three years of drought. Water export limitations caused by the drought and by restrictions imposed under the federal Endangered Species Act (ESA)[5] to assist struggling endangered species significantly reduced the availability of water for agricultural and urban uses.[6] At the same time, the salmon fishery was closed on most of the West Coast for a second consecutive year as a result of declines in that fishery. Both the agricultural and fishery sectors suffered job losses as a result of the drought and the water export restrictions.

The federal government responded to this ongoing water management crisis with a broad set of actions.[7] One of those actions was the creation of the Federal Bay Delta Leadership Committee, a Cabinet-level, multi-agency committee charged with coordinating federal responses to Bay Delta Estuary issues.[8] The Federal Bay Delta Leadership Committee released its Interim Federal Action Plan for the California Bay-Delta (Federal Action Plan) on December 22, 2009, outlining the federal government's plan to address the Bay Delta Estuary and to work with the State of California to build a sustainable water future.[9] The Federal Action Plan includes actions by EPA to "assess the effectiveness of the current regulatory mechanisms designed to protect water quality in the Delta and its tributaries, including standards for toxics, nutrients, and estuarine habitat protection." EPA will also evaluate voluntary mechanisms that may be used to restore water quality in the Bay Delta Estuary. This ANPR is the beginning of this assessment.

New scientific information about the Bay Delta Estuary and its aquatic resources has substantially increased in the past few years. This information has been developed and/or reviewed in reports[10] synthesizing information on aquatic resources and water quality by the following entities: the State/Federal Interagency Ecological Program Pelagic Organism Decline (POD) science team,[11] the State's Delta Vision Blue Ribbon Task Force, the Public Policy Institute of California (PPIC), the U.S. Fish and Wildlife Service (USFWS) and National Marine

Figure A. San Francisco Bay/Sacramento-San Joaquin Delta Estuary (Bay Delta Estuary)

Fisheries Service (NMFS) as part of their biological opinions and associated independent science reviews, the California State Water Resources Control Board (State Board) and the Central Valley Regional Water Quality Control Board (Central Valley RWQCB).[12] Most of these studies and reports involve resources protected under the Clean Water Act and other EPA programs.

EPA is using this ANPR to solicit and synthesize existing scientific information regarding the biological, chemical, and physical integrity of the Bay Delta Estuary's aquatic resources. EPA will comprehensively review this information as it evaluates its statutory and regulatory options in the Bay Delta Estuary and will develop an appropriate response. Specifically, the purposes of this ANPR are:

(1) To review the current status of the EPA and Water Boards'[13] responses to adverse water quality conditions that have been identified as potential contributors to the Bay Delta Estuary's aquatic resources decline;

(2) To determine how best to implement existing programs under the Clean Water Act and the Federal Insecticide, Fungicide and Rodenticide Act (FIFRA)[14] to improve Bay Delta Estuary water quality for aquatic resources;

(3) To identify barriers, either programmatic or statutory, to improving Bay Delta Estuary water quality;

(4) To identify any additional scientific information regarding water quality related to aquatic resources in the Bay Delta Estuary; and

(5) To solicit input on whether EPA should be taking new or different actions under its programs to address aquatic resource problems in the Bay Delta Estuary.

Specific topics on which EPA is requesting comments appear in the sections below.

Related Efforts in the Bay Delta Estuary

There are several major efforts underway to address Bay Delta Estuary resources, including the regulatory programs of the Water Boards under state and federal water quality statutes. In July 2008, the Water Boards adopted a Strategic Workplan to coordinate and guide their Bay Delta Estuary activities.[15] Over the next several years, these state activities will include, among others, multiple point source permit renewals, new pollutant and flow standards for the southern Delta and lower San Joaquin River, and Total Maximum Daily Loads (TMDLs) for pesticides in the Central Valley. EPA continues to support many of the elements in the State's Workplan through technical and financial assistance.

Any EPA action taken as a result of this ANPR will complement the Water Boards' actions, as EPA's priority is to support and augment these efforts. As these efforts unfold, EPA will monitor their progress and determine whether additional actions, consistent with its statutory authorities and responsibilities, are needed to ensure that the requirements of the Clean Water

Act are satisfied. Finally, regardless of whether EPA pursues any new actions as a result of this ANPR, EPA believes the information gathered through the ANPR process may provide a factual basis for EPA's ongoing activities under the Clean Water Act, the National Environmental Policy Act,[16] and other federal statutes in the Bay Delta Estuary.

There are other federal and state water resource planning efforts underway in the Bay Delta Estuary. Stakeholders and relevant government agencies are engaged in developing the Bay Delta Conservation Plan (BDCP) under the federal ESA and the California Natural Community Conservation Plan Act (NCCP).[17] The BDCP focuses on the recovery of ESA-listed species and their habitat in the Bay Delta Estuary and is expected to include major proposals for changing how water is diverted and conveyed through the Bay Delta Estuary to the state and federal water export pumping facilities in the south Delta.[18] The EPA's responsibilities under the Clean Water Act to protect designated uses, such as estuarine habitat, fish migration, and threatened and endangered species, overlap with ESA requirements being addressed in the BDCP. Some actions taken pursuant to the BDCP will need to comply with both the ESA and Clean Water Act. To that end, EPA will ensure that any action it might take as a result of this ANPR will be closely coordinated with other federal and state actions related to the BDCP, any biological opinions on water operations affecting the Bay Delta Estuary, and any other actions requiring ESA compliance.

In addition, recent state legislation has established the Delta Stewardship Council (DSC), an independent state agency charged with developing a comprehensive resource management plan, the Delta Plan, by January 2012.[19] The Delta Plan is intended to guide state and local agencies to help achieve the State's coequal goals of a reliable water supply and a restored Delta ecosystem. To inform the Delta Plan, the DSC's Independent Science Board will evaluate the multiple stressors in the Bay Delta Estuary.[20] Any EPA action taken as a result of this ANPR will also be coordinated with this and other related efforts.

The National Academy of Sciences (NAS) has initiated a review of some aspects of the science supporting ESA protections in the Bay Delta Estuary. Much of that scientific information is also relevant to Clean Water Act programs. Accordingly, EPA is coordinating with the NAS to assure that scientific evaluations serve the multiple regulatory programs in the Bay Delta Estuary.

Many activities discussed in this notice have been or are now the subject of a formal or informal rulemaking process conducted by either EPA or by a related state or federal agency. Nothing in this notice is intended to supersede those ongoing processes, nor does this notice constitute a decision under any of those processes. If commenters have submitted material in connection with those processes that is relevant to the issues raised in this notice, commenters may either reference earlier submissions (if submitted to EPA), attach earlier submissions (if submitted to a different agency), or, if appropriate, provide a link to the material online.

Scope of this ANPR

This ANPR is focused on the most significant water quality factors adversely affecting aquatic species designated uses in the Bay Delta Estuary. Aquatic species, specifically the salmonids and pelagic species suffering significant population collapse during the last decade, brought the Bay Delta Estuary's water resource management issues into sharp focus in recent years. EPA recognizes that the Bay Delta Estuary supports over 750 species of fish, mammals, birds, reptiles, amphibians, invertebrates, and plants, and that forty or more of these species are listed under state and/or federal endangered species laws.[21] This ANPR is focused on aquatic species designated uses for waterbodies in the Bay Delta Estuary, but welcomes comment on how other species are being affected by water quality.

This ANPR does not comprehensively discuss water quality issues related to other designated uses, including drinking water, recreation, fish consumption, agriculture, etc. For example, water contact has been restricted in certain Bay Delta Estuary waters due to toxic blue-green algae blooms. EPA acknowledges the ongoing need to evaluate and address these other issues.

Nothing in this ANPR constrains the discretion of the President or his successors to make whatever budgetary or legislative proposals he or his successors deem appropriate or desirable. The expenditure of any money or the performance of any obligation of the United States emanating from this ANPR shall be contingent upon appropriation or allotment of funds in accordance with 31 U.S.C. Section 1341 (Anti-Deficiency Act).[22]

II. INTRODUCTION TO EPA ACTIVITIES IN THE BAY DELTA ESTUARY

A. Factual Background

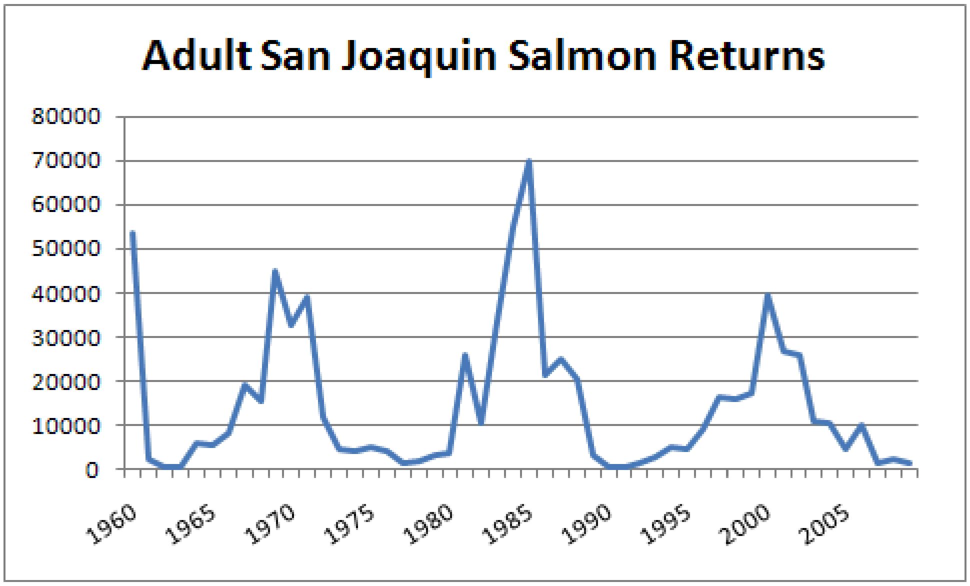
The Bay Delta Estuary is the intersection of two large river systems – the Sacramento and San Joaquin River basins – and a series of bays, marshes, and channels leading out to the San Francisco Bay and, ultimately, through the Golden Gate to the Pacific Ocean. Critical to California's social, political, economic and ecological well-being, the Bay Delta Estuary has long been the focus of competing interests (such as in-Delta agriculture, water exports, and flood control) that have significantly altered its waterways, flows, and adjacent lands. The Bay Delta Estuary is the hub of California's water distribution system, supplying drinking water to 25 million people and irrigation water to 4 million acres of farmland. Intensive urban and agricultural land uses in and upstream of the Bay Delta Estuary add an increasing and diverse array of water pollutants. As a result of these demands and stresses, the Bay Delta Estuary ecosystem, which is crucial habitat for many highly valued fish and wildlife species, has suffered greatly. Habitats are declining and fish populations have plummeted. Several species are listed as threatened or endangered under the ESA. Water quality in the Delta and its tributaries is impaired, contributing to the ecological and water supply crisis in the Bay Delta Estuary. The system is no longer a reliable source of high quality water for urban and agricultural use, especially in the quantities demanded in recent years. In addition, the Bay Delta Estuary's outdated earthen levees face an unacceptably high risk of breaching.[23]

1. Current State of Estuarine Resources

The decline of native fisheries in the Bay Delta Estuary over the past several decades is dramatic and well-documented.[24] The graphs below summarize that decline since the 1970's, for migratory and resident fish.[25]

The fall run of chinook salmon (*Onchorhynchus tshawytscha*) is the main run of salmon supporting the commercial and sport fisheries.[26] Winter run and spring run chinook salmon are listed as endangered and threatened, respectively, under the ESA. Central Valley populations of green sturgeon (*Acipenser transmontanus*) and steelhead trout (*Onchorhynchus mykiss*) are also listed as threatened.

Figure B. Adult San Joaquin Salmon Returns 1960-2009



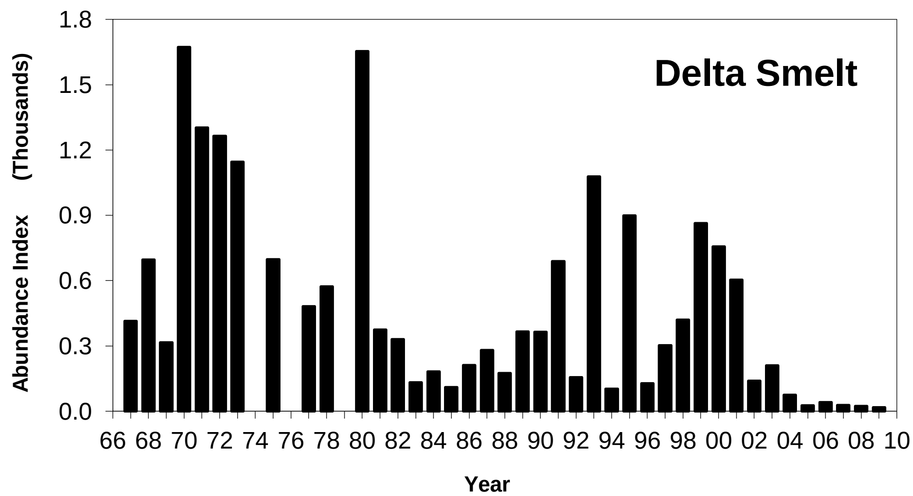
Commercial and sport fishing of salmon was cancelled by the Pacific Fishery Management Council for most of the western coast of North America in 2008 and 2009. A very limited season was authorized for 2010.[27]

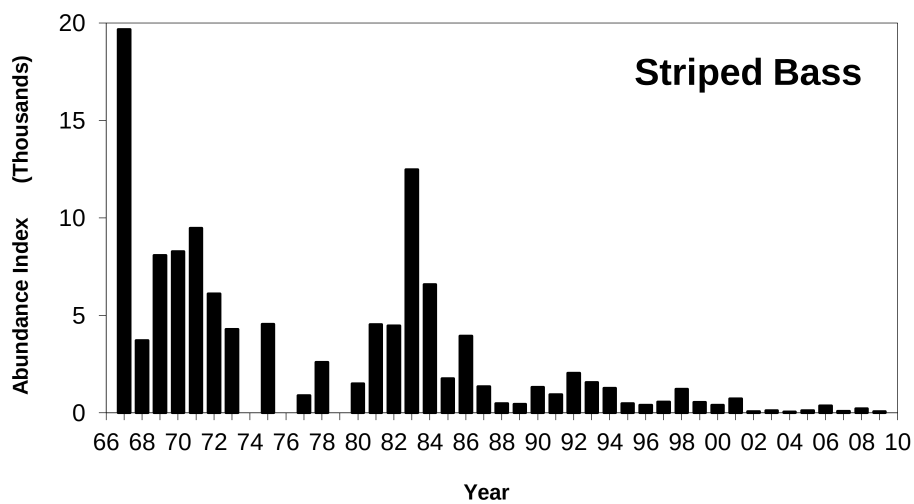
The decline between 2007 and 2010 in the abundance of salmon appears to be due to poor ocean conditions leading to very poor ocean survival of one and two year old fish.[28] However, the sensitivity of the species to these ocean conditions is heightened by the long-term decline in freshwater and estuarine conditions, including pollution, diversion, and loss of shallow habitats.[29] The loss of genetic diversity due to increased reliance on hatcheries has also contributed to reduced resilience of the fall run chinook salmon population. Impacts of the 2007-2009 drought on the adult salmonid population are not yet measurable due to the time lag between spawning and maturation.

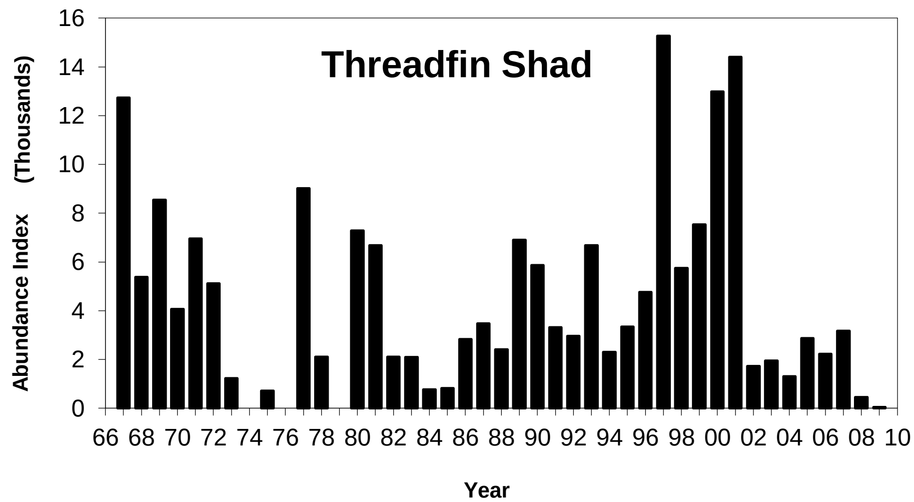
Many of the native and valued species of the upper Bay Delta Estuary are pelagic. Pelagic species live in open water, and are not usually associated with channel edges or physical structure. These species include two species (threadfin shad and striped bass) that were, until recently, the most abundant in the Bay Delta Estuary, as well as the ESA-listed delta and longfin smelt.

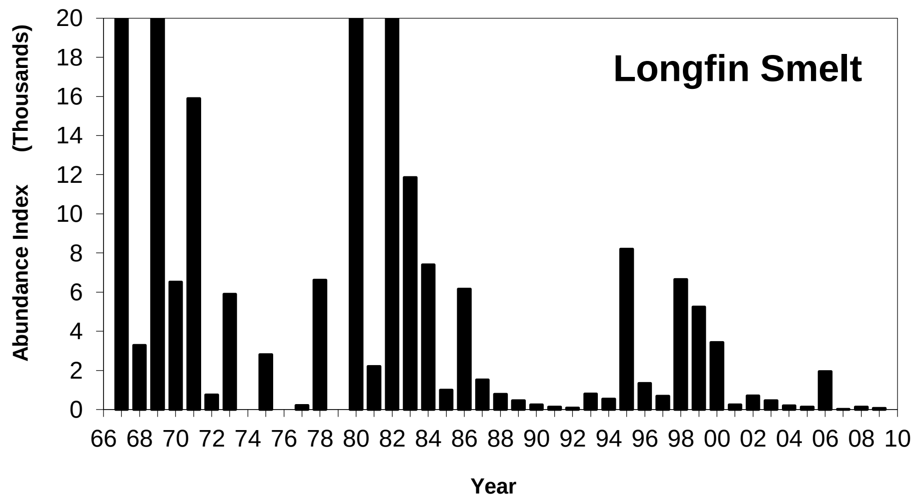
After 2001, many of the pelagic species suffered nearly simultaneous, sharp population declines despite relatively favorable hydrological conditions. The declines occurred without the weather patterns usually associated with year-to-year variations in abundance and with no obvious other cause. Even in wetter periods, which historically have been associated with higher numbers, several of these species had record low abundances.[30] The declining trends continued during the drought conditions of 2007-2009. Recent research indicates these declines represent an abrupt, significant drop in population abundance, rather than simply an extreme outcome of normal abundance cycles.[31]

Figure C. Trends in four pelagic fishes from 1967 to 2009 based on the Fall Midwater Trawl[32]









This sudden and unexpected decline (called the "Pelagic Organism Decline" or "POD") has been intensively studied. The Interagency Ecological Program (IEP)[33] began a number of investigations into likely causes of the decline including stock-recruitment, habitat degradation, increased predation or mortality at export facilities and changes in food web connections.[34] All of these factors changed in nature or intensity around the time of the decline and have been implicated in the resilience and abundance of these fish populations.

The government agency, academic, and stakeholder biologists studying the collapse of the pelagic and salmonid fisheries have identified several potential causes of the decline. These include:

(1) *Water project operations*. Sharp increases occurred in the number of fish trapped by and collected at the State Water Project (SWP) and Central Valley Project (CVP) export facilities at the same time that catches in all other collection programs declined and water exports out of the Bay Delta Estuary consistently increased.[35] After 2001, approximately 6 million acre-feet (MAF) of new water storage space became available south of the Delta. The availability of this new storage space enabled approximately 1 MAF of additional annual exports from 2001 through 2006. Total annual exports went from a maximum of about 5 MAF in the late 1990s to about 6 MAF in 2001-2007. Since that time, exports have dropped back down due to drought and ESA restrictions, but threatened and endangered fish populations have continued to stay at extremely low levels. Existing regulatory standards are oriented toward export restrictions in the spring to protect critical migration periods during high flow months. The 1 MAF of additional annual exports were generally taken during the fall and early winter months. The increased exports taken between 2001-2007 resulted in (1) greater levels of entrainment[36] and (2) reductions in Delta outflow and a parallel decline in the volume of estuarine habitat (measured by the areal extent of low salinity zones) for several species (delta smelt, striped bass, and threadfin shad) in the fall of those years.[37]

(2) *Invasive Species*. Invasive overbite clams have established year-round populations in the western Delta and are implicated in the reduction in abundance of both diatoms and zooplankton that are the base of the food web for pelagic fish.[38] At the same time, invasive jellyfish have become a large part of the pelagic environment and are known to compete with small fish for food and to prey directly on young fish. Further, the composition of the base of the food web has shifted to smaller and less nutritious invasive species.

(3) *Ocean conditions*. Ocean conditions (including limited ocean food sources and adverse temperature conditions) during the drought played a large part in the recent declines of anadromous fish, and upstream and migratory conditions made the populations less resilient to such oceanic stressors.[39] Ocean conditions alone appear to have little effect on the declining resident Delta fishes.[40]

(4) *Contaminants.* The contribution of water pollution, or contaminants, to the instability of the Bay Delta Estuary aquatic ecosystem and the specific role of contaminants in the decline of pelagic fishes has been examined in the past decade. Pyrethroid insecticide[41] use became much more common after the year 2000 and may be associated with tissue abnormalities found in delta smelt and striped bass.[42] Some pyrethroid insecticides are toxic to aquatic invertebrates, food for pelagic fishes, at very low levels.[43] In-Delta discharges from Delta islands are a source of contaminants to the Bay Delta Estuary. The composition of discharge from these Delta islands is largely uncharacterized; it consists primarily of irrigation return flow, levee seepage, and precipitation runoff.

Other contaminants are also present in the Bay Delta Estuary,[44] sometimes at toxic levels.[45] Ammonia/um discharges from the Sacramento and Stockton wastewater treatment plants led to loadings that could be expected to affect algal community composition and growth.[46] Although the Stockton plant converted to more effective levels of treatment in 2007, the Sacramento plant has continued to generate ammonia/um at levels that have prompted intensive examination of downstream impacts, particularly reductions in the growth of diatoms (which are the base of the food web for most pelagic fish). Chemical treatment of estuarine waters to combat the spread of submerged aquatic weeds began in 2002.[47] Summertime blooms of the toxic blue-green algae *Microcystis aeruginosa* became more widespread throughout the decade, extending downstream to the habitat usually occupied by delta smelt and young striped bass in 2007. Blue-green algal growth and blooms have been linked to ammonia loadings and herbicide treatments such as those used to treat aquatic weeds.[48]

Current research findings do not support the idea that a "single stressor" is responsible for the ecological changes in the Bay Delta Estuary.[49] Most research supports the idea of multiple stressors, interacting in concert, as the cause of the Bay Delta Estuary ecosystem decline. Most efforts at synthesizing Bay Delta Estuary research have converged on a vision of an ecosystem that is shifting its species composition in response to a suite of changes in flow, nutrients, contaminants, temperature and turbidity.[50]

2. Defining a Functional Estuary in a Changing Environment

Research efforts that began as a response to the POD have identified several significant and fundamental changes in the physical nature of the Bay Delta Estuary: water temperatures and water clarity have been increasing; nitrogen loading has been increasing while phosphorus loading has been decreasing, resulting in substantial changes in nutrient ratios; and water exports have been substantially increasing while outflows to the San Francisco Bay have been low and stable for much of the year. Simultaneously, the ecological community of the upper Bay Delta Estuary appears to have shifted from a food web based on diatoms, large copepods, and pelagic fish to one of cyanobacteria, jellyfish, clams, and emergent vegetation housing large populations of the predatory largemouth bass and their relatives. Species which prefer the shallow edges of riverbeds, such as non-native sunfish, bass, and minnows that live among invasive submerged vegetation, have become dominant. This change is associated with habitat shifts, as introduced vegetative coverage has increased each year.[51] The aquatic resources of the Bay Delta Estuary seem to be shifting from the former pelagic, estuarine community to an assemblage of invasive species more characteristic of a eutrophic stable system, including harmful algal blooms, jellyfish, clams, and freshwater fishes.[52]

Many, if not most, of these fundamental changes in Bay Delta Estuary ecology are the result of human activities over the past century or more: 800 million cubic yards of gold rush mining debris; the reclamation of delta islands for human use; the dredging, deepening and channelization of waterways; the export of significant amounts of water; the introduction of undesirable invasive species; and the introduction and the increase of a wide range of contaminants into the Bay Delta Estuary's waterways.[53] Equally significant additional changes affecting the Bay Delta Estuary will challenge resource managers in the future. The antiquated levee system - a system that has suffered at least 160 major levee failures over the past century[54] - will face new stresses from continued subsidence, seismic events, and climate change-induced rise in sea levels.[55] The pattern and nature of precipitation is also anticipated to change, as less snow and more rain present additional challenges for the flood control system in the Bay Delta Estuary and for water resource managers. Changes in precipitation and runoff patterns, combined with warmer air temperatures, will continue to raise water temperatures. [56]

Given these current and probable future changes in the Bay Delta Estuary, the challenge for California and federal regulatory agencies and water resource managers is to align regulatory programs and public investments to enable the Bay Delta Estuary to achieve all of its desired uses.

B. EPA Programs in the Bay Delta Estuary

Two federal statutes under EPA jurisdiction are important to Bay Delta Estuary aquatic resource issues. The most relevant is the federal Clean Water Act, which establishes standards for protecting the nation's water resources and establishes implementation approaches for point source discharges and nonpoint sources of pollution.[57] Under the Clean Water Act, EPA is authorized to delegate many Clean Water Act programs to requesting qualified states and tribes. In California, most of the Clean Water Act programs have been formally delegated to the State, with EPA retaining an oversight role and, in some cases, a mandatory review and approval role.

In addition to the Clean Water Act, the Federal Insecticide, Fungicide, and Rodenticide Act, 7 U.S.C. Sections 136 et seq. (FIFRA) governs pesticide use nationally and prescribes restrictions on the use of pesticides to assure reasonable certainty of no harm to aquatic species in the Bay Delta Estuary, taking into account the economic, social, and environmental costs and benefits of the pesticide use. Under FIFRA, EPA has accorded primary enforcement responsibility for pesticide use violations (primacy) to California, with EPA providing funding and technical assistance.

1. Clean Water Act

There are several regulatory components of the Clean Water Act that affect Bay Delta Estuary issues: water quality standards under Section 303(c) , point source discharge regulation under the National Pollution Discharge Elimination System (NPDES) program under Section 402, the listing of impaired waters with responsive Total Maximum Daily Load (TMDL) calculations under Section 303(d), nonpoint source management programs under Section 319, and the wetlands regulatory program under Section 404. EPA also provides annual grants to California to carry out Clean Water Act programs, including the programs under Sections 106 and 319. In 2010 alone, these grant programs provided more than $22 million to programs in California. In addition, each year EPA provides California with two large capitalization grants, one under the Clean Water Act and another under the Safe Drinking Water Act (SDWA). These funds are added to California's revolving loan programs which provide low-interest financing for a range of water quality and environmental improvement projects. Since 2008, EPA has awarded California $942 million through these two grant programs. In addition, through the National Estuary Program under Section 320, EPA provides additional funding to the San Francisco Estuary Partnership (as described below).

a. Water Quality Standards

Water quality standards (WQS) serve as the foundation for the water-quality based approach to pollution control and are a fundamental component of watershed management.
Section 303(c) of the Clean Water Act establishes the basis for the current water quality

standards program. That section:

1. Defines water quality standards;[58]

2. Identifies acceptable designated uses: public water supply, propagation of fish and wildlife, recreational purposes, agricultural and industrial water supplies and navigation;

3. Requires that state and tribal standards protect public health or welfare, enhance the quality of water and serve the purposes of the Act;[59]

4. Requires that states and tribes review their standards every three years; and

5. Establishes the process for EPA review and approval of state and tribal standards, including, where necessary, the promulgation of a superseding federal rule in cases where a state's or tribe's standards are not consistent with applicable requirements of the Clean Water Act or in situations where the Administrator determines that federal standards are necessary to meet the requirements of the Act.

Generally, states establish water quality standards on a watershed or broader basis, but they can also address unique aquatic circumstances through the use of site-specific standards. These site-specific standards can apply to a single waterbody or a particular segment of a waterbody, where hydrological or other factors make a broadly-applicable standard unacceptable.

Water quality standards for the Bay Delta Estuary waters are contained in three separate water quality control plans: (1) the State Board's 2006 Water Quality Control Plan for the San Francisco Bay/Sacramento-San Joaquin Delta Estuary (2006 WQCP), (2) Central Valley RWQCB's 2009 Sacramento River and San Joaquin River Water Quality Control Plan and (3) San Francisco Bay RWQCB's 2007 Water Quality Control Plan for the San Francisco Bay Basin. These plans contain water quality standards for the Bay Delta Estuary, including designated uses and water quality criteria. The State Board's 2006 WQCP is the final authority with respect to any overlap between the Regional Water Boards' water quality control plans. Collectively, these water quality control plans identify designated uses for Bay Delta Estuary waters that include: municipal, domestic, industrial, and agricultural water supply, groundwater recharge, navigation, water recreation, fishing, warm and coldwater habitat, migration habitat, spawning and reproduction habitat, wildlife, estuarine, and rare, threatened and endangered species habitat.

Narrative and numeric water quality criteria are established in each of the three water quality control plans to protect designated uses. The State Board's 2006 WQCP establishes flow criteria while the Regional Boards' plans contain contaminant criteria.[60] The 2006 WQCP protects fish and wildlife designated uses with ten water quality criteria focused on controlling levels of salinity, dissolved oxygen, and flow characteristics (volume, frequency, duration, timing, and direction of flow). The majority of criteria set numeric limits for the allowable amounts of pollutants (e.g., salinity or dissolved oxygen) or establish flow restrictions or characteristics that must be met at specific locations and times throughout the Delta based on the type of water year.[61] The Regional Boards' plans use narrative criteria for broad categories such as toxicity and use numeric criteria for specific contaminants such as chlorpyrifos and ammonia.

b. Point Source Regulation

The Clean Water Act requires EPA (or, in the case of delegated states such as California, the State) to control point source discharges through the issuance of NPDES permits, which may be issued for fixed terms that may not exceed five years.[62] EPA has issued comprehensive regulations that implement the NPDES program at 40 CFR part 122. The Clean Water Act also provides for the development of technology-based and water quality-based effluent limitations that are imposed through NPDES permits to control the discharge of pollutants from point sources.[63]

The Clean Water Act directs EPA to promulgate effluent limitations guidelines and standards (effluent guidelines) that reflect pollutant reductions that can be achieved by categories or subcategories of industrial point sources using technologies that represent the appropriate level of control.[64] For point sources that introduce pollutants directly into the waters of the United States (direct dischargers), the effluent limitations guidelines and standards promulgated by EPA are implemented through NPDES permits.[65] For sources that discharge to Publicly Owned Treatment Works (POTWs) (indirect dischargers), EPA promulgates pretreatment standards that apply directly to those sources and are enforced by POTWs and state and federal authorities.[66]

Two particular types of point source discharges are of particular interest in the Bay Delta Estuary. First, discharges from POTWs have been identified as possible contributors to impairments in the Bay Delta Estuary. There are ten POTWs discharging into the Bay Delta Estuary with a discharge capacity of 10 million gallons/day or more.[67] In recent years, the Water Boards have been updating and, generally, strengthening effluent discharge restrictions in some of the NPDES permits.[68] For example, the renewal of the City of Stockton's Waste Water Treatment Plant NPDES permit in 2002[69] and subsequent Cease and Desist Order[70] required a wastewater treatment plant upgrade including nitrification facilities to meet effluent restrictions on ammonia/ammonium discharges and protect downstream designated uses.

The second type of discharge particularly relevant in the Bay Delta Estuary is stormwater discharge. In 1987 Congress amended the Clean Water Act, adding section 402(p) which created a phased approach to the regulation of stormwater discharges under the Clean Water Act. EPA's Phase I stormwater regulations in 1990 established requirements for medium (serving between 100,000 and 250,000 people) and large (serving 250,000 people) municipal separate storm sewer systems (MS4s) and discharges associated with industrial activity.[71] In its 1999 Phase II stormwater regulations, EPA designated discharges associated with small construction activity and discharges from small MS4s (less than 100,000 people and located within an urbanized area defined by the Bureau of the Census) for regulation under the Clean Water Act.[72] In certain situations, a stormwater discharge may be more appropriately and effectively regulated by an individual permit, a region-specific general permit, or by inclusion in an existing Phase I permit. Thus, under current EPA regulations, there are three general categories of stormwater discharges that are directly regulated by EPA and California under the Clean Water Act: discharges from

MS4s, discharges associated with construction activity, and discharges associated with industrial activity.[73] In California, permits for discharges of stormwater are issued by the Regional Water Boards or the State Board.

Discharges from MS4s: An "MS4" is a conveyance or system of conveyances (including roads with drainage systems, municipal streets, catch basins, curbs, gutters, ditches, man-made channels, or storm drains): (i) owned or operated by a public body; (ii) designed or used for collecting or conveying stormwater; (iii) which is not a combined sewer; and (iv) which is not part of a Publicly Owned Treatment Works (POTW).[74] In California, large and medium MS4s obtain individual NPDES permits from the Regional Water Boards. The Central Valley RWQCB issues permits to the majority of the stormwater discharges from MS4s to the Bay Delta Estuary and its tributaries. Small MS4s include systems similar to general municipal storm sewer systems, such as systems at military bases, large hospital or prison complexes, and highways and other thoroughfares, but do not include separate storm sewers in very discrete areas, such as individual buildings.[75] In 2003, the State Board adopted a statewide general permit for discharges from small MS4s.[76]

Stormwater Discharges Associated with Construction Activity: Discharges associated with "large" construction activity includes those discharges associated with clearing, grading, and excavation of five acres or greater of total land area.[77] Discharges associated with "small" construction activity includes those discharges associated with clearing, grading and excavation that results in land disturbance of equal to or greater than one acre and less than five acres.[78] In California, stormwater discharges from construction sites are permitted by individual NPDES permits issued by the Regional Boards or the California Construction General Permit[79] issued by the State Board.

Stormwater Discharges Associated with Industrial Activity: Discharges associated with industrial activity include those from any conveyance that is used for collecting and conveying stormwater and that is directly related to manufacturing, processing or raw materials storage areas at an industrial plant as laid out at 40 C.F.R. 122.26(b)(14)(i)-(x). In California, stormwater discharges associated with industrial activity are permitted by individual NPDES permits issued by the Regional Boards or the California Industrial Stormwater General Permit (97-03-DWQ) issued by the State Board.

In addition to the above three general categories of stormwater discharges subject to regulation, both EPA and California have the authority to require NPDES permits for additional stormwater discharges that are currently not directly regulated under the Clean Water Act by using their residual designation authority. EPA and/or California may require a permit for an unregulated stormwater discharge if it determines that either (1) stormwater controls are needed for the discharge based on waste load allocations that are part of total maximum daily loads that address the pollutant(s) of concern; or (2) the discharge or category of discharges within a geographic area contributes to a violation of a water quality standard or is a significant contributor of pollutants to waters of the United States.[80] Additionally, EPA or California may designate small MS4s whose discharges are currently unregulated for NPDES permit coverage.[81]

c. Total Maximum Daily Loads

Regulation of point sources is not always sufficient to attain ambient water quality standards in all waterbodies. Clean Water Act Section 303(d)(1)(A) requires each state to identify and prioritize those waters where technology-based controls are inadequate to attain WQS:

> Each State shall identify those waters within its boundaries for which the effluent limitations required by section 1311(b)(1)(A) and section 1311(b)(1)(B) of this title are not stringent enough to implement any water quality standards applicable to such waters. The State shall establish a priority ranking of such waters, taking into account the severity of the pollution and the uses to be made of such waters.[82]

The state's identification of such impaired waters constitutes the "303(d) list."[83] States have been required, since 1992, to submit their 303(d) lists to EPA for review and approval every two years.[84.] If it disapproves a state's list, EPA must establish a list for the state.[85]

For all waters identified under Section 303(d)(1)(A) as exceeding water quality standards, the Act provides:

> Each State shall establish for the waters identified in paragraph (1)(A) of this subsection, and in accordance with the priority ranking, the total maximum daily load, for those pollutants which the Administrator identifies under section 1314(a)(2) of this title as suitable for such calculation. Such load shall be established at a level necessary to implement the applicable water quality standards with seasonal variations and a margin of safety which takes into account any lack of knowledge concerning the relationship between effluent limitations and water quality.[86]

The term "total maximum daily load" (TMDL) is not explicitly defined in the Clean Water Act. EPA's current regulations define a TMDL for a pollutant as the sum of the "wasteload allocations" allocated to point sources, the "load allocations" allocated to nonpoint sources or natural background, and a margin of safety.[87] Therefore, a TMDL identifies the maximum amount of a pollutant that can be added to a waterbody (loading capacity) without exceeding water quality standards.[88]

States must establish TMDLs for waters where pollutants are "preventing or expected to prevent attainment of water quality standards."[89] Under Section 303(d)(2), EPA is required to review and approve or disapprove TMDLs established by states for listed waters.[90] In its review, EPA takes into consideration the legal and technical adequacy of the TMDL, which includes elements identified above and an implementation schedule. If it disapproves a state TMDL, EPA must establish the TMDL.[91] Implementation is the responsibility of states. In California, the Porter-Cologne Water Quality Control Act requires that a TMDL include an implementation plan.

TMDLs established pursuant to Section 303(d)(1) for impaired waters are not self-executing. Limitations in loadings identified for point sources (waste load allocations) are enforced through permits issued pursuant to Section 402 of the Act.[92] Limitations in loadings identified for nonpoint sources (i.e., "load allocations"), on the other hand, may only be "required" under state law.[93]

All of the waters within the Bay Delta Estuary are listed as impaired by at least one factor, either due to the presence of pollutants at unacceptable levels or the lack of maintaining certain conditions such as adequate levels of dissolved oxygen. The State Board revised and adopted a new 303(d) list in August 2010 and submitted that list to EPA for its review and approval. On November 12, 2010, EPA partially approved and partially disapproved California's list, adding additional water bodies and pollutants.[94]

In California, TMDLs are developed by the Regional Boards but are not final until approved by the State Board and EPA. EPA has approved TMDLs for salinity, boron, mercury, selenium, diazinon, chlorpyrifos, pathogens and low dissolved oxygen to address impairments affecting the Delta. The Central Valley RWQCB is developing a salinity TMDL for the San Joaquin River upstream of Vernalis, as well as a pesticides TMDL for the Central Valley.[95]

d. Nonpoint Source Management Program

Nonpoint source pollution – pollution caused by a wide range of activities including urban development, agriculture and forestry – is a major cause of water quality impairment nationally and in California. Two primary federal statutes establish a framework in California for addressing nonpoint source water pollution: Section 319 of the Clean Water Act and Section 6217 of the Coastal Zone Act Reauthorization Amendments of 1990 (CZARA). Together these statutes require the state to assess water quality problems associated with nonpoint source pollution and to develop programs to address these challenging problems. EPA oversees these nonpoint source programs and provides funding to the state for program implementation.

California's Porter-Cologne Water Quality Control Act designates the Water Boards as the state agencies with primary responsibility for water quality control in California and obligates them to address all discharges of waste that could affect the quality of the waters of the state, including potential nonpoint sources of pollution. The Porter-Cologne Water Quality Control Act's scope and implementation authorities are significantly broader than those found in the federal Clean Water Act. In addition to using the Porter-Cologne Water Quality Control Act's planning, permitting, and enforcement authorities to prevent and control nonpoint sources of pollution, the Water Boards have implemented a program of outreach, education, technical assistance and financial incentives.

California submitted an "upgraded" nonpoint source pollution control program to EPA and the National Oceanic and Atmospheric Administration (NOAA) on February 4, 2000. The *Plan for California's Nonpoint Source Pollution Control Program (Program Plan)* was jointly submitted by the State Board and the California Coastal Commission (CCC) to satisfy the requirements of the Clean Water Act Section 319 and CZARA Section 6217. NOAA and EPA found that California satisfied all conditions of program approval pursuant to CZARA Section 6217, set forth in the *Findings on the California Coastal Nonpoint Program*, transmitted to the State on July 17, 2000. Furthermore, EPA found that the Program Plan successfully incorporates the nine key elements pursuant to Clean Water Act Section 319, which characterize an effective and dynamic state nonpoint source program. The California Nonpoint Source Pollution Control Program was fully approved pursuant to CZARA Section 6217 and Clean Water Act Section 319. As a result, California has continued to receive at least $10 million from EPA annually to implement the nonpoint source program.

e. National Estuary Program (NEP)

The San Francisco Estuary Partnership (SFEP) was established in 1987 under the National Estuary Program pursuant to Clean Water Act Section 320. The purpose of each of the 28 designated NEPs is to collaboratively develop and implement an EPA-approved Comprehensive Conservation and Management Plan (CCMP) for the protection of local estuarine resources. Nationally, NEP structures provide for broad stakeholder involvement. SFEP's structure includes an Executive Council, a Steering Committee and an Implementation Committee to provide strategic direction to the Director and program staff. The CCMP's geographic scope encompasses 60,000 acres of watershed drainage to the San Francisco Bay and Delta. SFEP recently developed a strategic plan to direct resources to wetland and watershed restoration, water quality improvements through green infrastructure, and climate change readiness, with most activities focused on the nine Bay Area counties. SFEP oversees and tracks implementation of the CCMP (as completed in 1993 and revised in 2007), manages research and restoration projects, and educates the public about Bay Delta Estuary issues including wetlands, wildlife, aquatic resources and land use. SFEP is funded through an array of federal, state, and local grants and contracts. EPA provides annual funding to each NEP. In 2010, EPA provided SFEP with $800,000.

f. Wetlands Program

Section 404 of the Clean Water Act regulates the discharge of dredged and fill materials into waters of the United States.[96] Activities regulated under Clean Water Act Section 404 include discharging fill material (e.g., dirt) into waters for urban development, water resource projects (dams, levees, canals, and pipelines), infrastructure (utilities, roads, airports), and mining (in-stream gravel mining, tailings discharge from mountaintop coal mining). Section 404 requires a permit to be issued before dredged or fill material may be discharged into waters of the United States.

Clean Water Act Section 404 protects water quality by restricting the destruction (fill) of aquatic resources that maintain and improve water quality and serve other important functions.[97] Clean Water Act Section 404 prohibits granting a permit for the discharge of fill material into waters of the United States when there is a practicable alternative that is less damaging to the aquatic environment and when the proposed discharge would significantly degrade aquatic or other natural resources.[98] EPA promulgated the Section 404(b)(1) Guidelines to implement these basic concepts.

Administration of Clean Water Act Section 404 is divided between the U.S. Army Corps of Engineers (Corps) and EPA. The Corps administers the permitting program by processing individual and general permits, determining Clean Water Act jurisdiction, and conducting compliance assistance. The Corps writes regulations and develops national and district policies.

EPA is responsible for oversight, including writing regulations that must be followed in issuing 404 permits, developing policy and guidance, determining the scope of geographic jurisdiction, reviewing and commenting on individual permit applications, conducting enforcement actions against unpermitted fill activities, and, where appropriate, objecting to or vetoing individual 404 permits.

Fill activities that destroy wetlands and other slow-moving waterways are relevant to water quality, in that wetlands, sloughs, mudflats, floodplains, and similar aquatic resources perform water filtration services that reduce common types of water pollution, like excessive nutrients, sediment, municipal sewage, pesticides, and toxicity events. Wetlands, sloughs, and floodplains are flat areas where water moves slowly, allowing sediment to drop out of the water column and deposit on the bottom. Nutrients and other contaminants from pesticide and fertilizer application, animal waste, septic tanks, stormwater and municipal sewage are often absorbed by plant roots and microorganisms in the soil while other pollutants stick to sediment particles.[99] Wetlands can be so effective at removing pollutant loads that artificial wetlands are occasionally constructed to treat stormwater and wastewater.

Wetlands, sloughs and floodplains also provide important floodwater storage and aquatic habitat services, by absorbing flood waters in times of high precipitation and slowly releasing them back into the larger tributary system. This important service not only mitigates the economic damage of floods, it improves the quality of flood waters by allowing pollutants to settle out and be processed by vegetation and/or sediment microorganisms. These aquatic resources also provide necessary spawning, forage, and refuge habitat for fish and wildlife. Clean Water Act Section 404 protects these services by limiting the discharge of dredged and fill material and the subsequent destruction of wetlands.

g. State Water Quality Certification Program

The Clean Water Act Section 401 water quality certification program provides states with an opportunity to address aquatic resource impacts from federally issued permits and licenses. Section 401 restricts federal agencies from issuing a permit or license for any activity that may result in a discharge to waters of the United States from a point source until the state certifies that the proposed discharges do not violate water quality protection provisions. States have several options under the Clean Water Act Section 401 program. They can (1) grant certification, (2) grant certification with conditions, (3) deny certification, or (4) waive the requirement for certification. In California, the federal licenses and permits most frequently requiring Section 401 certification include Clean Water Act Section 404 permits, Federal Energy Regulatory Commission (FERC) hydropower licenses, and Rivers and Harbors Act Section 9 and 10 permits issued by the Corps.

2. Pesticide Regulation under the Clean Water Act and FIFRA

Pesticides are being discussed separately in this notice because they are regulated under at least two major statutes that take different approaches to regulation. First, some pesticides are classified as pollutants pursuant to the Clean Water Act, and, as such, are subject to the Clean Water Act programs outlined above (water quality standards, NPDES permits, TMDLs, nonpoint source management programs, etc.)

Pesticides are also regulated under Federal Insecticide, Fungicide and Rodenticide Act (FIFRA). Under FIFRA Section 3, every pesticide product must be registered with EPA or specifically exempted under FIFRA Section 25(b) before being sold or distributed in the United States. An applicant for a new registration or an existing registrant (collectively referred to as applicant here) must demonstrate to EPA's satisfaction that, among other things, the pesticide product, when used in accordance with widespread and commonly recognized practice, will not cause ''unreasonable adverse effects'' to humans or the environment. This safety determination requires EPA to weigh the risks of the use of the pesticide against any benefits. EPA must determine that the standard for registration contained in FIFRA is met before granting a registration. The three primary action points for EPA under FIFRA are registration, reregistration, and registration review.

1. *Registration*. Section 3 of FIFRA contains the requirements for registration. FIFRA Section 3(c)(2) provides EPA broad authority, before and after registration, to require scientific testing and submission of the resulting data to EPA by applicants for registration of pesticide products. An applicant must furnish EPA with data on the pesticide, its composition, toxicity, potential human exposure, environmental properties, and ecological effects, as well as information on its product performance (efficacy) in certain cases. Although the data requirements are imposed primarily as a part of initial registration, EPA is authorized under FIFRA Section 3(c)(2)(B) to require a registrant to develop and submit additional data to maintain a registration.

2. *Reregistration*. FIFRA Section 4 requires that EPA reregister each pesticide product first registered before November 1984. This date was chosen because pesticides registered before then, were not subject to the more stringent 1984 regulation review process. EPA has completed the reregistration/tolerance reassessment process for food use pesticides and expects to complete all reregistration activities by 2014.

3. *Registration review*. FIFRA section 3(g) mandates that all pesticide registrations are to be periodically reviewed. Changes in science, public policy, and pesticide use practices occur over time. Through the new registration review program implemented via a regulation promulgated in 2006,[100] EPA periodically reevaluates all registered pesticides to assure that they continue to meet the statutory standard of "no unreasonable adverse effects." Starting in 2006, registration review began to replace EPA's reregistration program as the mechanism for systematic review of existing pesticides.

A major component of the FIFRA program for protecting sensitive species is the reliance on pesticide container labeling to disseminate use restrictions. In addition to label instructions physically attached to pesticide containers, users are required to comply with geographically specific use limitations, if any, that are reflected in EPA's Endangered Species Protection Bulletins. Users are required to follow label and Bulletin instructions or they are subject to enforcement actions under the misuse provisions of FIFRA.

As discussed in detail below, pesticide registration for pesticides affecting Bay Delta Estuary aquatic resources has been the subject of intensive review and litigation in recent years.

III. PROGRAM AREAS FOR PUBLIC COMMENT

In this ANPR, EPA is asking the public to consider broadly whether EPA should take new or different actions under its programs to address problems in the Bay Delta Estuary. EPA is not limiting its request to actions that would require actual rulemaking; there may be a range of changes in EPA's activities in the Bay Delta Estuary that would be constructive, including enforcement, research, revisions to water quality standards, etc. Any change in EPA activities would be dependent on existing authority and the availability of existing or new resources. Any changes requiring EPA rulemaking would provide for public comment through the notice and comment rulemaking process.

A substantial amount of research was performed and evaluated in connection with the scientific review of the pelagic organism decline. As noted above, that process identified a number of potential stressors affecting the Bay Delta Estuary aquatic ecosystem. Many of those potential stressors are directly or indirectly affected by the EPA programs described above. EPA has identified certain topics for more focused consideration in this ANPR. These are:

- Ammonia
- Selenium
- Pesticides
- Contaminants of Emerging Concern
- Estuarine Habitat
- Fish Migration Corridors
- Wetlands

EPA has not made any attempt to rank these topics as to their importance in resolving Bay Delta Estuary issues.[101] EPA's preliminary evaluation suggests that each of these topics, if addressed, could contribute to a resolution of Bay Delta Estuary resource conflicts. While this ANPR discusses these topics separately, EPA is mindful that the more significant concern is the cumulative and interactive effects of multiple stressors on the Bay Delta Estuary's aquatic resources.

Commenters may also identify additional topics that impact Bay Delta Estuary resource management, if EPA has some programmatic involvement in the topic.

A. Contaminants

Poor water quality in the Bay Delta Estuary and its tributaries affects terrestrial and aquatic ecosystems, drinking water, recreation, industry, agriculture, and the local, state, and interstate economy. The State of California collects data on contaminants that degrade water quality to generate its Clean Water Act Section 303(d) list of water bodies with designated use impairments. All Bay Delta Estuary waters are impaired due to many different contaminants, including pesticides, manufacturing compounds, metals (including selenium), pathogens, nutrients/low dissolved oxygen, invasive species, salinity, and toxicity from unknown sources.[102] Some pesticides and metals are legacy problems, such as the banned organochlorine pesticide DDT and mercury from abandoned mines. Most contaminants contributing to poor water quality in the Bay Delta Estuary are the result of current-use compounds from industrial, agricultural, urban, transportation, and natural sources. In addition, there is growing concern about new classes of contaminants, such as pyrethroid pesticides, pharmaceuticals and personal care products.

Contaminant "toxicity" refers to effects ranging from death to behavioral abnormalities or other impairments to growth, reproduction and survival.[103] Numeric water quality criteria are usually identified for individual chemicals as concentrations that protect designated uses from toxicity due to short-term (acute) exposure and longer-term (chronic) exposure. In recent years, more attention has turned to the potential for contaminants, individually or in combination in the aquatic environment, to produce "sub-lethal" effects (e.g., glycogen depletion, cellular stress, impaired swimming ability, reduced reproductive success) that can lead to declining populations in sensitive species.

It is difficult to evaluate and address contaminants in the Bay Delta Estuary in the absence of a comprehensive water quality monitoring program. Some contaminants are monitored only on an incidental or occasional basis, or not at all. Consistent monitoring data over any particular time period is unavailable. Monitoring data is collected by multiple agencies, with little standardization of monitoring procedures, data quality assurance or presentation protocols, and is not readily accessible in any single database. This makes data interpretation difficult. EPA is working with the Water Boards and other partners to develop a comprehensive Regional Monitoring Program to address these problems.

Contaminants are considered one of the contributing factors in the abrupt drop in pelagic organisms. The IEP's Pelagic Organism Decline science review is investigating how individual contaminants affect pelagic species. Initial studies have somewhat conflicting conclusions. One study evaluated historic monitoring data of contaminants and Bay Delta Estuary organism population estimates and concluded that direct toxicity to POD species from contaminants in Bay Delta Estuary waters is unlikely to be the cause of the recent large population declines. That study also concluded, however, that contaminants cannot be ruled out as a major contributor to the POD due to the potential for direct toxicity to POD food sources and gaps in monitoring data that prevent a more complete evaluation.[104] Another study used statistical methods to evaluate the relationships between the POD and various hypothesized causes such as contaminants and water exports out of the Bay Delta Estuary. This statistical analysis suggested that contaminant loadings of ammonia and ammonium to the Bay Delta Estuary are more highly correlated with the POD than water exports over a 30-year period.[105] Other important studies show high levels of toxicity to aquatic invertebrates from urban stormwater pyrethroid pesticide loadings to Bay Delta Estuary tributaries[106] and sub-lethal, population-level impacts to sport fish from the mixture of contaminants in Bay Delta Estuary waters.[107]

The existing research indicates that contaminants are likely contributors to the POD and ecosystem collapse. It is a complex task to determine which of the contaminants in the Bay Delta Estuary are individually, or in combination with one another, or under specific physical conditions, responsible for the POD and current state of the Bay Delta Estuary aquatic ecosystem. A list of contaminants has emerged as potentially significant, including ammonia and ammonium, selenium, and pesticides. Another group of contaminants, usually containing some hormonally-active ingredients, are considered "contaminants of emerging concern" (CECs). The following sections examine these contaminants with respect to impacts to Bay Delta Estuary aquatic resources and source control provided by the current regulatory framework.

1. Request for Public Comment

Many activities discussed in this notice are already the subject of a formal or informal rulemaking process conducted by either EPA or a related state or federal agency. Nothing in this notice is intended to supersede those ongoing processes, nor does this notice constitute a decision under any of those processes. If commenters have submitted material in connection with those other processes that is believed to be relevant to the issues raised in this notice, the commenter may either reference the earlier submission (if it was submitted to EPA), attach the earlier submission (if it was submitted to a different agency), or, if appropriate, provide a link to the material online.

Please provide the reason(s) for answers to the following questions and scientific, policy, and/or legal information with citations that support your comments.

1. Are there contaminants, other than those named above, causing adverse impacts to aquatic resource designated uses in the Bay Delta Estuary and that should receive more focused review?

2. How can pollutant-specific water quality criteria effectively address or incorporate interactive effects between multiple contaminants and other physical, chemical, and biological stressors?

3. What methods can be used in developing and implementing TMDLs to effectively address or incorporate interactive effects between multiple contaminants and other physical, chemical, and biological stressors on individual water bodies or for water bodies within a watershed?

4. What information exists about how climate change impacts will affect contaminant pollution (generally or for individual contaminants)?

2. Ammonia: Toxic and Nutrient Effects

a. Aquatic Resource Issues

Background

Total ammonia nitrogen in aquatic systems is both a toxic substance and a source of nutrients for aquatic plants, depending on its form. Ammonia is a chemical compound containing nitrogen that exists in two forms in water, un-ionized ammonia (NH_3) gas and dissolved ionized ammonium (NH_4+).[108] This document will use the term un-ionized ammonia to refer to ammonia gas (NH_3), ammonium to refer to the ammonium ion (NH_4+) and total ammonia nitrogen to refer to the combination of ammonia and ammonium. Un-ionized ammonia gas is toxic to vertebrates[109] and ammonium is a source of nitrogen, a necessary nutrient, for aquatic plants. Total ammonia nitrogen is the term used to inclusively refer to both un-ionized ammonia gas and ammonium and their collective impacts.

Total ammonia nitrogen toxicity is primarily a function of pH but also depends on temperature and salinity. Total ammonia nitrogen is toxic to all forms of aquatic life.[110] Un-ionized ammonia is considerably more toxic to vertebrates than ammonium; toxicity increases with pH as the proportion of un-ionized ammonia to ammonium increases. Toxicity decreases with pH as the proportion of ammonium rises. Nevertheless, ammonium makes a relevant contribution to total ammonia nitrogen toxicity. Toxic effects of total ammonia nitrogen exist at lower pH[111] and some aquatic invertebrates may be more sensitive to ammonium than to un-ionized ammonia.[112]

Un-ionized ammonia is especially harmful to vertebrates in aquatic environments where ambient total ammonia nitrogen levels can become concentrated. High levels of un-ionized ammonia gas in water reverse the diffusive gradient of un-ionized ammonia movement out of cells, leading to a rise of ammonia gas in the blood stream, which causes cell death in the central nervous system, convulsions, coma and death.[113] Non-lethal impacts of ammonia gas on fish include swelling and thickening of gills, respiratory and oxidative stress, and increased occurrences of gill disease from parasites and harmful bacteria.[114]

Around the country, excessive total ammonia nitrogen is a water pollution problem because it is a source of nitrogen. Although some amount of nitrogen is necessary for plant growth, elevated amounts can inhibit plant growth. Excessive nitrogen stimulates harmful blooms of some types of algae (phytoplankton), which in turn reduce dissolved oxygen during algae decomposition and can lead to die-offs of aquatic animals. Elevated levels of ammonium are also known to inhibit growth of some types of desirable estuarine phytoplankton such as diatoms. These conditions reduce ecosystem biodiversity and stability after prolonged periods. Harmful algal blooms also cause taste and odor problems in drinking water and cause respiratory distress and neurological problems in human recreational users.[115]

One unique characteristic of the Bay Delta Estuary is that it has both excessive nutrient loadings and low phytoplankton primary productivity. The Bay Delta Estuary is one of the least productive tidal estuaries in the world. Between the late 1970's and 1990's phytoplankton biomass and photosynthetic productivity declined 60% and 40% respectively.[116] Ammonium loadings to the Bay Delta Estuary have increased since the 1980's and may be one reason why phytoplankton biomass and productivity have decreased. Excessive nutrients are often associated with high primary productivity and algal blooms. In the Bay Delta Estuary, however, nutrient (ammonium) concentrations are high enough to inhibit growth of diatoms, important algae in the food web.[117]

Total ammonia nitrogen sources in the Bay Delta Estuary include wastewater treatment plants and agricultural and urban runoff containing ammonium fertilizers and animal waste. The largest total ammonia nitrogen point sources affecting the Bay Delta Estuary are wastewater treatment plants.[118]

Total Ammonia Nitrogen and the Decline of Bay Delta Estuary Pelagic Organisms

Total ammonia nitrogen discharges to the Bay Delta Estuary are one of the potential contributors to the long-term decline and recent collapse of pelagic organism populations and the Bay Delta Estuary food web. The relationship between total ammonia nitrogen levels and plunging fish populations is being actively investigated by the U.S. Geological Survey (USGS), the State Board, the Central Valley RWQCB, the Interagency Ecological Program, academic research groups, and some water supply agencies. Collectively, these research efforts suggest that total ammonia nitrogen concentrations in the Bay Delta Estuary may be contributing to the decline in pelagic fishes through one or more of the following mechanisms: (1) direct toxicity to pelagic fishes; (2) toxicity to pelagic organism food sources; (3) increased toxicity to pelagic organisms in the presence of other contaminants or physical conditions; and/or (4) by contributing to trophic (ecosystem) food web changes that negatively impact resource availability for pelagic species.[119]

Total ammonia nitrogen levels observed in the Bay Delta Estuary may be directly toxic to pelagic species, such as delta smelt, and their food sources. Increases in total ammonia nitrogen loadings to the Bay Delta Estuary are correlated with decreases in fish[120] and copepod populations;[121] however, the relative contribution of total ammonia nitrogen versus other variables (hydrologic modification, water exports, invasive species, other contaminants) to the pelagic organism decline is unclear.

Completed toxicity investigations on delta smelt suggest that ambient total ammonia nitrogen concentrations present in the Bay Delta Estuary do not cause acute toxicity in delta smelt.[122] Chronic toxicity conditions for delta smelt potentially exist when pH is greater than 8.0;[123] however, the Central Valley RWQCB reports that pH levels in the Delta do not often exceed 8.0.[124]

Ambient total ammonia nitrogen levels in the Bay Delta Estuary may be contributing to acute and chronic toxicity in copepods, an important pelagic fish food source. Ten percent mortality was observed in copepods at ambient Bay Delta Estuary concentrations, indicating the potential for acute total ammonia nitrogen toxicity.[125] Preliminary experimental data show a negative effect on copepod reproduction and survival rates at ambient ammonia concentrations commonly observed in the Bay Delta Estuary.[126]

The toxic effect of total ammonia nitrogen on pelagic species and food sources may occur at lower concentrations than established toxicity endpoints when present with other contaminants or due to differences between toxicity testing and exposure in natural environments. Multi-pollutant experiments show that copepods may be considerably more sensitive to total ammonia nitrogen concentrations in the presence of copper and pesticides.[127] Methods for establishing toxicity end points use delta smelt larvae reared in hatcheries that may be healthier and less vulnerable to pollutant exposures than delta smelt larvae reared in the Bay Delta Estuary exposed to a mixture of pollutants from the start of their life cycle. Similarly, toxicity identification experiments for individual species generally use non-swimming fish even though there is evidence that swimming, unfed fish may be several times more sensitive to ambient ammonia levels than laboratory exposures.[128]

Abundant nitrogen from increased ammonium discharges into Bay Delta Estuary waters may be a significant variable contributing to changes that negatively impact the food supply for pelagic organisms. The Bay Delta Estuary is characterized by some of the lowest photosynthetic (primary) productivity by phytoplankton in tidal systems globally. Phytoplankton productivity is the food supply for higher trophic level pelagic organisms. Ammonium loadings and other stressors to the Bay Delta Estuary have increased since the 1980's while phytoplankton biomass and productivity have decreased. Ammonium concentrations that inhibit phytoplankton growth rates are frequently present in the Bay Delta Estuary[129] along with multiple other stressors, such as high filtering rates from introduced clams, hydromodification, and presence of other contaminants that affect food web biomass and composition.[130]

The phytoplankton community in the Bay Delta Estuary has changed from one dominated by diatoms to one dominated by blue-green algae and flagellate phytoplankton species.[131] Diatoms were the primary food item for the calanoid copepod *Eurytemora affinis*, an important food source for pelagic fish.[132] Copepods prefer diatoms over blue-green algae and flagellates[133] potentially because diatoms are more nutritious, containing greater amounts highly unsaturated fatty acids than blue-green algae,[134] and calanoid copepods cannot capture small particles such as nutritionally rich nanoflagellates.[135]

The long-term decrease in phytoplankton biomass coupled with the change from a diatom-dominated community to blue-green algae and flagellate-dominated community represents a reduction in quality and quantity at the base of the food web that may affect fish populations. Diatoms are food for copepods; copepods are food for forage fish and other pelagic species; forage fish are food for both native and non-native fish species. As diatom biomass declined, so did some populations of copepods and crustaceans.

Increased loadings of total ammonia nitrogen to the Bay Delta, along with other variables, may contribute to the reduction of pelagic food sources and subsequently pelagic fish populations by supporting the growth of blue-green algae and suppressing growth of diatoms. Long-term population declines of Bay Delta Estuary pelagic fishes are correlated with long-term increases in wastewater effluent and ammonium loadings to Bay Delta Estuary waters.[136] Flagellates and blue-green algae may out-compete diatoms by preferentially using nitrogen in the form of ammonium,[137] while diatoms more easily use nitrogen in the form of nitrate.[138] Ambient ammonium levels in the Bay Delta Estuary inhibit diatom uptake of nitrate, suppress diatom growth, and prevent spring time diatom blooms that support higher trophic level pelagic species.[139] Phytoplankton composition and declining pelagic fish populations are also correlated with Bay Delta Estuary flows and water temperature.[140]

A recent important change in the Bay Delta Estuary food web composition is the increase in abundance of toxic blue-green algae, *Microcystis aeurginosa (Microcystis).* Blooms of *Microcystis* were first observed in 1999 and have quickly spread throughout the central and southern Delta. *Microcystis* exists as an algae layer on the water surface that impairs recreation activities, reduces dissolved oxygen, causes taste and odor problems in drinking water and toxicity problems in fish. Microcystin, the toxin produced by *Microcystis,* promotes tumors in fish, has been measured in phytoplankton, zooplankton, and fish tissue in the Bay Delta Estuary, and may be negatively impacting the health of striped bass and other Bay Delta Estuary fish.[141]

Estuarine fisheries may be impacted by *Microcystis* through direct toxicity from microcystin and/or indirectly through food web impacts from degraded nutritional value. *Microcystis* blooms are occurring with increasing frequency in the Bay Delta Estuary.[142] Some data show positive correlations between ammonia loadings to the Bay Delta Estuary and *Microcystis* abundance and distribution.[143] However, other research shows that high water temperature and stream flow has a stronger relationship with *Microcystis* cell density than nutrient loadings to the Bay Delta Estuary.[144]

b. Regulatory Status

i. Water Quality Standards

Water Quality Control Plans are written by the Water Boards and contain the state and region's applicable water quality standards, which are composed of designated uses and narrative or numeric criteria for regulated pollutants. Neither the State Board nor the Central Valley RWQCB has adopted narrative or numeric criteria specifically for total ammonia nitrogen, un-ionized ammonia or ammonium. They do, however, contain narrative toxicity criteria that prohibit concentrations of toxic substances that cause acute or chronic toxicity to aquatic life. The San Francisco RWQCB adopted numeric criteria for un-ionized ammonia concentrations (0.025 mg/L annual median) but the San Francisco Bay Water Quality Control Plan does not have numeric or narrative criteria for total ammonia nitrogen or ammonium.[145]

EPA publishes and periodically updates its recommended aquatic life water quality criteria to reflect the latest scientific knowledge. These criteria are a guide for states, territories, and tribes to develop water quality standards and a foundation for controlling discharges of total ammonia nitrogen into waterways. The 1999 EPA Aquatic Life Ambient Water Quality Criteria for Ammonia – the most recent final recommended criteria for ammonia – identifies the chronic limit for total ammonia nitrogen as 1.3 mg/L (measured by milligrams of nitrogen per liter of water at pH 8.0 and temperature 25 degrees Celsius).[146] The acute limit is 5.6 mg/L under the same test conditions. [147] Monitoring data indicate that Sacramento River and Bay Delta Estuary total ammonia nitrogen concentrations are below the 1999 EPA-recommended numeric water quality criteria for ammonia.[148]

Recent independent investigations in the Bay Delta Estuary raise the possibility that the 1999 EPA ammonia criteria may not be protective of pelagic species in the Bay Delta Estuary. The lethal concentration of total ammonia nitrogen for two copepod species, *Eurytemora affinis* and *Psuedodiaptomus forbesi* (an important pelagic fish food sources) occurs at or below the calculated 1999 EPA ammonia criteria, and the estimated chronic criterion concentration for these copepods is below the 1999 EPA chronic ammonia criteria.[149] A study at the University of California concluded that the chronic 1999 EPA ammonia criteria may not be protective of delta smelt because the lethal concentration of un-ionized ammonia for delta smelt is approaching the chronic criteria at high pH (8.3).[150] This study may not be conclusive in the Bay Delta Estuary because the Central Valley RWQCB found that pH values above 8.0 are rare in the Sacramento River downstream of the Sacramento Regional Wastewater Treatment Plant (WWTP).[151]

EPA proposed to update the recommended Ammonia Aquatic Life Criteria on December 20, 2009. The proposed acute limit is 2.0 mg/L (25 degrees Celsius, pH 8.0, mussels present);

the proposed chronic limit is 0.26 mg/L (25 degrees Celsius, pH 8.0, mussels present.)[152] Once final, the updated EPA criteria are not effective in California until the Water Boards adopt them as a change to their Basin Plans, the Water Boards use the updated criteria in effluent limitations in permits for point source discharges, or the EPA promulgates the updated criteria as a water quality standard for California.

It is unclear whether total ammonia nitrogen levels in the Bay Delta Estuary would meet or exceed the proposed 2009 Ammonia Aquatic Life Criteria. A Central Valley RWQCB field study shows that ambient ammonia concentrations measured in the Bay Delta Estuary between March 2009 and February 2010 did not exceed the proposed 2009 chronic ammonia criteria.[153] Contrary information submitted to the Central Valley RWQCB suggests that total ammonia nitrogen concentrations immediately outside of the Sacramento Regional WWTP mixing zone would have exceeded the proposed 2009 criteria 21 per cent of the time between 2007 and 2008 and 41 per cent of the time in 2009.[154]

ii. Point Source Ammonia Discharges

Regulating point source discharges of total ammonia nitrogen is a major component of the water quality regulatory approach in the Bay Delta Estuary. The Water Boards directly control point sources of total ammonia nitrogen through ammonia effluent limits in NPDES permits. In the absence of numeric ammonia criteria, these permits are generally designed to meet the narrative toxicity criteria. NPDES permit limits for ammonia are site-specific and are based on the 1999 EPA Aquatic Life Ambient Water Quality Criteria for Ammonia, the narrative toxicity criteria, effluent ammonia concentrations from the discharge source, concentration of total ammonia nitrogen in the receiving water body, and available dilution.

The major ammonia point sources affecting the Bay Delta Estuary are publicly owned treatment works (POTWs). The table below shows the permit status of these facilities. The two largest POTWs discharging treated sewage to the Bay Delta Estuary are the Sacramento Regional WWTP and the Stockton Regional Wastewater Control Facility (WWCF). Sacramento Regional WWTP is the largest wastewater discharge in the Bay Delta Estuary with an average dry design flow of 181 million gallons per day. The Sacramento Regional WWTP is the greatest source of ammonia/ammonium loading to the Bay Delta Estuary, discharging approximately 14 tons of ammonia/ammonium per day to the Sacramento River.[155]

The Central Valley RWQCB recently issued a new NPDES permit to the Sacramento Regional WWTP changing the ammonia effluent limits and requiring tertiary treatment and nitrogen removal.[156]

Major Ammonia NPDES Discharges in and near Delta[157]

Facility Name	Permit Expiration Date	NPDES Permit	Discharge Design Flow (million gallons/day)	Treatment Level Secondary (S) or Tertiary (T)	Ammonia Effluent Limit (mg/L)
Sacramento Regional Wastewater Treatment Plant (WWTP)	8/1/2005	R5-2000-0811	181	S	none
Stockton Regional Wastewater Control Facility (WWCF)	12/23/2014	R5-2008-0154	55	T	5
Central Contra Costa Sanitation District WWTP	3/31/2012	R2-2007-0008	53.8	S	none
Fairfield-Suisun WWTP	5/31/2014	R2-2009-0039	17.5	S	2
Vallejo Sanitary Flood Control District WWTP	9/30/2011	R2-2006-0056	15.5	S	none
Easterly WWTP	4/1/2013	R5-2008-0055	15	S	1.3
City of Woodland Water Pollution Control Facility (WPCF)	3/27/2009	R5-2009-0010	10.4	T	0.8
City of Manteca WPCF	10/1/2014	R5-2009-0095	9.9	T	1.4
Tracy WWTP	5/1/2014	R5-2008-0086	9	S	1.3
City of Lodi, White Slough WPCF	9/1/2012	R5-2007-0133	7	T	1.3
Mountain House WWTP	5/1/2012	R5-2007-0039	5.4	T	1
Brentwood WWTP	12/31/2012	R5-2008-0087	5	T	0.8
City of Benicia WWTP	3/1/2008	R2-2008-0014	4.5	S	35
Ironhouse Sanitary District WWTF	4/1/2013	R5-2008-0057	4.3	T	1.1
UC Davis Main WWTP	12/1/2013	R5-2008-0183	3.6	T	0.75[3]
Mt. View Sanitary District WWTP	5/17/2010	R2-2006-0063	3.2	S	8
City of Galt WWTP	1/1/2009	R5-2004-0001	3	T	3.5[2]
Discovery Bay WWTP	11/30/2013	R5-2008-0179	2.1	S	4.64[1]

1. Effluent limit at ph 8.0, T 26 deg C with salmonids present
2. Effluent limit at pH 7.1, T 22 deg 30 day average/
3. Effluent limit seasonal 0.75 mg/L 1 May – 31 Oct, 1.11 1 Nov – 30 April.

The Stockton Regional WWCF discharges have an average dry design flow of 55 million gallons/day, approximately one third the size of the Sacramento RWTP. The Stockton Regional WWCF was upgraded to include treatment processes that remove ammonia because it could not meet the ammonia effluent limits established in its 2002 NPDES permit.[158] The upgraded Stockton Regional WWCF is operating and significantly reducing ammonia in the treated effluent.[159]

iii. Nonpoint Source Ammonia Discharges

Potential nonpoint source discharges of total ammonia nitrogen into the Bay Delta Estuary include runoff from livestock waste, onsite waste water treatment systems (septic tanks) and runoff containing agricultural and urban fertilizer. There is limited information available about the volume of nonpoint sources of ammonia in the Bay Delta Estuary. A recent evaluation of nutrient loading to the Bay Delta Estuary by the Central Valley RWQCB suggests that the Sacramento Regional WWTP is the primary source of nitrogen to the Bay Delta Estuary downstream of the effluent discharge point from March 2009 to February 2010.[160] This suggests a limited contribution of total ammonia nitrogen from nonpoint sources.

c. Request for Public Comment

Many activities discussed in this notice are already the subject of a formal or informal rulemaking process conducted by either EPA or a related state or federal agency. Nothing in this notice is intended to supersede those ongoing processes, nor does this notice constitute a decision under any of those processes. If commenters have submitted material in connection with those other processes that is believed to be relevant to the issues raised in this notice, the commenter may either reference the earlier submission (if it was submitted to EPA), attach the earlier submission (if it was submitted to a different agency), or, if appropriate, provide a link to the material online.

Please provide the reason(s) for answers to the following questions and scientific, policy, and/or legal information with citations that support your comments.

1. What, if any, information is available on the sources or impacts of total ammonia nitrogen in the Bay Delta Estuary that is not reflected or cited above?

2. Is there any information available that suggests site-specific water quality standards for total ammonia nitrogen in the Bay Delta Estuary may be more effective than current standards due to unique hydrological, chemical, biological, or physical conditions?

3. What information is needed to determine effective site-specific water quality standards for total ammonia nitrogen, including narrative or numeric criteria?

4. What information is available on nonpoint sources of total ammonia nitrogen and how they may most effectively and efficiently be controlled?

3. Selenium

a. Aquatic Resource Issues

Selenium is a naturally occurring element that, when mobilized in the environment and transformed to organic, bioavailable forms, is highly bioaccumulative.[161] Although selenium is a micronutrient, it is highly dose-sensitive and can be toxic to organisms at very low levels of chronic exposure.[162] Selenium toxicity in fish and wildlife reduces reproductive success through effects that lower embryo survival, such as deformed growth (teratogenesis).[163] In California, the damaging consequences of toxic levels of selenium first came to public attention in the 1980s when deformed waterfowl were discovered at Kesterson Reservoir in the San Joaquin Valley. Subsequent research has substantially advanced understanding of selenium sources and mobilization in the Bay Delta Estuary, the processes through which selenium enters and builds up in the ecosystem, and the effects of selenium on different species. In particular, this science points to the role of site-specific conditions, such as hydrology, geochemistry, food web, and species characteristics in determining risk to aquatic life and wildlife.[164] The new information raises significant questions as to whether the existing regulatory regime adequately protects aquatic life and wildlife.[165]

Selenium is naturally present in certain soils of marine origin and can enter the environment when precipitation introduces the selenium-bearing deposit to water. Environmental problems with selenium typically occur when large amounts are mobilized through human activities such as irrigation, mining or processing of organic fuels. Once converted to an actively bioavailable form, selenium tends to stay in a bioavailable form – a characteristic that contributes to build up in the environment over time.[166] Selenium has several dissolved forms (notably selenate, selenite and organo-selenide) that differ in transformation rates and bioavailability. The least bioavailable form, selenate, can be reduced by organisms to selenite and then incorporated into cells as organo-selenium.

Aquatic food webs can be particularly efficient in taking up selenium and transferring it up the food web. At the base of the food web, microorganisms such as bacteria and algae take in and assimilate selenium from ambient water. Since biotic exposure to selenium occurs through diet, rates of exposure are affected by concentrations in species' food sources. Some prey species bioaccumulate selenium more efficiently than others. For example, *Corbula amurensis*, an introduced clam that occurs from San Pablo Bay through Suisun Bay and Marsh and the central and southern Delta, accumulates selenium at roughly three times the rate of supplanted native clam species.[167] As a result, predator species that feed on *Corbula*, such as diving ducks (scaups and scoters) and white sturgeon, suffer high exposure to bioaccumulated selenium. In contrast to the Delta-dwelling white sturgeon, green sturgeon are more sensitive to selenium but spend less time in the Bay and Delta waters; compared to white sturgeon, green sturgeon spend more time in marine waters and also upstream of the Delta in the Sacramento River.[168] In addition to duration of exposure, timing of exposure relative to sensitive life stages can be a factor in impacts. For example, concerns have been expressed about the possibility that juvenile salmon, which use the Delta and San Joaquin River, might be sensitive to selenium.[169]

Biological variables, such as species sensitivity to selenium and preferred habitat and diet, are among the reasons that water column concentration of selenium is not in itself a reliable indicator of exposure. Differences in hydrologic conditions and associated water chemistry also affect the degree to which selenium accumulates at a given site. Where waters are relatively still and flushing is limited (lentic systems), conditions promote build-up of the more bioavailable forms of selenium such as selenite. In flowing rivers or streams (lotic systems) both the flushing function of flows and the typical form of selenium (selenates) limit uptake.

The main controllable sources of selenium in the Bay Delta Estuary are agricultural drainage (generated by irrigation of seleniferous soils in the western side of the San Joaquin basin) and discharges from North Bay refineries (in processing selenium-rich crude oil from the southern San Joaquin Basin). Both the San Joaquin River and North Bay selenium loads have declined in the last 15 years in response to, first, a control program in the San Joaquin Grasslands area, and, second, NPDES permit requirements established for refineries in the late 1990s.[170] The annual loads of selenium (mostly as selenate) entering the Bay Delta Estuary from the San Joaquin and Sacramento rivers vary by water year (that is, by flow), but dissolved selenium loadings averaged 2,380 kg/year from the San Joaquin and 1,630 kg/year from the Sacramento in the 1990-2007 period.[171] The Sacramento River selenium concentration, however, is essentially at background levels (.06 +/- .02 micrograms/L), without evidence of significant controllable sources.

Pollutant loading, transport, and residence time in the Bay Delta Estuary could change appreciably as a result of actions that are under consideration or being implemented. These actions include increases in San Joaquin River flows to restore the river and salmon runs, changes in water supply conveyance and related channel flow in the Bay Delta Estuary, and habitat restoration projects within the Bay Delta Estuary. San Joaquin River restoration or other flow augmentation programs could change the capacity of flows to mobilize and transport selenium-rich water and suspended sediments into the Bay Delta Estuary. Within the Bay Delta Estuary, exposure to selenium could increase in planned restoration habitats such as wetlands and floodplains. Thus, while the actions may have beneficial ecosystem and/or water supply objectives, there is some risk of exacerbating the impacts of selenium unless corrective measures are taken.

b. Regulatory Status

i. Water Quality Standards

EPA promulgated ambient water quality criteria for selenium in the Bay Delta Estuary and watershed through the National Toxics Rule (NTR) in 1992. The National Toxics Rule values are reiterated in the California Toxics Rule, issued by EPA in 2000.[172] Subsequently, the California Toxics Rule and Water Boards' Basin Plan amendments have established consistent values for aquatic life. The applicable chronic aquatic life criterion (5 micrograms/L chronic exposure (four day average) measured as a water column concentration) is used more frequently than the acute value.[173] In the Grasslands waterways and Salt Slough, a more protective chronic value of 2 micrograms/L applies in consideration of sensitive listed species. The lentic conditions of water in the marshes were also a factor in setting these site-specific objectives.[174]

The existing criteria for waterbodies listed in the table below, "Current Water Quality

Standards," refer to longer-term (chronic) and short-term (acute) exposure of aquatic life to selenium. The numbers represent water column concentrations of dissolved selenium and suspended particulates. All criteria listed below are set for aquatic life. The more stringent criteria in the Grasslands marshes and nearby areas are intended to protect threatened and endangered species.

Current Water Quality Standards

LOCATION	**CRITERIA**		**REGULATORY ACTION**
	(Chronic)	**(Acute)**	
San Francisco Bay, including Suisun Bay and Marsh; Delta	5 microg/L – 4 day average	20 microg/L – 1 hr max	National Toxics Rule – 1992
San Joaquin River from Merced River to Vernalis	5 microg/L – 4 day average	12 microg/L – max instantaneous	Cent. Valley Region Basin Plan – 1996; National Toxics Rule – 1992 (chronic only)
Mud Slough; San Joaquin River from Sack Dam to Merced River	5 microg/L – 4 day average	20 microg/L – max instantaneous	Cent. Valley Region Basin Plan – 1996; National Toxics Rule – 1992
Grasslands marshes; Los Banos State WMA; San Luis NWR; Salt Slough	2 microg/L – monthly mean	20 microg/L – max instantaneous	Cent. Valley Region Basin Plan – 1996

The current selenium standards lack criteria specific to water-dependent wildlife,[175] do not account systematically for differences in the physical and chemical characteristics of waterbodies (e.g., lentic versus lotic water)[176] and use a measure (water column concentration, determined through dose-response tests) that is not a consistent indicator of exposure and environmental risk, because it fails to account for variables such as food web characteristics[177]. Water column values developed in a dose-response methodology, for example, do not take into account the relative efficiency of food webs in concentrating selenium. An 'efficient' food web would be one involving a selenium-sensitive species with a diet including a selenium-concentrating species (e.g., the clam, *Corbula*). Over the last decade EPA has been working with other agencies to expand the scientific knowledge of selenium and update regulatory tools.

Establishing a framework for regulating selenium that integrates protective requirements and implementation across a diverse watershed is challenging. For example, standards set to protect designated uses in lotic (flowing) systems may not protect downstream designated uses in a different environment in terms of hydrology, water chemistry, and food web relationships. Higher river flows can function to transport large, albeit dilute, loads of selenium that settle in quieter downstream locations susceptible to food web uptake. Recently presented data on concentrations of selenium in North Bay clams, which do not show a clear-cut decline in selenium despite reductions in water column concentrations in San Joaquin River water entering the Bay Delta Estuary, suggest that more information is needed to determine the relationship between river inputs and processes in the downstream environment that affect biotic uptake.[178]

Several efforts are underway to revise and expand standards for selenium in the Bay Delta Estuary. At the national level, EPA plans to propose Clean Water Act Section 304(a) selenium guidance criteria for aquatic life for freshwater. The guidance criteria will include chronic values only, and will distinguish between flowing and standing waters. These guidance criteria will form the basis for adopting protective water quality standards expressed as tissue concentration of selenium in fish egg or ovary and a corresponding water column concentration, where tissue concentration data are not available. Concentrations in tissue, such as bird eggs or fish tissue, better indicate actual exposure and, in combination with food web information, provide a basis for deriving site-specific numeric water column values.

The revised national guidance criteria will be supplemented by regional efforts. EPA Region 9, in conjunction with the USGS, USFWS, and NMFS, and pursuant to its obligations under the ESA, is developing criteria to protect threatened and endangered wildlife species, aquatic-dependent species and aquatic life in California. The first phase of this effort addresses the San Francisco Bay and Delta. It uses data on affected species and relies on the Presser-Luoma ecosystem-based model, a model that accounts for food web processes and site-specific conditions. [179] This phase is scheduled for completion in 2011, followed by a second phase for statewide criteria (including the San Joaquin River and its tributaries).

ii. TMDLs and Implementation

North San Francisco Bay, a three-mile reach of the San Joaquin River between Mud Slough and the Merced River confluence (downstream), and the six-mile reach of Mud Slough North downstream of the San Luis Drain are each listed as impaired for selenium.[180] These Clean Water Act listings, which appear in the 2010 Integrated Report, are based principally on evidence of ambient selenium exceeding concentration-based standards.[181] Reductions in selenium discharges from agriculture in the San Joaquin Basin have been a major factor in meeting water quality objectives in the San Joaquin River between the Merced and Vernalis. Based on this evidence, the State Board recently declined to list this section of the River but retained the listing for selenium impairment in the reach with lower flow between Mud Slough and the Merced River.[182] Delta waters are not considered impaired for selenium at the present time, largely on evidence of water column concentrations.

North Bay

Compliance with NPDES permit requirements by the oil refineries that discharge selenium in the North Bay has led to reduced loads and shifted the form of discharge towards selenate, rather than selenite.[183] Estimates of selenium loadings prior to improvements required in 1998 are in the range of 1700-2900 kg/year; improved wastewater treatment post-1998 has reduced loadings to an estimated 200 to 550 kg/year.[184] In March 2010, the San Francisco RWQCB amended four refinery permits, setting limits for total selenium, with a range from 34-50 micrograms/L maximum daily, and 33-42 micrograms/L average monthly. The limits are based on a 10:1 dilution credit, with reference to the 5 microgram/L NTR criterion.[185] The permit for a fifth refinery was amended in late 2009 to require similar limits.

These point sources are also incorporated into a TMDL being developed for selenium in the North Bay. The San Francisco RWQCB began work on the TMDL in 2007 and is now coordinating the schedule and completion date with the forthcoming EPA wildlife criteria and aquatic life guidance criteria. While there are some nonpoint sources within the North Bay watersheds, the two major anthropogenic sources of North Bay selenium are the point source refineries and agricultural drainage from the San Joaquin Basin.

San Joaquin Grassland Bypass Project

The Grasslands Bypass Project, located west of the San Joaquin River and spanning the boundary between Merced County on the north and Fresno County to the south, is the current focus for implementation of selenium controls in the San Joaquin Basin. This 97,000-acre area is the northern portion of the much larger drainage problem area (730,000 acres total) described in the federal document, San Luis Unit Drainage Feature Reevaluation.[186] The watershed affected by the Grasslands Bypass Project encompasses both irrigated agriculture and extensive private and publicly managed wetlands. Begun in 1995, the Project is significant because it includes most of the lands that discharge subsurface drainage to the San Joaquin River and Bay Delta Estuary.[187]

The Grasslands Bypass Project is designed to achieve immediate protection of sensitive wetlands by routing agricultural drainage water away from this habitat into the federal San Luis Drain (a lined drainage canal) and from there into Mud Slough. Six miles downstream of this discharge point, Mud Slough enters the San Joaquin River at a reach with typically low flows. Over time, selenium load reductions implemented by the Grasslands drainers are intended to lead to fully meeting water quality objectives for all waters, including Mud Slough and the San Joaquin River.

Three TMDLs, adopted between 1999 and 2002, are being implemented through the Grasslands Bypass Project.[188] The regulatory framework laid out in the Basin Plan (and reinforced by conditions in a Waste Discharge Requirement) sets immediate compliance for the marshes and Salt Slough (2 ppb, monthly mean) and allows a longer period to meet existing standards for Mud Slough and the River (5 ppb, 4 day average).[189] Some of the implementation framework is also provided in an Agreement for use of the Drain that has been negotiated between the U.S. Bureau of Reclamation (USBR) and the Delta-Mendota Water Authority.[190]

Implementation through drainage re-routing and reduction of selenium loads has resulted in meeting water quality objectives in the wetlands and Salt Slough and a 130 mile stretch of the San Joaquin River. Between 1996 and 2007, relying largely on control measures such as reduced water application, water conservation, and water recycling and use on salt tolerant crops, the project managers have reduced selenium loading to surface waters by approximately two-thirds.[191] The Project has not, however, achieved the load reductions needed to fully meet the objectives by the compliance date of October 2010 set by the Central Valley RWQCB. During the 15-year project period, the project managers have tested various technologies beyond on-site drainage management to meet selenium load-reduction targets but recently reported to the Central Valley RWQCB that full success in meeting the October 2010 date was hampered by delays in expected state funding assistance and technical difficulties with treatment technologies.[192] In a request to the State to extend the compliance period until 2019, the project managers expressed intent to introduce drainage treatment and disposal technologies that would result in eliminating discharges to the San Joaquin River, provided the funding and treatment technology issues are resolved. In approving this extension, the Water Boards emphasized that the Project is subject to a prohibition of discharge in 2019. Additionally, the project managers were directed to submit a progress report by January 2013 that includes a plan for compliance with the discharge prohibition and water quality objectives, even if drainage treatment is not found to be a feasible solution.[193]

Controlling selenium, once mobilized, is problematic. Feasible techniques for removal from the biotic system are not evident. Various approaches to removing selenium from water have been tested since Kesterson (e.g., use of algae or bacteria to remove selenium from water, resulting in bioavailable forms that can pose a disposal problem). Currently, membrane technologies (reverse osmosis) are also being investigated.

The amount of selenium stored in the San Joaquin Basin is such that contamination in the Basin and Delta can be expected for years - possibly centuries.[194] Unlike contaminants that can be readily reduced by ending use, selenium is now so widely distributed through the groundwater of the west side of the San Joaquin Basin that it can continue to be a problem even with efficient agricultural irrigation and drainage activities. The situation suggests a need for sustained management and regulatory strategies, as well as a continued commitment to research and assessment.[195]

c. Request for Public Comment

Many activities discussed in this notice are already the subject of a formal or informal rulemaking process conducted by either EPA or a related state or federal agency. Nothing in this notice is intended to supersede those ongoing processes, nor does this notice constitute a decision under any of those processes. If commenters have submitted material in connection with those other processes that is believed to be relevant to the issues raised in this notice, the commenter may either reference the earlier submission (if it was submitted to EPA), attach the earlier submission (if it was submitted to a different agency), or, if appropriate, provide a link to the material online.

Please provide the reason(s) for answers to the following questions and scientific, policy, and/or legal information and citations that support your comments.

1. What, if any, additional information is available to better characterize selenium sources, loadings and impacts within the watershed of the Bay Delta Estuary?

2. What data, studies, and analytical techniques (for example, models) could be used to improve our understanding of the physical processes, including surface-groundwater interactions, controlling selenium mobilization and transport to and within the Bay Delta Estuary?

3. What data are needed to track selenium impacts in the Bay Delta ecosystem as currently configured, and to evaluate potential impacts of selenium under changed flow and transport conditions into and within the Delta?

4. Are there additional selenium control methods or programs that should be considered for reducing selenium inputs and impacts?

4. Pesticides

a. Aquatic Resource Issues

General Information

Pesticides are any substance or mixture of substances intended for preventing, destroying, repelling, or mitigating pests. They include products such as insecticides, herbicides, fungicides, rodenticides, piscicides, and antimicrobials. Pesticides are applied indoors and outdoors to structures and landscapes, in urban, suburban and agricultural areas. They are used to control disease-causing or other harmful organisms, including rodents, insects, and weeds that threaten crops and property. Pesticides can, however, present a risk to human health and the environment because they are designed to adversely affect living organisms.[196]

Pesticides can cause water quality problems when they are deposited into aquatic environments where they are potentially toxic to non-target organisms. Pesticides may be transported to aquatic sites long distances from application areas by precipitation and overland flow, irrigation runoff and return flow, POTW and stormwater discharges, and atmospheric drift. The USGS National Water Quality Assessment Program analyzes surface waters throughout the United States for pesticides and found that 100% of streams examined contained at least one pesticide; more than 56% of surface water samples contained one or more pesticides in concentrations exceeding aquatic-life benchmarks.[197]

Pesticides in the Bay Delta Estuary

More than twenty years of water quality monitoring show pesticides present in California's Central Valley waterways, including the Bay Delta Estuary, at concentrations that affect aquatic ecosystems.[198] The Central Valley RWQCB measured insecticides in irrigation return flows and receiving waters and established a connection between elevated pesticide levels and toxicity events in the Sacramento and San Joaquin Rivers and the Bay Delta Estuary beginning in the late 1980's. This work documented many toxicity events related to pesticide loadings including: (1) toxicity to striped bass (*Morone saxatilis*) larvae, local invertebrate (*Neomysis mercedis*) and standard test invertebrate (*Cerodaphnia dubia*) in the Sacramento River during 1987-1990 from rice irrigation return flows;[199] (2) invertebrate toxicity along a 43-mile stretch of the San Joaquin River about 50% of the time between 1988 and 1990;[200] (3) 3-day and 12-day invertebrate toxicity events at two sampling locations within the Bay Delta Estuary in 1993 related to orchard insecticides;[201] (4) consistent invertebrate toxicity in the mid-1990's from insecticides in urban stormwater runoff that discharges directly to the Bay Delta Estuary from Central Valley and Bay Area Cities;[202]and (5) multiple diazinon toxicity events in the San Joaquin River at Vernalis, Sacramento Slough, and Orestimba Creek during January and February of 1996 and 1997.[203] Algal toxicity was also observed as a result of herbicides in combination with elevated copper and zinc.[204] More recent research documents toxic conditions for invertebrates caused by pyrethroid pesticides on a 30 km stretch of the American River, a tributary to the Sacramento River and Bay Delta Estuary, in the winter of 2009 from urban stormwater discharges.[205] The majority of this toxicity was attributed to bifenthrin.

Aquatic habitat designated uses are impaired in all of the Bay Delta Estuary waterways by various pesticide pollutants including: Group A pesticides (aldrin, endrin, heptachlor, heptachlor epoxide, hexachlorecyclohexane (including lindane), endosulfan, and toxaphene), chlordane, dieldrin, chlorpyrifos, diazinon, DDT, and unknown toxicity.[206] Tributaries upstream of the Bay Delta Estuary are also impaired for many different current-use pesticides including, but not limited to, bifenthrin, dimethoate, dacthal, malathion, diuron, simazine, trifuluralin, and cis-permethrin.[207] In addition, pesticide investigations in the Bay Delta Estuary and upstream tributaries indicate that the source contaminant for "unknown toxicity"[208] most likely involves current-use pesticides, which have been detected in surface waters throughout the Bay Delta Estuary (e.g., diazinon and bifenthrin).[209]

Sources of pesticides to the Bay Delta Estuary include urban point source (POTW and stormwater outfalls) and agricultural nonpoint source discharges. Analysis by the Urban Pesticide Pollution Prevention project of data from the California Department of Pesticide Regulation (DPR) indicate that approximately half of all California pesticide use, as measured by weight of active ingredients, occurs in urban areas.[210] Examples of urban pesticide use include indoor pest control and flea and tick shampoos and outdoor landscape and pest control application. In the greater Bay Delta Estuary watershed[211] approximately 8,430 tons (active ingredient) of 160 different pesticides[212] were applied in 2006 to control various agricultural and urban pest problems.[213] Some groups of pesticides are associated with urban usage while others are primarily agricultural. Urban stormwater, runoff, and POTWs are the primary source of pyrethroid pesticides, while agriculture remains the primary source of organophosphate (with the exception of malathion) pesticides.[214]

Pesticides and the Bay Delta Estuary Ecosystem Collapse

The relationship between pesticide toxicity and the long-term decline and recent plunge in pelagic fish populations is not clear.[215] One evaluation reported that maximum concentrations of measured pesticides were two to four orders of magnitude below established 96-hour LC50s (lethal concentration at which 50% of test organisms die) for many fish.[216] However, numeric water quality criteria protective of aquatic life are usually lower than the 96-hour LC50; for example, the Central Valley RWQCB considers one tenth of a well established 96-hour LC50 for the most sensitive aquatic species as the daily maximum exposure to an individual pesticide when numeric criteria and other toxicological data are not available.[217] In addition, exposure to multiple pesticides for time frames that exceed 96 hours, coupled with other physical stressors, may have lethal or sublethal impacts that cause or contribute to toxicity at lower concentrations than estimated 96-hour LC50, EC50s (concentration that has a specific survival effect such as impaired swimming for 50% of the test population), or lowest observed effect concentration. Larval and juvenile stages of some important pelagic species, including delta smelt, occurs in the late winter and spring overlapping with the storm season and peak concentrations of pesticides in the Bay Delta Estuary.[218] These exposures could result in direct acute and/or chronic toxicity to pelagic fish or an indirect effect to fish populations from toxicity to prey items.

Cellular and tissue abnormalities found in delta smelt and striped bass have been linked with insecticide exposure and reduced growth. A 3-year exposure study of delta smelt to pesticides in the Bay Delta Estuary spanning the years 1998 to 2000 shows that peak densities of larval and juvenile delta smelt overlap with elevated concentrations of pesticides, and that delta smelt are exposed to complex pesticide mixtures for a minimum of 2-3 weeks.[219] Approximately 10% of delta smelt in this experiment had fragmented DNA in blood cells, an established effect of pyrethroid pesticides and other stressors.[220] Mixtures of pesticides measured in this study contained between 2 and 14 different pesticides at each sampling site. Striped bass researchers observed pesticides and other contaminants in striped bass eggs; brain, abdominal, and fin lesions in more than 65% of tested juveniles; and abnormal brain, liver, and overall development in river collected striped bass.[221]

Pesticide toxicity to prey may contribute to the long-term decline and recent drop in pelagic fish populations by limiting food availability or by contributing to fish toxicity through consumption. Some aquatic invertebrates are more vulnerable to pesticide toxicity[222] and make up a considerable portion of the diet for larval and juvenile pelagic fish.[223] Invertebrate prey items could experience toxicity during periods of peak pesticide discharges to the Bay Delta Estuary, limiting available food for larval and juvenile pelagic fish. This is consistent with observed decline in zooplankton densities in the freshwater portion of the Bay Delta Estuary.[224] Other stressors such as declining phytoplankton primary production and excessive nutrient loading could contribute to the zooplankton decline as well.

The two pesticide groups of recent concern and attention are organophosphates (e.g., diazinon and chlorpyrifos) and pyrethroids.[225] Both are insecticides, designed to kill invertebrates. Aquatic habitat designated uses are impaired in the Bay Delta Estuary due to the presence of organophosphate (OP) pesticides diazinon and chlorpyrifos.[226] Use of OP pesticides has been replaced in the urban market with pyrethroid pesticides.[227] Pyrethroids are very toxic to fish and invertebrates with 96-hour LC50s generally lower than 1 part per billion and "effect concentrations" (e.g., impaired swimming) approaching detection levels in the range of low to medium part per trillion.[228] There are many other pesticides of concern, including, for example, herbicides and carbamates, but they have not received the recent attention focused on pyrethroids and organophosphates.[229]

Interaction between Multiple Stressors

The diversity and high volume of pesticides applied in the San Francisco Bay watershed that eventually emerge in the Bay Delta Estuary raise the possibility of interactive toxicity from complex pesticide mixtures and/or pesticides interacting with other chemical, physical, or biological stressors. Interactions of greatest concern are additive and greater than additive responses. Additive responses increase toxic conditions by an amount that is approximately equal to the summation of the toxicity elicited from individual stressors. Greater than additive responses increase toxic conditions by an amount greater than the summation of the toxicity elicited from individual stressors. Additive and greater than additive relationships result in toxic responses in aquatic organisms at lower contaminant concentrations than produced by exposure to individual contaminants.

Many studies identify interactive effects between pesticides and a resulting increase in toxicity to aquatic organisms. Additive toxicity to organisms produced by exposure to binary combinations of OP insecticides,[230] herbicides,[231] and carbamate/OP pesticides[232] has been demonstrated in species and pesticides that commonly occur in the Bay Delta Estuary and its tributaries. Greater than additive toxicity to aquatic organisms has also been demonstrated with OP and pyrethroid combinations[233] and OP and herbicide (atrazine and cyanizine) combinations that commonly occur in the Bay Delta Estuary.[234]

Data Gaps

Data gaps are substantial regarding pesticide use, sources, toxicity, and contribution to the Bay Delta Estuary ecosystem collapse. It is difficult to accurately estimate source contributions of land-based pesticide applications due to an incomplete record of pesticide use, inadequate water quality monitoring data and the diversity of current-use pesticides.[235] DPR collects information on pesticide use that is more detailed than required by most other states; nonetheless, an estimated 70% of pesticide use does not require reporting (e.g., home and garden use).[236] Information documenting the concentration of pesticides in waterways does not exist for many pesticides. One evaluation reported that less than half of the 160 different pesticides documented in the Bay Delta Estuary watershed are analyzed in water quality monitoring programs.[237]

Established toxicity testing using individual contaminants over four days with test organisms may not fully represent toxicity to organisms in receiving waters. Unlike organisms in laboratory toxicity testing procedures, aquatic organisms in the Bay Delta Estuary are exposed to multiple stressors including chemical (contaminants), physical (water exports, salinity, temperature, turbidity) and biological (invasive species) stressors. The Central Valley RWQCB reports that approximately 100 different pesticides have been measured in rural and urban water bodies throughout the Central Valley.[238] Potential interactive effects between contaminants and/or physical and biological stressors are not identified by establishing toxicity endpoints for individual pesticides in ideal laboratory conditions. In addition, observations within the Bay Delta Estuary and Central Valley tributaries illustrate that contaminant exposure times are at least four days and often much longer than the conventional 96-hour toxicity testing.[239] Some of these issues are addressed by research and toxicity monitoring in receiving waters and procedures for identifying pollutants responsible for toxic response.

Finally, the relative contribution of pesticide contamination to the recent collapse in pelagic fish populations and other ecosystem changes in the Bay Delta Estuary, such as the decline in zoo- and phytoplankton, is not straightforward. Research summarized above indicates that pesticide concentrations in the Bay Delta Estuary are below estimated acute toxicity thresholds for pelagic fish, but data indicating pesticides are responsible for fish abnormalities may be evidence of chronic toxicity causing population-level impacts to pelagic fish. There is evidence that ambient pesticide concentrations are acutely toxic to invertebrate prey items for pelagic fish; however, it unclear whether pelagic fish populations have declined due to food limitation. Lastly, conventional toxicity testing generally does not capture the negative impact on the aquatic ecosystem from multiple stressors present in the Bay Delta Estuary.[240]

b. Regulation under FIFRA

Pesticide regulation under FIFRA affecting Bay Delta Estuary aquatic resources is presently dominated by ongoing litigation involving the ESA.

In the first ESA case, Washington Toxics Coalition v. EPA,[241] the plaintiffs alleged that EPA needed to consult with the NMFS over the potential effects on West Coast salmonids of registering 55 pesticides. This case covered salmonid watersheds in Washington, Oregon, and California, and included the Bay Delta Estuary and its tributary watersheds. Pursuant to a consent decree issued in 2004, EPA conducted a review of the possible effects of pesticides on these salmonids. After determining that there may be effects on 37 of the salmonid species, EPA initiated consultations with NMFS under Section 7 of the ESA.

Given the number of species and pesticides involved, EPA and NMFS have been conducting the consultations in stages, grouping the pesticides into manageable sets. The first NMFS biological opinion under this process, which considered the widely used pesticides chlorpyrifos, diazinon, and malathion, was issued on November 18, 2008.[242] EPA responded to the NMFS biological opinion in its letter of September 10, 2009, outlining its proposals for restricting the use of these pesticides under FIFRA in the Bay Delta Estuary region. More recently, on May 14, 2010, EPA committed to implement revised pesticide labeling requirements for these pesticides, creating additional specific pesticide application limitations (buffers, concentrations) designed to prevent the introduction of these pesticides to waterways used by listed salmonids.[243]

Under the consent decree, this process of consultation will continue for each of the 37 pesticides determined by EPA to have potential adverse effects on listed salmonids. During the pendency of these consultations, application of the named pesticides is governed by a court order prescribing applications methods and watercourse setbacks.[244]

A second case involving pesticides in the Bay Delta Estuary is Center for Biological Diversity v. EPA,[245] (CBD v. EPA). In this case, the plaintiffs alleged the need for EPA to consult under the ESA with the USFWS over the possible adverse effects on 11 listed terrestrial and aquatic species in the greater San Francisco Bay Delta area of 75 registered pesticides. These species include the delta smelt and the tidewater goby, species that inhabit the Bay Delta Estuary. The two cases involve many of the same pesticides.

On May 17, 2010, the U.S. District Court issued a stipulated injunction in CBD v. EPA. Although there are some differences, the stipulated injunction roughly followed the model of Washington Toxics Coalition. EPA agreed to conduct initial assessments of the ingredients in each of the 75 pesticides and, where potential effects to species are identified, consultation with the USFWS would be carried out. Again, given the long list of pesticides and listed species involved, the stipulated injunction breaks this process into manageable groups for evaluation.

EPA is not asking for public comment on the pesticides FIFRA litigation in this ANPR. Those two cases are active and under judicial supervision. As a part of that litigation, the public has had several opportunities to comment on the nature of the stipulated injunctions and the draft biological opinions being developed pursuant to the litigation. This information is included here to explain how EPA is addressing pesticides in the Bay Delta Estuary under one of the two major federal statutes regulating pesticides. Taken together, the evaluations and consultations being prepared under the FIFRA litigation cover both the major ESA-listed pelagic fish and the ESA-listed salmonids in the Bay Delta Estuary system.

c. Regulation under the Clean Water Act

Pesticides fall within the scope of the Clean Water Act in addition to regulation under FIFRA. The primary areas of current interest in the Clean Water Act regulation of pesticides in the Bay Delta Estuary are: (1) developing chemical specific (numeric) water quality criteria; (2) developing TMDLs for waters impaired by pesticides; (3) addressing agricultural pesticides; (4) addressing pesticides in stormwater discharges through permits; and (5) issuing a general NPDES permit for the discharge of pesticides into waters of the U.S.

i. Water Quality Standards

Water quality standards are the foundation for regulating pesticides in California under the Clean Water Act. Water quality standards, composed of water quality criteria and designated uses, for the Bay Delta Estuary are contained in three basin plans: San Francisco Bay Basin Plan (SF Bay Basin Plan), San Francisco/Sacramento-San Joaquin Delta Estuary Basin Plan (Bay Delta Estuary Basin Plan) and the Water Quality Control Plan for the Sacramento and San Joaquin River Basins (Sacramento/San Joaquin Basin Plan). The Sacramento/San Joaquin Basin Plan contains narrative water quality criteria for pesticides as a group of pollutants, numeric criteria for a few individual pesticides, and narrative toxicity criteria that are relevant when pesticides are the source of aquatic toxicity.[246] The SF Bay Basin Plan contains a narrative toxicity criteria, similar to the Sacramento/San Joaquin Basin Plan, but does not contain narrative or numeric criteria for pesticides as a group or for individual pesticides.[247] The Bay Delta Estuary Basin Plan does not contain water quality criteria that directly regulate pesticide concentrations.[248]

The State Board recently proposed statewide numeric toxicity criteria in its *Policy for Toxicity Assessment and Control*.[249] The proposed numeric toxicity criteria are expressed as statistical endpoints which represent the toxicant response that causes a given percent reduction in a biological measurement. The proposed chronic toxicity criterion establishes an unacceptable level of chronic toxicity consistent with the in-stream toxicant concentration at which 25% or more of the test organisms show adverse biological effects. The proposed acute criterion establishes an unacceptable level of acute toxicity consistent with the in-stream lethal toxicant concentration that affects 20% or more of the test organisms.[250]

There are seven elements in the narrative toxicity water quality criteria contained in the Sacramento/San Joaquin River Basin Plan. Four of these elements are most relevant to this ANPR and state: (1) no individual pesticide or combination of pesticides shall be present in concentrations that adversely affect designated uses; (2) discharges shall not result in pesticide concentrations in bottom sediments or aquatic life that adversely affect designated uses; (3) pesticide concentrations shall not exceed those allowable by applicable antidegradation policies;

and (4) pesticide concentrations shall not exceed the lowest levels technically and economically achievable. When numeric criteria are not adopted for individual pesticides and other information such as lowest observed effect and no observed effect concentrations for individual pesticides are not available, the Central Valley RWQC uses a figure of one tenth of the 96-hour LC50 for the most sensitive species tested as the upper limit or daily maximum for the protection of aquatic life.[251]

There are two numeric criteria for individual pesticides: diazinon (0.016 micrograms/L 1-day average; 0.010 micrograms/L 4-day average) and chlorpyrifos (0.025 micrograms/L 1-day average; 0.015 micrograms/L 4-day average).[252] The narrative toxicity criteria in the Sacramento/San Joaquin River and the SF Bay Basin Plans (under "Population and Community Ecology") generally prohibit concentrations of toxic substances that cause acute or chronic toxicity to aquatic life.[253]

The Central Valley RWQCB is developing the Pesticides Basin Plan Amendment (Pesticides BPA) to address pesticide water quality impairments including interactive effects. Some objectives of the Pesticides BPA include identifying: (1) streams that should fully support aquatic life in the absence of elevated contaminant levels; (2) pesticides that present the greatest risk to aquatic life; (3) numeric metrics, including water quality criteria, that will protect aquatic life from the interactive or individual effects of high-risk pesticides; and (4) best management practices to prevent pesticide impacts.[254]

The Pesticides BPA is divided into two phases, with additional work on supporting studies. Completed supporting studies identify twenty eight individual pesticides as having a high overall relative risk to aquatic life, ten individual pesticides with moderate risk,[255] and draft numeric water quality criteria for six of the high relative risk pesticides: cyfluthrin, lambda cyhalothrin, bifenthrin, malathion, diazinon, and diuron.[256] Phase I of the BPA, focused on OP pesticides diazinon and chlorpyrifos, will include proposed water quality criteria and TMDLs for diazinon and chlorpyrifos-impaired waterbodies. A draft staff report for Phase I is anticipated in late 2010. Phase II will focus on developing numeric water quality criteria and TMDL development for pyrethroid and other high-risk pesticides, and is scheduled to be completed in late 2012.[257]

ii. TMDLs

The Central Valley RWQCB adopts TMDLs to address water quality impairments. The 2010 303(d) list recently adopted by the State Board identifies violations of state water quality standards as a result of pesticide concentrations exceeding narrative and numeric criteria causing impairments to aquatic habitat designated uses in all Bay Delta Estuary Waterways.[258] The Central Valley RWQCB adopted TMDLs and TMDL implementation plans addressing organophosphate pesticides in the Bay Delta Estuary and upstream watersheds and is developing an organochlorine TMDL for the Central Valley. These TMDLs are designed to reduce pesticide concentrations in the Bay Delta Estuary and its upstream tributaries with the goal of attaining water quality standards.

The draft organochlorine pesticides TMDL addresses legacy pesticides whose registrations were cancelled by EPA in the 1970's. This persistent class of contaminants is still detected in water, sediment, and biological tissue at levels high enough to warrant listing Bay Delta Estuary and Central Valley tributaries on the 2010 303(d) list. Organochlorine pesticides include (but are not limited to) dichlorodiphenyltrichloroethane (DDT), aldrin, endrin, heptachlor, hexachlorecyclohexane, and endosulfan (still in use but being phased out). The proposed TMDL includes numeric targets for the water column, sediment, and fish tissue derived from the existing narrative criteria.[259]

The Central Valley RWQCB has adopted TMDLs and TMDL implementation plans for diazinon and chlorpyrifos in the Sacramento and Feather Rivers, Sacramento County urban creeks, San Joaquin River, and the Sacramento-San Joaquin Delta (Bay Delta Estuary) waterways. The diazinon and chlorpyrifos TMDLs for these waterways include wasteload allocations for point sources and load allocations for non-point sources that address the additive toxicity of diazinon and chlorpyrifos. Point sources are addressed by implementing effluent limitations in NPDES permits. Agricultural pesticide sources are partially addressed through the Central Valley RWQCB Irrigated Lands Regulatory Program (ILRP).[260]

iii. Regulation of Agricultural Discharge

The ILRP is part of a unique regulatory framework in California that addresses pesticide water pollution. Historically, the Central Valley RWQCB addressed agricultural pesticide discharges into the Central Valley and Bay Delta Estuary waters through Conditional Waivers issued under the California Water Code. In 2003, in response to reform legislation adopted by the State Legislature, the Central Valley RWQCB adopted a Conditional Waiver of Waste Discharge Requirements for Irrigated Lands (renewed in 2006) and directed staff to develop environmental documentation for a long-term Irrigated Lands Regulatory Program.[261]

The Coalition Group Conditional Waiver of Waste Discharge Requirements for Discharges from Irrigated Lands is a general permit that waives the requirement for an individual permit for entities that join a "coalition group." Coalition groups conduct water quality monitoring to determine the effect of member discharges on water quality. If specific water quality problems are identified in the monitoring reports, coalition groups create management plans and coordinate with members to implement best management practices that reduce pesticides or other contaminant loadings to waters.[262] The current Irrigated Lands waste discharge requirement waiver for irrigated lands in the Central Valley will expire in June 2011. It may be renewed or the Central Valley RWQCB may transition to implementation through the proposed long-term ILRP.

The Central Valley RWQCB released a draft programmatic Environmental Impact Report (PEIR) for the proposed long-term ILRP in July 2010 for public comment. The overall goals of the long-term ILRP are to (1) restore and/or maintain the highest reasonable quality of state waters considering all the demands being placed on the water; (2) minimize waste discharge from irrigated agricultural lands that could degrade the quality of state waters; (3) maintain the economic viability of agriculture in California's Central Valley; and (4) ensure that irrigated agricultural discharges do not impair access by Central Valley communities and residents to safe and reliable drinking water.[263] The Final EIR and Central Valley RWQCB action are planned for

2011.[264]

iv. Stormwater Permits

Stormwater discharges from MS4s, associated with construction activity, and associated with industrial activity have been shown to carry pesticides to surface waters and affect water quality.[265] The current NPDES permits for these stormwater discharges, to some degree, address the issue of pesticides in stormwater discharges, in addition to other pollutants.

In California, stormwater discharge permits are issued by the Water Boards under the authority of the Clean Water Act. There are six individual MS4 stormwater permits potentially affecting the Bay Delta Estuary, as well as a statewide general permit for smaller dischargers.[266] Much of the area surrounding the Bay Delta Estuary is covered by one of these stormwater permits.

The MS4 permit for Sacramento County and associated cities requires permittees to implement a Pesticide Plan approved by the Central Valley RWQCB. The plan addresses the permittees' use of pesticides including diazinon, chlorpyrifos, and other lower priority pesticides. The permit requires implementation of Integrated Pest Management practices, public education and outreach, and studies of local or regional sales and use of residential and commercial pest control products potentially found in stormwater runoff.

The California Construction General Permit (CA CGP)[267] was issued by the State Board on September 2, 2009 and expires in 2014. The CA CGP requires that stormwater discharges not contain pollutants that cause or contribute to an exceedance of any applicable water quality objective. The CA CGP requires that all dischargers develop a sampling and analysis strategy for monitoring pollutants that are not visually detectable in stormwater. Of significant concern for stormwater discharges associated with construction activity are the pollutants found in materials used in large quantities at construction sites throughout California and exposed throughout the rainy season, in particular glyphosate (herbicide), diazinon and chlorpyrifos (pesticides), nutrients (fertilizers), and molybdenum (lubricants). Diazinon and chlorpyrifos are commonly used by landscape professionals and may trigger sampling and analysis requirements if these materials come into contact with stormwater.

On December 1, 2009, EPA promulgated the final Construction and Development Effluent Limitations Guideline and Standards (C&D ELG) which state that construction site operators must "[d]esign, install, implement, and maintain effective pollution prevention measures to minimize the discharge of pollutants. At a minimum, such measures must be designed, installed, implemented and maintained to…[m]inimize the exposure of building materials, building products, construction wastes, trash, landscape materials, fertilizers, *pesticides*, herbicides, detergents, sanitary waste and other materials present on the site to precipitation and to stormwater."[268] Any new or reissued NPDES permit for stormwater discharges associated with construction activity in California must incorporate the applicable requirements in the C&D ELG.[269]

The California Industrial Stormwater General Permit[270] (CA IGP) was issued by the State

Board in 1997. The State Board noticed a draft reissuance of the Industrial Stormwater General Permit in 2005; however no final action has been taken on the reissuance. The current permit requires that operators reduce or prevent pollutants in stormwater discharges associated with industrial activity and ensure that such discharges will not cause or contribute to an exceedance of any applicable water quality standards. Additionally, the CA IGP addresses stormwater and non-stormwater coming into contact with "significant materials" on industrial sites, defined in the permit to include pesticides.

The stormwater permit programs described above may not cover all stormwater discharges of concern. If EPA or California finds that other currently unregulated stormwater discharges are contributing pollutants to waters of the U.S. or contributing to water quality standards exceedances, EPA and/or California may require those discharges to obtain NPDES permits through "residual designation."[271] Examples of currently unregulated point source discharges of stormwater include small MS4s currently outside urbanized areas that may not meet the population threshold for a regulated small MS4 and stormwater discharges from impervious surfaces, such as commercial facilities, retail centers, or residential subdivisions.

As part of its implementation of the Phase I and II stormwater regulations, California has used its authority under 40 C.F.R. 122.35 to designate unregulated small MS4s as requiring NPDES permit coverage.[272] EPA and/or California may designate additional discharges from unregulated MS4s to surface waters in the Bay Delta Estuary or its tributaries as necessary in order to address the impacts of pesticides on the water quality.

Alternatively, instead of designating discharges from MS4s, EPA and/or California may designate individual or categories of stormwater discharges for regulation under the Clean Water Act. For example, EPA Region 1 (New England) is in the process of using the residual designation authority under 40 C.F.R. 122.26(a)(9)(i), to designate and require an NPDES permit for stormwater discharges from two or more acres of impervious surface in the Charles River watershed in Massachusetts. While the Charles River residual designation and proposed NPDES permit are not focused exclusively on the discharges of pesticides, a byproduct of regulating stormwater discharges from developed sites will be a reduction in various pollutants, including pesticides, discharged to surface waters. The Region 1 proposed permit includes a provision for the proper management of landscaped areas in the watershed that includes the requirement to "minimize the risk that any landscaped pervious surfaces will contribute pollutants to stormwater discharges from the [site]…[a]t a minimum, this shall include assuring the proper storage, use, and disposal of fertilizers, *pesticides*, and herbicides…."[273] To date, the residual designation approach has not been proposed or used in the Bay Delta Estuary.

Another approach to addressing stormwater discharges is being undertaken by EPA Region 3 and the EPA Office of Water in the Chesapeake Bay watershed.[274] In a nationwide effort to revise EPA's stormwater regulations,[275] EPA may propose revisions to the existing MS4 regulations for stormwater discharges from MS4s under Clean Water Act Sections 402(p)(3)-(4) and (p)(6) and/or the designation and regulation of stormwater discharges from developed sites under Clean Water Act Section 402(p)(6). As part of any national rule, EPA is considering designating stormwater discharges from newly developed and redeveloped sites to protect water quality; revising the scope of regulated MS4 discharges subject to NPDES permitting; addressing discharges from existing development (e.g. to address existing impairments in receiving waters). EPA is considering Chesapeake Bay-specific provisions, such as expanding the regulatory coverage to a greater number of discharges than required under any national stormwater rule. This includes the consideration of Chesapeake Bay-specific requirements that may be needed to meet the TMDL wasteload allocations. While this Region 3 and EPA Office of Water effort is not focused exclusively on the discharges of pesticides, regulating stormwater discharges from developed and redeveloped sites and revising the requirements in MS4 permits will likely reduce multiple pollutants, including pesticides.

v. General NPDES Permits for Aquatic Pesticide Application

On March 12, 2001, the Ninth Circuit Court of Appeals, in Headwaters, Inc. v. Talent Irrigation District,[276] held that discharges of pollutants from the use of aquatic pesticides to waters of the United States require coverage under a Clean Water Act NPDES permit. As a result, in 2004, the State Board issued general permits for the discharge of aquatic pesticides to surface waters for vector control[277] and weed control.[278] Additionally, the State Board has released a preliminary draft general permit for adulticide to cover the discharge of residual pesticides to waters of the U.S. resulting from adult mosquito spray applications.[279] Thus, in the Bay Delta Estuary, the application of pesticides directly to, over, or near, water may require permit coverage under either the State's vector control general permit, the State's weed control general permit, or the adulticide general permit that is currently being proposed by the State Board.

d. Request for Public Comment

Many activities discussed in this notice are already the subject of a formal or informal rulemaking process conducted by either EPA or a related state or federal agency. Nothing in this notice is intended to supersede those ongoing processes, nor does this notice constitute a decision under any of those processes. If commenters have submitted material in connection with those other processes that is believed to be relevant to the issues raised in this notice, the commenter may either reference the earlier submission (if it was submitted to EPA), attach the earlier submission (if it was submitted to a different agency), or, if appropriate, provide a link to the material online.

Please provide the reason(s) for answers to the following questions and scientific, policy, and/or legal information with citations that support your comments.

1. What, if any, additional scientific information is available on (a) the effects of pesticides in stormwater discharges, or (b) the potential interactive effects of combinations of pesticides on aquatic resources in the Bay Delta Estuary?

2. What, if any, actions should EPA take under its authority to improve the effectiveness of regulating pesticide contamination of the Bay Delta Estuary watershed?

3. How can the process for establishing numeric water quality criteria be streamlined while maintaining technical integrity?

4. What are the benefits and constraints of using fish tissue in place of, or in addition to, water column concentrations when establishing water quality criteria for pesticides?

5. Are there testing protocols that would effectively and efficiently identify synergistic toxic effects in the Bay Delta Estuary?

6. What, if any, specific combinations of contaminants are of particular concern in the Bay Delta Estuary?

7. Should EPA and our state partners move away from evaluating isolated aquatic species for one or two pollutants, and towards evaluations of water conditions more representative of the actual aquatic conditions in the Bay Delta Estuary? How might this be done?

8. What new or revised effluent limitations, monitoring requirements or other permit requirements could be included in NPDES permits for discharges of pesticides from MS4s in the Bay Delta Estuary in order to better meet the regulatory standard of reducing discharges to the maximum extent practicable? What information is necessary to determine permit requirements, such as identifying effluent limits that can effectively reduce ambient contaminant concentrations and restore designated uses? Please provide any available information on water quality benefits that may result from such requirements.

9. What new or revised effluent limitations, monitoring requirements or other permit requirements could be included in NPDES permits for stormwater discharges associated with construction activity and/or stormwater discharges associated with industrial activity to address pesticides? What information is necessary to determine permit requirements, such as identifying effluent limits that can effectively reduce ambient contaminant concentrations and restore designated uses? Please provide any available information on water quality benefits that may result from such requirements.

10. Should EPA use its residual designation authority at 40 C.F.R. 122.35 to designate currently unregulated small MS4s to ensure that municipalities have programs in place to control the discharge of pesticides in stormwater to the maximum extent practicable? What information is necessary to determine permit requirements, such as identifying effluent limits that can effectively reduce ambient contaminant concentrations and restore designated uses? Please provide any available information on water quality benefits that may result from such requirements.

11. Should EPA use its residual designation authority at 40 C.F.R. 122.26(a)(9)(i)(C)-(D) to designate currently unregulated stormwater discharges that contribute pesticides to surface waters? What information is necessary to determine permit requirements, such as identifying effluent limits that can effectively reduce ambient contaminant concentrations and restore designated uses? Please provide any available information on water quality benefits that may result from such requirements.

5. Contaminants of Emerging Concern

a. Aquatic Resource Issues

Nationally, researchers are documenting potentially significant effects on aquatic ecosystems from compounds that have not traditionally been considered or regulated. These "contaminants of emerging concern" (CECs) include pharmaceuticals, personal care products, solvent stabilizers, flame retardants, pesticides and other commonly used commercial and industrial compounds. These substances can be introduced into the aquatic environment through a variety of sources including municipal and industrial wastewater systems, urban stormwater, animal husbandry operations and agricultural runoff.

Some of these substances may be endocrine disrupting chemicals (EDCs), which are exogenous substances that change endocrine function and cause adverse effects at the level of the organism, its offspring, and/or (sub)populations of organisms. EDCs can alter hormone levels, potentially resulting in the masculinization of female mollusks,[280] the feminization of male fish, and reproductive effects.[281] Of the CECs detected in surface waters of the U.S., EDCs have received the most attention because field studies have shown that very low concentrations of some of these compounds can significantly affect natural populations of aquatic vertebrates.

In San Francisco Bay (downstream of the Delta), the Bay Regional Monitoring Program began collecting data on CECs since 2001 and has generated a relatively extensive dataset for CECs in the Bay, with a few sampling locations in the Delta.[282] Several pilot studies have collected data in the Delta and upstream tributaries but there are significant data gaps. Very few CECs are routinely monitored in the environment. Some Regional Water Boards have begun to include permit conditions for major POTWs to conduct special studies, technical reports and additional monitoring for CECs in their effluent.

Although there is not sufficient data in the published literature to adequately assess the ecological implications of CECs in the Bay Delta Estuary,[283] there is ample evidence to warrant additional attention. Compounds that may be EDCs have been found in waters of the Central Valley and at particularly high levels in the Delta and Napa River.[284] In addition, endocrine disrupting effects, such as skewed sex ratios in a population and developmental disruptions in individuals, have been found in fishes of the Delta.[285] One researcher showed that sex ratios in adult striped bass were skewed toward males to the extent that the altered sex ratio might account for the near absence of young fish in recent years.[286] Many more male than female silversides (*Menidia beryllina*) were found at an urban sampling site compared to an agricultural site in Suisun Marsh. This study also measured the effects of potential EDCs in the water from these sites on sensitive cell lines and found estrogenic activity at both sites, but significantly higher androgenic activity at the urban site.[287] Evidence of low frequency endocrine disruption was found in 2005 in adult delta smelt collected in the Delta and Suisun Marsh. In this study, 9 of 144 (6%) of adult delta smelt males were intersex, having immature oocytes in their testes.[288]

Like other contaminants, CECs exist in the environment in mixtures. Some studies (not in the Delta) have begun to look at interactive effects though much more research is needed to draw meaningful conclusions.

b. Regulatory Status

On a national level, EPA's strategy for addressing the effects of CECs includes improving science and public understanding; identifying partnership and stewardship opportunities; and taking regulatory action when appropriate.[289]

There are currently no water quality aquatic life criteria or drinking water standards, making data difficult to interpret.[290] EPA is evaluating the potential impacts of CECs on aquatic life and developing an approach for determining protective levels for aquatic organisms. EPA uses guidelines established in 1985 to derive ambient water quality criteria (AWQC) for aquatic life.[291] These guidelines consider acute effects (short-term effects such as survival) and chronic effects (longer-term effects such as reproduction) for traditional pollutants. Developing aquatic life criteria for CECs and potential EDCs may require modified methodologies along with effects endpoints not previously evaluated using the 1985 guidelines. For instance, potential EDCs may demonstrate low acute toxicity but cause reproductive effects at very low levels of chronic exposure. In addition, the effects of exposure on aquatic organisms during the early stages of life may not be observed until adulthood. Therefore, traditional toxicity test endpoints may not be sufficient for criteria derivation for these chemicals and the chemicals may also have specific modes of action that may affect only certain types of aquatic animals (e.g., vertebrates such as fish).

In response to this challenge, in June 2008, EPA developed a white paper detailing technical issues and recommendations to serve as a basis for modifying the 1985 guidelines to better address CECs and develop AWQC protective of aquatic life.[292] This paper was reviewed by EPA's Science Advisory Board.[293] The SAB supports development of risk-based aquatic life criteria for EDCs which include consideration of probable direct and/or indirect impacts on food webs, ecological processes and services, and endangered or unique species of special value or concern. In addition, the SAB noted the potential for interactive effects that may occur in CEC mixtures in the environment and which may also interact with environmental variables such as temperature.

EPA has developed new analytical test methods for particular CECs, although much such work remains to be done. Since the first reports that CECs were occurring in surface waters, questions have been raised regarding their presence in sewage influent, effluent and sludge. At the time of these first reports, no suitable analytical methods were available for these waste streams. EPA has developed two new analytical methods to identify and measure certain CECs, specifically, pharmaceuticals, steroids and hormones in sewage influent, effluent and sludge. These methods currently cover over 100 chemicals (74 pharmaceuticals and personal care products and 27 steroids-hormones) and three wastewater matrices (raw and treated sewage water and sludge). EPA has also revised the flame retardants (PBDE) analytical method. The contaminants in these methods are not currently regulated, nor have the methods been promulgated at 40 C.F.R. Part 136.[294]

In California, a workshop in 2009 brought together scientists, water quality managers, and stakeholders to initiate an effective CEC management strategy. Consensus was reached around certain findings and recommendations, including: (1) the current chemical-specific risk assessment approach is neither feasible nor cost-effective for prioritizing and managing the vast majority of CECs; (2) developing regulatory limits is premature given the state of knowledge; (3) flexible, multi-element prioritization framework is needed to identify compounds of highest concern; (4) a single master list of CECs that agencies could apply effectively across all applications is unlikely; (5) the interpretation of monitoring data and subsequent decision-making should be based on tiered, multiple thresholds; and (6) an adaptive management strategy is imperative to respond to rapidly changing knowledge.[295]

The "Policy for Water Quality Control for Recycled Water" adopted by the State Board in February 2009 included mandated monitoring of CECs in municipal recycled water.[296] To provide guidance on implementing this aspect of the policy, the State Board tasked the Southern California Coastal Water Research Program (SCCWRP) with convening a Science Advisory Panel. The recommendations from that panel[297] are under consideration by the State Board.[298] SCCWRP is convening another scientific panel to advise the State on how best to limit the impact of CECs on oceans, estuaries and wetlands.[299]

c. Voluntary Activities

Federal, state and local agencies have experimented with voluntary source control efforts, such as "take-back" programs and events, which are collection methods aimed at reducing the quantity of unused pharmaceuticals entering the environment. Some communities have ongoing pharmaceutical take-back programs or community solid waste programs that allow the public to bring unused drugs to a central location for more appropriate disposal. In 2009, EPA partnered with the California Pharmacists Association, East Bay Municipal Utility District, California Association of Sanitation Agencies, TriTac, and others on the No Drugs Down the Drain campaign.

On October 12, 2010, President Obama signed the Secure and Responsible Drug Disposal Act of 2010. The bill establishes programs to safely dispose of unused or unwanted prescription drugs and controlled substances through community-based efforts, amends the Controlled Substance Act to allow the attorney general to develop drug disposal programs, and allows long-term care facilities to dispose of drugs on behalf of their residents.

In September 2010, EPA issued a draft guidance document, "Best Management Practices for Unused Pharmaceuticals at Health Care Facilities" for hospitals, medical clinics, doctors' offices, and long-term care facilities. It describes techniques for reducing or avoiding pharmaceutical waste, practices for identifying and managing unused pharmaceuticals, and applicable disposal regulations. EPA is revising the document based on public comment.

d. Request for Public Comment

Many activities discussed in this notice are already the subject of a formal or informal rulemaking process conducted by either EPA or a related state or federal agency. Nothing in this notice is intended to supersede those ongoing processes, nor does this notice constitute a decision under any of those processes. If commenters have submitted material in connection with those other processes that is believed to be relevant to the issues raised in this notice, the commenter may either reference the earlier submission (if it was submitted to EPA), attach the earlier submission (if it was submitted to a different agency), or, if appropriate, provide a link to the material online.

Please provide the reason(s) for answers to the following questions and scientific, policy, and/or legal information with citations that support your comments.

1. What, if any, additional information is available regarding the effects of CECs on aquatic resources in the Bay Delta Estuary?

2. What, if any, specific information exists to identify the sources and nature of discharges of CECs into the Bay Delta Estuary?

3. What, if any, monitoring mechanisms or methodologies are available to assist in identifying CECs?

4. What, if any, methods are most effective to minimize introduction of CECs into the Bay Delta Estuary?

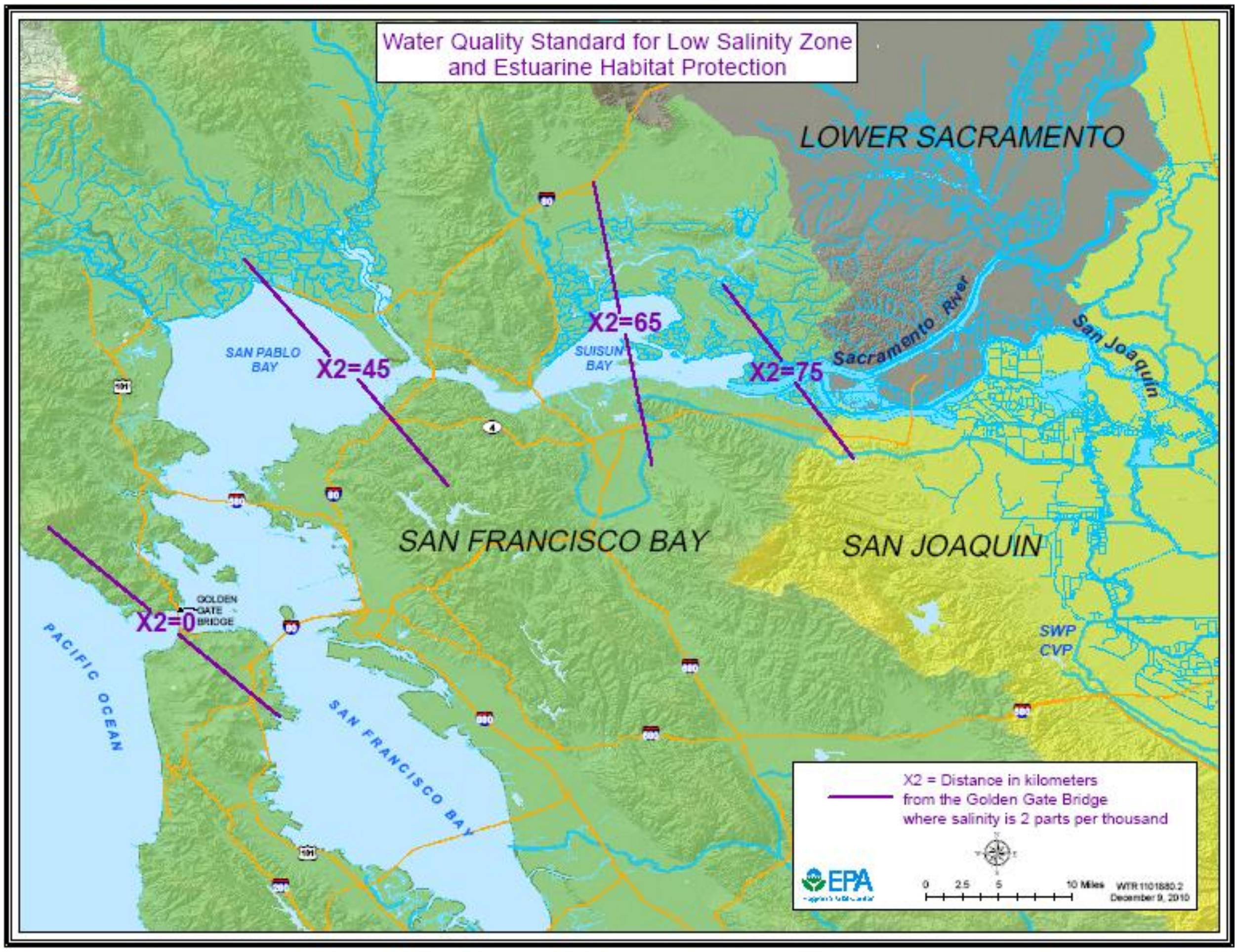


Figure D. Low Salinity Zone (X2) in the Bay Delta Estuary

B. Protecting Estuarine Habitat, Fish Migration Corridors and Wetlands

1. Estuarine Habitat

a. Aquatic Resource Issues

For many species of fish and invertebrates in San Francisco Bay, ocean conditions and broad climatic changes drive population abundance, but estuarine species of Suisun Bay and the Delta are controlled by other factors.[300] A number of factors are apparently important for the health of estuarine species, but the location of the low salinity zone (X2[301]) plays a large role, both historically[302] and recently.[303] The low salinity zone is the location of the greatest abundance of many pelagic organisms of the upper Bay Delta Estuary,[304] including the threatened delta smelt (*Hypomesus transpacificus*), the state-listed longfin smelt (*Spirinchus thaleichthys*) and juvenile striped bass (*Morone saxatilis*), the former premier sport fish of the Bay Delta Estuary. The average springtime location of the low salinity zone (X2) is also tied to the survival or abundance of a number of fish and larger invertebrates of the Bay Delta Estuary.[305] The nature of the low salinity zone is also important for less desirable species. For one major invasive species, the overbite clam (*Corbula amurensis*) salinity variability is an important determinant of their distribution and impact.[306] Given these correlations, X2 is an effective indicator of ecosystem conditions from year to year.[307] The community-level, rather than species-specific, nature of X2 makes it uniquely suitable as a broad estuarine habitat protection standard.[308] Climate change and associated sea-level rise are expected to make salinity distribution in the Bay Delta Estuary an even more important ecological driver than at present.[309]

Recent research suggests that the quantity and quality of low salinity estuarine habitat, as measured by the location of the 2 ppt salinity gradient or X2, has declined during the fall period since 1985.[310] As shown in Figure E, the low salinity zone in the fall has moved upstream, especially after 2000. When the low salinity zone moves upstream, its areal extent shrinks as the low salinity zone is forced into the narrow, deeper channels of the interior Delta and away from the broad shallow shoals of Honker Bay and Suisun Bay downstream. Figure F reflects this correlation between the location of the low salinity zone and its areal extent. In the late 1990s, the median areal extent of this low salinity estuarine habitat was about 9000 hectares in the fall; since 2000, that habitat declined by about 78 percent.

Figure E also shows the dramatic decline in the variability of the location (and therefore the extent) of low salinity habitat. Prior to 2000, the location of the low salinity zone during the fall varied significantly from year to year, based on springtime precipitation and releases from summertime carryover reservoir storage. The areal extent of low salinity habitat for smelt and striped bass in the fall thus also varied from year to year.

Since 2000, the low salinity zone in the months of September through November (fall X2) has been consistently further upstream in the watershed in all water year types,[311] in the western Delta (rather than fluctuating between the western delta and further west into Suisun Bay). This consistent upstream shift of the low salinity zone has greatly reduced areal extent of the fall habitats of delta smelt and young striped bass. This change in the fall X2 has also been associated both with increased upstream abundance of invasive clams[312] and jellyfish[313] and with declines in abundance of young striped bass and pre-spawning delta smelt.[314] The combined indicators of adult delta smelt abundance and the location and extent of fall habitat appear to be a good predictor of subsequent summer delta smelt abundance.[315]

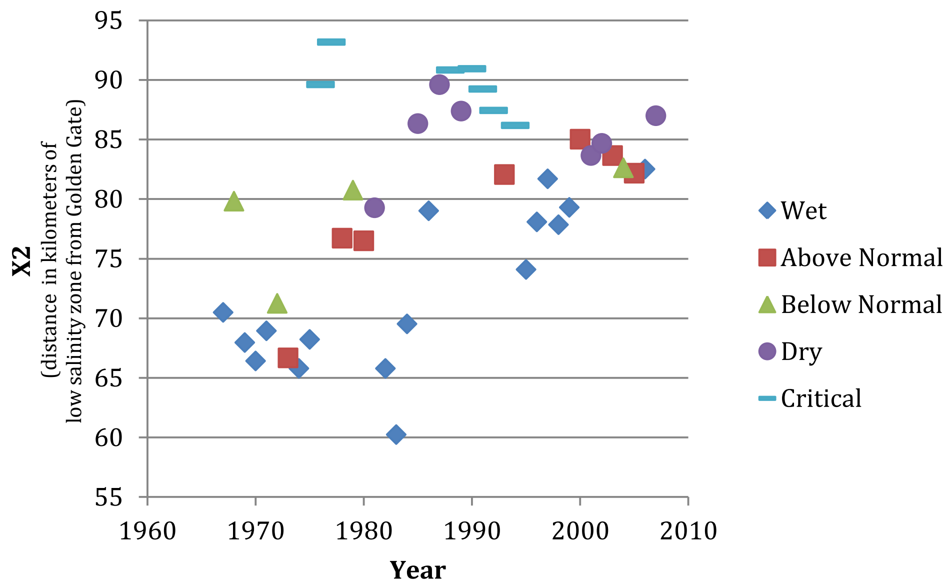


Figure E. Fall Location of Low Salinity Zone (X2) 1960-2010, by water year[316]

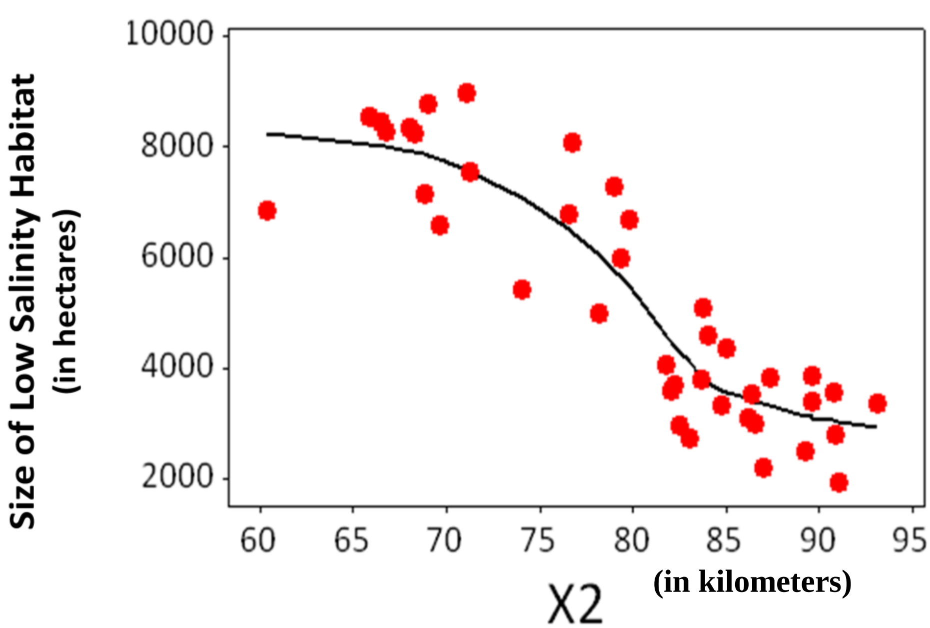


Figure F. Habitat Size based on Fall Location of Low Salinity Zone (X2)

b. Regulatory Status

The State Board's Water Quality Control Plan has included "estuarine habitat" as a designated use since 1989. Pursuant to the Clean Water Act, EPA reviews a state's water quality standards to determine whether the state has adopted criteria that protect the designated water uses.[317] In the past, this review has included a consideration of physical, chemical, and biological parameters such as temperature and salinity.[318] In 1995, the State Board adopted outflow requirements during the spring to protect the estuarine habitat designated use. These outflow requirements were based on the X2 concept and reflected several years of discussion and refinement in a collaborative effort between regulatory agencies and interested water export and environmental organizations. When adopted, the X2 standard was widely praised as a broad ecosystem standard that provided protection for estuarine species generally, as opposed to the individual species orientation of other regulatory measures.[319] Although the degree of correlation between X2 and abundance has shifted somewhat for some species since 1994, analyses show that X2 remains an important factor affecting the suite of species that have declined since 2000.[320]

The X2 standard, adopted by the State Board and approved by EPA in 1995 and restated in 2006, applies only in the spring months (February - June). During these months, most young salmonids are migrating downstream and most resident estuarine fishes are spawning. Correlations of X2 with species abundance or survival, upon which the standard was based, were highest for spring months. In many years springtime conditions in the Delta are driven by high precipitation and flood control activities rather than export operations. The 1995 Water Quality Control Plan was influenced by concerns raised during the 1987-92 drought, when springtime conditions were exceptionally more adverse than in preceding years. Most of the fish now listed under the ESA were listed in the years immediately following the 1987-92 drought.

After adoption of the 1995 Water Quality Control Plan and the return of more normal springtime flows, most species of interest showed a resurgence in abundance. Delta smelt almost achieved the criteria for delisting identified in their ESA recovery plan,[321] adult striped bass populations returned to levels not seen since the 1970s, threadfin shad were sharply rising in abundance and longfin smelt were achieving fairly high abundances.[322] Around the year 2000, however, the well-sampled pelagic fishes all simultaneously declined.[323] At the time of this decline, the location of the low salinity zone moved upstream during fall months of all years and was greatly reduced in areal extent. This change in habitat, and the proposed project operations to maintain these conditions into the future, was identified as a threat to the survival of delta smelt and as a degradation of its critical habitat.[324] Consequently, the 2008 USFWS Biological Opinion on the impact of SWP and CVP operations on delta smelt included a provision to manage low salinity zone habitat in the fall.[325] That provision mandates specific fall X2 values, and the associated areas of suitable habitat, during fall months after wet and above-normal water years.[326] This fall X2 provision restores some of the fall habitat that characterized the Bay Delta Estuary until 2000.[327]

The fall X2 requirement in the 2008 Delta Smelt Biological Opinion has been reviewed in two independent peer review processes.[328] Both reviews supported the importance of habitat protection and the suitability of using X2 as a surrogate for that habitat. At the same time, both reviews also questioned the basis for the exact targets specified in the Opinion and supported the requirement for intensive study and monitoring of the effects of the requirement. The NAS review also questioned the predictive nature of the relationship for delta smelt abundance. Recent litigation over the ESA biological opinion on water export operations raised similar issues on the X2 approach.[329]

The State Board included the fall X2 flow prescriptions of the USFWS Biological Opinion for delta smelt in its recommendation for flows needed to broadly protect public trust resources, but did not recommend greater flows until the values of the Biological Opinion flows were analyzed and potential risks to cold water habitat for salmon spawning were avoided.[330] Likewise, the California Department of Fish and Game (DFG) recommended maintaining X2 between 74 km and 81 km between September and November in wet and above normal years, but did not recommend greater flows unless studies show they will not compete with preservation of cold water pool resources needed for the protection of winter-run salmon.[331]

c. Request for Public Comment

Many activities discussed in this notice are already the subject of a formal or informal rulemaking process conducted by either EPA or a related state or federal agency. Nothing in this notice is intended to supersede those ongoing processes, nor does this notice constitute a decision under any of those processes. If commenters have submitted material in connection with those other processes that is believed to be relevant to the issues raised in this notice, the commenter may either reference the earlier submission (if it was submitted to EPA), attach the earlier submission (if it was submitted to a different agency), or, if appropriate, provide a link to the material online.

Please provide the reason(s) for answers to the following questions and scientific, policy, and/or legal information with citations that support your comments.

1. What information is available on the effect of lower salinities in the western Delta on undesirable species such as *Microcystis*, overbite clams, or jellyfish? What, if any, information is available to determine if an increase in low salinity habitat would affect the fate, concentration and distribution of nutrients and toxics that are potentially negatively affecting the estuarine food web?

2. Could the frequency, area, and/or duration of low salinity habitat be changed so as to achieve ecosystem benefits for the suite of species that use the low salinity zone? If so, how? Is historical data on inter- or intra- annual frequency of variability the best basis for setting goals or are there other bases that could be used? How might climate change impacts, including sea level rise, affect the size, frequency, and duration of low salinity habitat?

3. Are methods available for more systematically addressing ecological or biological connections between springtime X2 and subsequent fall X2 conditions? If so, what are they and what are their strengths and weaknesses?

4. Would changes in water system operations to move X2 seaward in the fall adversely affect the reservoir storage needed to conserve salmonid fish spawning and other designated uses in the watershed? If so, under what conditions?

5. What information is available on the effects of salinity management on terrestrial plant communities and/or tidal marsh endemic species? What indirect effect does this have on aquatic communities?

6. Does the geographic location of low-salinity habitat have an effect on the quality of the habitat or its availability to species of concern? If so, what is the nature and extent of such effect? Is the distribution pattern of low salinity habitat important in determining its quality?

7. Are spring/neap differences in tidal water quality important for aquatic species? If so, how should these habitat characteristics be evaluated?

8. How can performance measures for species population and/or habitat condition be used to evaluate restoration of Bay Delta Estuary water quality?

2. Fish Migration Corridors

a. Aquatic Resource Issues

San Joaquin Valley salmonid populations have suffered a long-term decline. Spring-run salmon that spawned on the upper San Joaquin were eliminated after the construction of the Central Valley Project's Friant Dam in the 1940's on the San Joaquin River near Fresno and the Mendota and Friant-Kern Canals. On average, over 90% of the San Joaquin River flow at Friant Dam has been diverted annually, resulting in dewatering of several reaches (totaling 60 miles) of the main stem San Joaquin River. As discussed in more detail below, salmon runs on the main stem San Joaquin River upstream of the confluence with the Merced River are being restored pursuant to the San Joaquin River Restoration Settlement Act of 2009 (San Joaquin Restoration Act).[332]

The San Joaquin River basin downstream of the confluence of the mainstem San Joaquin River and the Merced River also support salmon populations. Fall-run chinook salmon, presently not listed under the ESA, are able to spawn below the major dams on each of the three main tributaries to the San Joaquin River (the Stanislaus, Tuolumne, and Merced rivers), but their abundance has declined sharply in the last 10 years.[333] At present, only the Stanislaus River is believed to support a population of steelhead, listed as threatened since 1998. Migratory survival measured for salmon through the southern Delta is poor compared to survival of Sacramento River outmigrants, and juvenile survival since 2000 has been on a steady and steep decline, see Figure G.[334] Although information about steelhead in the San Joaquin system is limited, the available information suggests a significant decline.

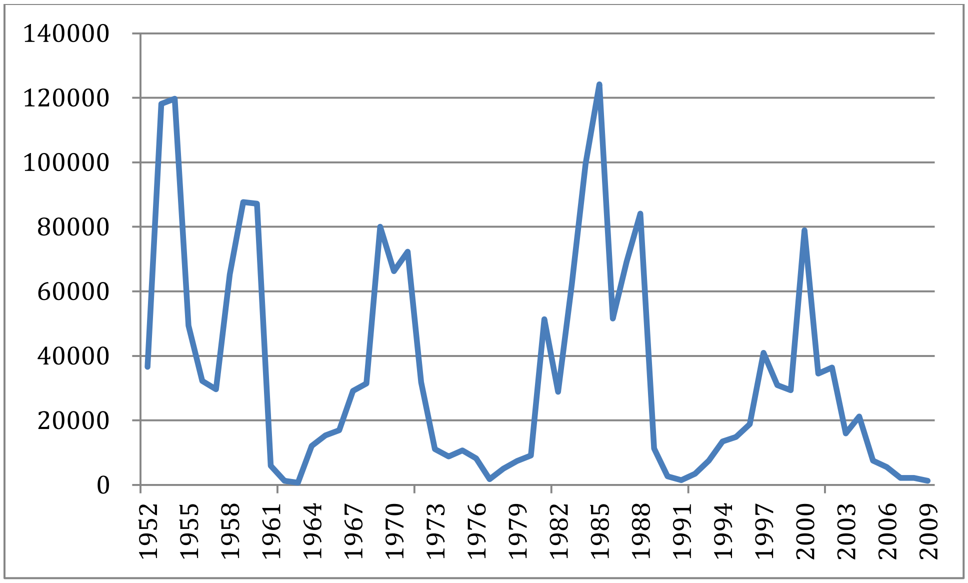


Figure G. Estimated natural production of chinook salmon in the San Joaquin River[335]

Survival of salmonids migrating between the San Joaquin River basin and the Bay Delta Estuary is likely affected by many stressors, including high predation rates, high temperatures, low dissolved oxygen, agricultural contaminants, urban stormwater impacts, diversion into local agricultural diversions and the state and federal export facilities that pump water south of the Delta for agricultural and urban consumption. Migration of salmonids is broadly believed to be guided by multiple cues – particular physical or chemical characteristics of the natal stream or migratory corridor that trigger or enable migration. Recent research suggests that, because most San Joaquin River water was diverted either upstream or as it enters the Delta, in almost all months of almost all years approximately 40 kilometers of San Joaquin River channels in the delta contain almost exclusively water derived from the Sacramento River.[336] The 40-kilometer discontinuity of non-natal water in the Bay Delta Estuary between the San Joaquin River and the ocean suggests that salmon and steelhead migratory abilities may be severely compromised due to the absence of the necessary physical or chemical cues usually found in the natal waters or particular migration corridors. The absence of these characteristics may compromise migration independent of the effects of predation, temperature, oxygen depletion, contaminants and diversion.

Retrospective analysis[337] of earlier sonic tagging data[338] found significant impairment of adult salmon migration to San Joaquin tributaries when total state and federal exports exceeded three times the volume of water entering from the San Joaquin River at Vernalis.[339] Prior to the drought of 1987-1992, ratios greater than 3:1 were uncommon, while during the drought such conditions occurred almost every year. Between 1992 and 2001, such conditions varied from year to year based on hydrology, with ratios above and below 3:1. However, October conditions (the center of the fall migration period) from 2001 to 2008 have exceeded the 3:1 ratio in all but two years (see Figure H). As expected from the results of this research, returning numbers of salmon have been very low in all recent years.

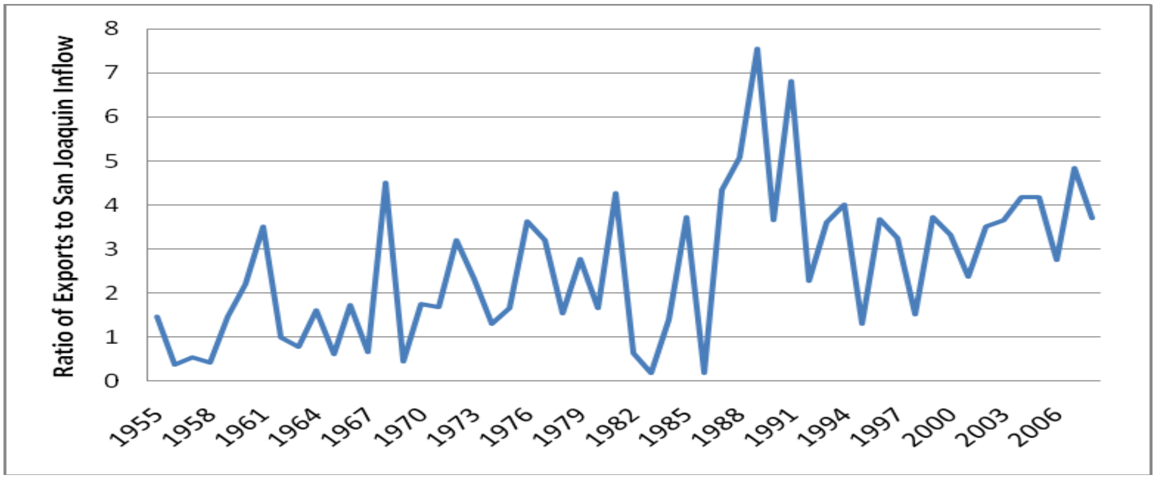


Figure H. Ratio of average combined CVP and SWP exports in October to monthly average October inflows of the San Joaquin River into the Delta.[340] Ratios less than 3 were associated with successful migration of adult salmon to San Joaquin River Tributaries.[341]

b. Regulatory Status

The lower San Joaquin River and its major tributaries all include "Migration of Aquatic Species" as a designated use protected under the Clean Water Act.[342] The State Board, in its 1995 Water Quality Control Plan (unchanged in the 2006 revision), includes narrative criteria to protect the "Migration of Aquatic Species" designated use in the San Joaquin Basin.[343] The narrative criteria establish a goal of doubling natural salmon production on the tributary streams of the Central Valley consistent with the federal goal embodied in the Central Valley Project Improvement Act of 1992. The Basin Plans implementing these narrative criteria have usually included a combination of changes to flows, diversions rates and gate manipulations to protect fish migration corridors, with emphasis on juvenile salmon outmigration in the February through June period. Since the mid-1990's, the primary implementation mechanism of the narrative salmon criteria with respect to fall run salmon has been through the Vernalis Adaptive Management Plan (VAMP). The VAMP is a fixed-term, multi-year experiment designed to evaluate salmon migration success under different combinations of San Joaquin River inflows at Vernalis and CVP/SWP export restrictions. The VAMP experiment is drawing to a close, and the State Board is considering replacement implementation approaches based in part on the results of the VAMP.

The Water Boards have adopted numeric criteria to address low dissolved oxygen in Delta waters.[344] Since at least the 1970's, blockage of adult salmonid migration due to low dissolved oxygen has received much scientific attention. Dissolved oxygen barriers occur in the Stockton Deep Water Ship Channel on the lower San Joaquin River and on Old and Middle Rivers. A TMDL for dissolved oxygen in the Ship Channel was adopted by the Central Valley RWQCB on January 27, 2005 and approved by EPA on February 27, 2007.[345] The TMDL includes a phased control program to reduce the amount of oxygen-demanding substances and their precursors. Early steps in implementing this TMDL include adoption of source controls from the outfall from the City of Stockton wastewater treatment plant and implementation of aeration facilities at the Port of Stockton. Longer term changes in channel form are also proposed for action by the Corps, and studies are required both upstream and downstream on the sources and impacts of oxygen depletion.[346]

Chinook salmon and steelhead have specific temperature tolerances during various life-stages, including both juvenile and adult migration. Temperature conditions at various life stages may currently be the limiting factor for successful recruitment.[347] The Central Valley RWQCB Basin Plan includes narrative and numeric criteria protecting, among others, the migratory aquatic organisms designated use.[348] Recently, CDFG recommended that the Central Valley RWQCB list the San Joaquin and its tributaries as impaired waterbodies under the Clean Water Act for coldwater fisheries due to high water temperature. CDFG data show that EPA temperature guidance criteria for protecting salmon are frequently exceeded for all life stages.[349] In particular, CDFG has found that temperatures in the San Joaquin, Stanislaus, Tuolumne, and Merced Rivers exceeded EPA's adult chinook migration criterion (18 degrees) for 33% to 75% of the migration season, and for certain reaches, exceeded the criterion for juvenile migration for more than 50% of the season. The State Board declined to list the San Joaquin River and its tributaries as impaired due to elevated temperature, but EPA, in its review of the 303(d) list, added this listing when it acted on the State Board's submission.[350] Listing these water bodies as impaired is also supported by NMFS, who cite warm water temperatures below Central Valley dams as one of four major factors contributing to the decline of listed salmonids.[351]

The State Board has initiated a comprehensive reevaluation of San Joaquin River Flow and Southern Delta Salinity Objectives and a program of implementation to achieve these objectives. A staff report on the scientific basis for objectives was released in October 2010,[352] and final action on any changes is currently scheduled for 2012.[353] These objectives protect a suite of designated uses. With respect to fish and wildlife designated use protection (including salmonids), the report concludes that "a higher and more naturally variable inflow regime from the [San Joaquin River] to the Delta during the spring period (February through June) is needed."[354]

Pursuant to recent state law, the State Board recently issued recommendations on the flow necessary to protect public trust resources in the Bay Delta Estuary. This report identifies the need for an October pulse flow of 3600 cubic feet per second for a minimum of ten days on the San Joaquin River and concurrent reduction in exports to ensure a hydraulic connection between the River and the San Francisco Bay to allow adult salmon upmigration.[355] These recommendations were identified in the report as "Class A," meaning there was more robust scientific information to support specific numeric criteria than some other recommendations. The report notes that this recommendation is based on the needs of fall-run salmon and that similar flow needs for migrating adult steelhead are largely unknown.

The 2009 NMFS Biological Opinion on the effects of SWP and CVP project operations included requirements specifically addressing the needs of San Joaquin steelhead.[356] Steelhead migrate during the same timeframe as fall-run salmon and are thought to respond similarly to environmental conditions. The NMFS Biological Opinion requires attraction flows in October of 1500 cubic feet per second from Goodwin Dam on the Stanislaus River.[357] No steelhead protection measures were included in the Delta for the adult migration season, September to November, largely because there is little information on steelhead migration and fall-run salmon are probably a poor surrogate.[358] The ability of steelhead juveniles to hold over in their natal streams for more than one year may buffer them from some of the effects suffered by fall-run salmon.

The San Joaquin River Restoration Act[359] is a federal commitment to restoring chinook salmon on the San Joaquin River. The legislation implements a court settlement reached in 2007 amongst the USBR, the water contractors, and certain environmental groups. Under the settlement, specific physical restoration actions to reestablish the river channel and sufficient river flows will occur on the San Joaquin River in conjunction with reintroduction of spring-run salmon by December 31, 2012. The San Joaquin Restoration Act is focused on activities and habitat upstream of the confluence of the San Joaquin and Merced Rivers. The measured survival[360] and decreasing populations of salmon in the San Joaquin watershed suggest that fall-run salmon restoration to the San Joaquin River tributaries cannot succeed until the lower migratory corridor is more supportive of salmon migration. Much attention has focused on the outmigration of young fish, but there is reason for concern that adults are not able to migrate upstream.

c. Request for Public Comment

Many activities discussed in this notice are already the subject of a formal or informal rulemaking process conducted by either EPA or a related state or federal agency. Nothing in this notice is intended to supersede those ongoing processes, nor does this notice constitute a decision under any of those processes. If commenters have submitted material in connection with those other processes that is believed to be relevant to the issues raised in this notice, the commenter may either reference the earlier submission (if it was submitted to EPA), attach the earlier submission (if it was submitted to a different agency), or, if appropriate, provide a link to the material online.

Please provide the reason(s) for answers to the following questions and scientific, policy, and/or legal information with citations that support your comments.

1. What role, if any, do gradients in physical and chemical constituents of water play in the suitability of the Bay Delta Estuary and San Joaquin River Basin migratory corridor for salmon?

2. What are the best measures of success for restoration of a migratory corridor? Could these measures be incorporated into new or revised biological criteria protecting the fish migration designated use?

3. Should temporal characteristics be included in the definition of the physical and/or chemical properties of a migration corridor based on a reference condition? If so, how? What frequency and duration of such a corridor is required for salmonids? How might these characteristics change with the impacts of climate change?

4. Would establishing a migratory corridor for upmigrating adult chinook salmon succeed in improving adult migration success if temperatures in the river channels upstream of Vernalis are unchanged? If so, how? How might actions to establish a migratory corridor in the south Delta also moderate temperature and/or dissolved oxygen problems in the San Joaquin River?

5. Are additional efforts to improve dissolved oxygen regimes in the Delta necessary to provide an adequate migratory corridor for San Joaquin salmonids? If so, what should those efforts include?

6. What other information is available on barriers to salmon migration in the Bay Delta Estuary and San Joaquin River watershed?

3. Wetlands

a. Aquatic Resource Issues

The extensive historical destruction of the Bay Delta Estuary's wetland and riparian areas increases the importance of the remaining wetland, riparian, and slough resources and the services they perform for Bay Delta water quality and flood protection. Over 95% of the historical 350,000 acres of tidal wetlands, sloughs, and riparian areas have been eliminated in the Bay Delta Estuary.[361] Wetlands, sloughs, and riparian areas in the upper watersheds of the Sacramento and San Joaquin River basins experienced a similar reduction in areal extent.[362] The elimination of these aquatic resources destroyed natural pollution filtration services (e.g., sediment, nitrogen, phosphorus, heavy metals)[363] and flood protection functions that protected the Bay Delta Estuary.

b. Regulatory Status

The Clean Water Act Section 404 Program is a significant component of the Clean Water Act regulatory framework in the Bay Delta Estuary. The California State Reclamation Board estimates that approximately 130,000 new homes[364] are at various stages of planning and implementation within the Bay Delta Estuary, potentially converting up to 55,000 acres[365] of tracts and islands that are near or below sea level to urban landscape. Other potential large projects that could result in the discharge of dredge or fill material to protected waters include building a new conveyance through or around the Delta to divert water from the Sacramento River south to the export facilities in the southern Delta, dredging of the Sacramento and Stockton (San Joaquin) deepwater ship channels, tidal barrier projects, large-scale restoration activities, and a large-scale (22,000 acres) water storage project. This ANPR is not meant to suggest a decision or commitment to undertake any of these types of projects. Any such projects would need to go through all appropriate planning and decision-making processes before such a commitment is made.

These potential large projects may require Clean Water Act Section 404 permits, and some have the capability to negatively impact water quality in the Bay Delta Estuary. While potentially improving export water quality and reducing fish entrainment at the south Delta export facilities, any conveyance project that diverts relatively clean Sacramento River water before it enters the Bay Delta Estuary also has the potential to exacerbate existing water pollutions problems (such as increased salinity and low dissolved oxygen) in the Bay Delta Estuary. Dredging operations have the potential to re-suspend sediments and contaminants, thereby contributing to existing water quality impairments. Tidal barrier and storage projects have the potential to reduce circulations in areas of the Estuary that suffer from salinity and low dissolved oxygen impairments.

Urban development of Bay Delta Estuary rural islands and tracts eliminates the ability of these areas to retain and assimilate sediment and associated contaminants and store and absorb flood waters. Statewide, salt marsh and riverine wetlands are showing declining function as a result of urbanization.[366] Conversion of agricultural land use to urban land use on these islands and tracts may also adversely impact water quality as higher urban stormwater and POTW discharges increase the volume and array of pesticides and contaminants discharged into the adjacent waterways.

c. Request for Public Comment

Many activities discussed in this notice are already the subject of a formal or informal rulemaking process conducted by either EPA or a related state or federal agency. Nothing in this notice is intended to supersede those ongoing processes, nor does this notice constitute a decision under any of those processes. If commenters have submitted material in connection with those other processes that is believed to be relevant to the issues raised in this notice, the commenter may either reference the earlier submission (if it was submitted to EPA), attach the earlier submission (if it was submitted to a different agency), or, if appropriate, provide a link to the material online.

Please provide the reason(s) for answers to the following questions and scientific, policy, and/or legal information with citations that support your comments.

1. What different approaches under the Clean Water Act Section 404 program should EPA consider, in consultation with the U.S. Army Corps of Engineers, to improve the protection of aquatic resource functions in the Bay Delta Estuary?

2. What information exists that describes the relationship between the quantity and quality of wetlands and Bay Delta Estuary water quality and fish populations?

3. In light of projected impacts of climate change (including sea level rise and its effects on levee stability), what specific activities can EPA undertake to improve long-term protection of existing and future wetlands, especially those resources on subsided islands?

IV. EXECUTIVE ORDER 12866, Regulatory Planning and Review

Under Executive Order 12866, entitled *Regulatory Planning and Review* (58 Federal Register 51,735, October 4, 1993), this is a "significant regulatory action." Accordingly, EPA submitted this action to the Office of Management and Budget (OMB) for review under Executive Order 12866 and any changes made in response to OMB recommendations have been documented in the docket for this action.

Because this action does not propose or impose any requirements and instead seeks comments and suggestions for the Agency to consider in possibly developing a subsequent proposed rule, the various statutes and Executive Orders that normally apply to rulemaking do not apply in this case. Should EPA subsequently determine to pursue a rulemaking, EPA will address the statutes and Executive Orders applicable to that rulemaking.

Dated: February 10, 2011

(original signed by)

Jared Blumenfeld
Regional Administrator, U.S. Environmental Protection Agency, Region 9

V. ENDNOTES

[1] There is no commonly accepted precise geographic definition of the Bay Delta Estuary. The "legal Delta" is well-defined for purposes of the California Delta Protection Commission and related California statutes, but is not co-terminous with the functioning estuary. This ANPR will generally refer to the larger estuary upstream of the San Francisco Bay as the Bay Delta Estuary or the Estuary. It will also refer to the Delta, which usually means the "legal Delta" plus Suisun Marsh and Suisun Bay. Occasionally, this ANPR may also reference the Bay Delta Estuary watershed, which is a huge land area that includes the drainages of the Sacramento and San Joaquin River basins.

[2] Clean Water Act, 33 U.S.C. §§ 1281-1387 (2006).

[3] "Anadromous" species are those, such as chinook salmon and steelhead, that spend at least some of their life cycle in salt water. Usually, these species return to freshwater to spawn.

[4] Water years in California are defined as October 1 through the following September 30. For example, the 2011 water year began October 1, 2010 and continues through September 30, 2011. Water years in California are categorized based on the particular rainfall that year. The categories are wet, above normal, below normal, dry, and critically dry.

[5] Endangered Species Act, 16 U.S.C. §§ 1531-1544 (2006).

[6] *See* CAL. DEP'T OF WATER RES. & BUREAU OF RECLAMATION, WATER SUPPLY CONDITIONS 2009 (Aug., 2009), *available at* http://www.water.ca.gov/news/newsreleases/2009/08122009martinmilligan2.pdf (suggests that approximately a quarter (500 thousand acre feet) of the 2.1 million acre feet water export shortfall in 2009 was due to new environmental restrictions, whereas three quarters (1.6 million acre feet) of the shortfall was due to the drought itself).

[7] *See* Press Release, U.S. Dep't of the Interior, Secretary Salazar, Senior Administration and Congressional Officials Hold Town Hall Meeting on California Water Shortage (June 28, 2009), *available at* http://www.doi.gov/news/pressreleases/2009_06_28_release.cfm (discussing several water augmentation initiatives).

[8] California Bay-Delta Memorandum of Understanding among Federal Agencies (Sept. 29, 2009), *available at* http://www.doi.gov/documents/BayDeltaMOUSigned.pdf.

[9] INTERIM FEDERAL ACTION PLAN FOR THE CALIFORNIA BAY-DELTA (Dec. 22, 2009), *available at* http://www.doi.gov/documents/CAWaterWorkPlan.pdf.

[10] Citations to these many reports and reviews are provided below, as each issue is discussed in detail.

[11] RANDALL BAXTER, ET AL., PELAGIC ORGANISM DECLINE PROGRESS REPORT: 2010 SYNTHESIS OF RESULTS (2010), *available at* http://www.water.ca.gov/iep/docs/FinalPOD2010Workplan12610.pdf.

[12] The State Board, Central Valley RWQCB, and San Francisco Regional Water Quality Control Board (San Francisco RWQCB) will sometimes be referred to collectively as the "Water Boards."

[13] As noted in more detail below, much of EPA's statutory mandate is to perform oversight and review of state water quality agency activities.

[14] Federal Insecticide, Fungicide and Rodenticide Act, 7 U.S.C. § 136-136y (2006).

[15] STATE WATER RES. CONTROL BD., CENT. VALLEY WATER BD., & SAN FRANCISCO BAY WATER BD., STRATEGIC WORKPLAN FOR ACTIVITIES IN THE SAN FRANCISCO BAY/SACRAMENTO-SAN JOAQUIN DELTA ESTUARY (2008), *available at* http://www.waterboards.ca.gov/waterrights/water_issues/programs/bay_delta/strategic_plan/docs/baydelta_workplan_final.pdf.

[16] National Environmental Policy Act, 42 U.S.C. § 4321-4370f (2006).

[17] Natural Community Conservation Plan Act, CAL. FISH & GAME CODE § 2800-2835 (2003).

[18] Although the scope of the BDCP covers at least nine listed aquatic species and a geographic area of over one-half million acres, the BDCP is not intended to be a comprehensive Delta recovery plan. By its own terms, it is intended to meet ESA requirements by addressing only the operations of the state and federal water export projects and their impacts on listed species and their habitat.

[19] CAL. WATER CODE § 85300-85350 (2010).

[20] Letter from Delta Independent Science Board to Phil Isenberg, Chair, Delta Stewardship Council (Jan. 26, 2011), *available at* http://www.deltacouncil.ca.gov/delta_science_program/pdf/isb/d-isb_20110126_stressor_short_memo_final.pdf.

[21] DELTA VISION BLUE RIBBON TASK FORCE, DELTA VISION STRATEGIC PLAN (Oct. 2008), *available at* http://deltavision.ca.gov/StrategicPlanningProcess/StaffDraft/Delta_Vision_Strategic_Plan_standard_resolution.pdf;

Estimate of federal and state endangered and threatened species based on discussion with U.S. Fish & Wildlife Service biologists; BAY DELTA CONSERVATION PLAN, STEERING COMMITTEE WORKING DRAFT (Nov. 18, 2010), *available at* http://baydeltaconservationplan.com/Libraries/Whats_in_Plan/draft_BDCPreport_11292010_ClickableLinks7.pdf; CALFED BAY DELTA PROGRAM, MULTI-SPECIES CONSERVATION STRATEGY, FINAL PROGRAMMATIC EIS (July 7, 2000), *available at* http://dfg.ca.gov/erp/envcomp_mscs.asp.

[22] Anti-Deficiency Act, 31 U.S.C. § 1341 (2007).

[23] JAY LUND ET AL., ENVISIONING FUTURES FOR THE SACRAMENTO-SAN JOAQUIN DELTA (Feb. 2007), *available at* http://www.ppic.org/main/publication.asp?i=671; *See* DELTA VISION BLUE RIBBON TASK FORCE, OUR VISION FOR THE CALIFORNIA DELTA (Jan. 2008), *available at* http://deltavision.ca.gov/BlueRibbonTaskForce/FinalVision/Delta_Vision_Final.pdf (The current status and future threats to the Estuary have been well documented. Good summaries of these issues can be found in these sources).

[24] JOHN E. SKINNER, AN HISTORICAL REVIEW OF THE FISH AND WILDLIFE RESOURCES OF THE SAN FRANCISCO BAY AREA 226 (Cal. Dept. of Fish and Game, Water Projects Branch Rep. No. 1, 1962), *available at* http://www.estuaryarchive.org/archive/skinner_1962/; W.A. Bennett & Peter Moyle, *Where Have All the Fishes Gone? Interactive Factors Producing Fish Declines in the Sacramento-San Joaquin Estuary, in* SAN FRANCISCO BAY: THE ECOSYSTEM 519, 519-42 (J.T. Hollibaugh ed., 1996); PETER MOYLE ET AL., 2010 CHANGING ECOSYSTEMS: A BRIEF ECOLOGICAL HISTORY OF THE DELTA (Feb. 2010), *available at* http://www.waterboards.ca.gov/waterrights/water_issues/programs/bay_delta/deltaflow/docs/intro_delta_history_14feb2010.pdf.

[25] Ted Sommer, et al., *The Collapse of Pelagic Fishes in the Upper San Francisco Estuary*, 32 FISHERIES, n.6, 270, 270-77 (2007) (Graphs originally prepared for Ted Sommer, et al., updated for 2008 and 2009 with data from Cal. Dep't of Fish & Game, http://www.dfg.ca.gov/delta/projects.asp?ProjectID=FMWT (last visited Nov. 16, 2010)).

[26] Fall run chinook salmon is also an important food source for the southern population of killer whales, which are listed as threatened under the ESA.

[27] Since harvest data are a large part of the population estimation tool, data for these three years are probably not directly comparable with earlier yearly population estimates.

[28] S.T. LINDLEY ET AL., WHAT CAUSED THE SACRAMENTO RIVER FALL CHINOOK STOCK COLLAPSE? (2009), *available at* http://swr.nmfs.noaa.gov/media/SalmonDeclineReport.pdf.

[29] *Id.*

[30] Sommer et al., *supra* note 25; Alan Jassby & T.M. Powell, *Hydrodynamic Influences on Interannual Chlorophyll Variability in an Estuary: Upper San Francisco Bay Delta*, 39 ESTUARINE, COASTAL & SHELF SCI. 595, 595-618 (1994); W.J. Kimmerer, *Effects of Freshwater Flow on Abundance of Estuarine Organisms: Physical Effects or Trophic Linkages?*, 243 MARINE ECOLOGY PROGRESS SERIES 39, 39-55 (2002).

[31] James R. Thomson et al., *Bayesian Change-Point Analysis of Abundance Trends for Pelagic Fishes in the Upper San Francisco Estuary*, 20 ECOLOGICAL APPLICATIONS 1431, 1431-48 (2010); Ralph Mac Nally et al., *An Analysis of Pelagic Species Decline in the Upper San Francisco Estuary using Multivariate Autoregressive Modeling (MAR)*, 20 ECOLOGICAL APPLICATIONS, 167, 167-80 (2010).

[32] The Fall Midwater Trawl is an ongoing annual survey of pelagic species abundance conducted by the California Department of Fish and Game. Some of the numbers in the 1970's are not comparable because the survey was not conducted in 1974, 1976 or in part of the fall of 1978. Therefore, the entries on the chart represent "no data." In addition, the index for longfin smelt shows substantial variation over the period, and graph presents only the lower quartile of the actual range of index numbers.

[33] The IEP is a consortium of nine state and federal agencies plus the San Francisco Estuary Institute. Since the 1970's, it has, primarily through its member entities, collected and analyzed data on water quality, fish, wildlife and related hydrodynamic processes in the Bay Delta Estuary.

[34] BAXTER ET AL., *supra* note 11; RANDALL BAXTER, ET AL., PELAGIC ORGANISM DECLINE PROGRESS REPORT: 2007 SYNTHESIS OF RESULTS (2008), *available at* http://www.science.calwater.ca.gov/pdf/workshops/POD/2007_IEP-POD_synthesis_report_031408.pdf; CHUCK ARMOR, ET. AL, INTERAGENCY ECOLOGICAL PROGRAM SYNTHESIS OF 2005 WORK TO EVALUATE THE PELAGIC ORGANISM DECLINE IN THE UPPER SAN FRANCISCO ESTUARY (2005).

[35] Lenny F. Grimaldo, et al., *Factors Affecting Fish Entrainment into Massive Water Diversions in a Tidal Freshwater Estuary: Can Fish Losses be Managed?*, 29 N. AM. J. OF FISHERIES MGMT. 1253, 1253-70 (2009).

[36] *Id.* Entrainment refers to the diversion and probable loss of fish at the export facilities.

[37] Frederick Feyrer, M.L. Nobriga & T.R. Sommer, *Multi-Decadal Trends for Three Declining Fish Species:*

Habitat Patterns and Mechanisms in the San Francisco Estuary, California USA, 64 CAN. J. OF FISHERIES & AQUATIC SCI. 723, 723-34 (2007).

[38] William Bennett, *Critical Assessment of the Delta Smelt Population in the San Francisco Estuary, California*, 3 SAN FRANCISCO ESTUARY & WATERSHED SCI. 1, 1-70 (2005), *available at* http://repositories.cdlib.org/jmie/sfews/vol3/iss2/art1; M.L. Nobriga & B. Herbold, *The Little Fish in California's Water Supply: a Literature Review and Life-History Conceptual Model for Delta Smelt (Hypomesus transpacificus) for the Delta Regional Ecosystem Restoration and Implementation Plan (DRERIP)* (2010) (in review)(on file with authors); Frederick Feyrer, T. Sommer & S.B. Slater, *Old School vs. New School: Status of Threadfin Shad (Dorosomapetenense) Five Decades After its Introduction to the Sacramento-San Joaquin Delta*, 7 SAN FRANCISCO ESTUARY & WATERSHED SCI. 1, 1-17 (2009), *available at* http://repositories.cdlib.org/jmie/sfews/vol7/iss1/art3.

[39] LINDLEY ET AL., *supra* note 22; JAY R. LUND ET AL., PUB. POLICY INST. OF CAL., COMPARING FUTURES FOR THE SACRAMENTO-SAN JOAQUIN DELTA (2008), *available at* www.ppic.org/content/pubs/report/r_708EHR.pdf.

[40] James Cloern et al., *Biological Communities in San Francisco Bay Track a North Pacific Climate Shift*, 37 GEOPHYSICAL RES. LETTERS 1, 1-6 (2010).

[41] Agency for Toxic Substances & Disease Registry (ATSDR), Fact Sheet: Pyrethrins and Pyrethroids (2003), *available at* http://www.atsdr.cdc.gov/tfacts155.pdf ("Pyrethroids are manufactured chemicals that are very similar in structure to the pyrethrins, but are often more toxic to insects as well as to mammals, and last longer in the environment than the pyrethrins….Pyrethrins are naturally-occurring compounds with insecticidal properties that are found in pyrethrum extract from certain chrysanthemum flowers").

[42] W.A. BENNETT, J.A. HOBBS & S.J. TEH, INTERPLAY OF ENVIRONMENTAL FORCING AND GROWTH-SELECTIVE MORTALITY IN THE POOR YEAR-CLASS SUCCESS OF DELTA SMELT IN 2005 (2008), *available at* http://www.science.calwater.ca.gov/pdf/workshops/POD/2008_final/Bennett_PODDeltaSmelt2005Report_2008.pdf.

[43] Some pyrethroid insecticides are toxic to invertebrates, which are food for pelagic fish, at or near the low "detection level." The "detection level" is the concentration at which feasible test methods can detect the presence of a constituent.

[44] Kathryn Kuivila & G.E. Moon, *Potential Exposure of Larval and Juvenile Delta Smelt to Dissolved Pesticides in the Sacramento-San Joaquin Delta, California,* 39 AM. FISHERIES SOC'Y SYMP. 229, 229-42 (2004).

[45] Weston et al., *Distribution and Toxicity of Sediment-Associated Pesticides in Agriculture-Dominated Water Bodies of California's Central Valley*, 38 ENVTL. SCI. & TECH. 2752, 2752-59 (2004).

[46] Richard C. Dugdale, F.P. Wilkerson, V.E. Hogue & A., Marchi, *The Role of Ammonium and Nitrate in Spring Bloom Development in San Francisco Bay*, 73 ESTUARINE, COASTAL & SHELF SCI. 17, 17-29 (2007).

[47] Erin Lee Hestir, D. Schoellhammer, T. Morgan & S.L. Ustin, Trends in Submerged Aquatic Vegetation and Turbidity in the Sacramento-San Joaquin Delta, Presentation at the 5th Biennial CALFED Science Conference (Oct. 22-24, 2008); M.J. Santos, L.W. Anderson & S.L. Ustin, *Effects of Invasive Species on Plant Communities: An Example Using Submersed Aquatic Plants at the Regional Scale*, BIOLOGICAL INVASIONS 1, 1-15 (Jul. 28, 2010), *available at* http://www.springerlink.com/content/b883gr221203xr37/ (Despite these treatments, the area occupied by submerged aquatic vegetation continues to spread at an average annual rate of 13%. In recent years treatment has focused solely on Franks Tract for aquatic vegetation control and has been successful in that locale).

[48] M.F.L.L Lurling & I. Roessink, *On the Way to Cyanobacterial Blooms: Impact of the Herbicide Metribuzin on the Competition Between a Green Alga (Scenedesmus) and a Cyanobacterium (Microsystis)*, 65 CHEMOSPHERE 618, 618-26 (2006); Hans Paerl, *Nutrient and Other Environmental Controls of Harmful Cyanobacterial Blooms Along the Freshwater-Marine Continuum in Cyanobacterial Harmful Algal Blooms: State of the Science and Research Needs*, 619 ADVANCES IN EXPERIMENTAL MED. & BIOLOGY 217, 217-37 (2008).

[49] Patricia M. Glibert, *Long-term Changes in Nutrient Loading and Stoichiometry and their Relationships with Changes in the Food Web and Dominant Pelagic Fish Species in the San Francisco Estuary, California*, 18 REVIEWS IN FISHERY SCI. 211, 211-32 (2010) (The existence of multiple interacting stressors can confound results of single-stressor research. For example, increased ammonia loading is linked to decreased diatom production); Kimmerer, *supra* note 30 (Equally consistent with the data is the establishment of overbite clams, increasing diatom consumption); James R. Thomson et al., *Bayesian Change-Point Analysis of Abundance Trends for Pelagic Fishes in the Upper San Francisco Estuary*, 20 ECOLOGICAL APPLICATIONS 1431, 1431-48 (2010) (Both factors are probably responsible for the decline in diatoms in the low salinity zone but both factors are also affected by hydrological changes: low river flows due to drought have likely increased the effects of ammonia loading while stabilized salinity regimes have allowed high densities of overbite clams to accrue in the western delta).

[50] PETER MOYLE ET AL., DELTA SOLUTIONS CTR. FOR WATERSHED SCI., UNIV. OF CAL., DAVIS, HABITAT VARIABILITY AND COMPLEXITY IN THE UPPER SAN FRANCISCO ESTUARY (2010), *available at* http://deltasolutions.ucdavis.edu/pdf/WorkingPapers/HabitatVariabilityandComplexity-2010Draft.pdf; BROWN ET AL., IEP POD WORKPLAN 2010 (forthcoming 2010), *available at* http://calwater.ca.gov/science/pod/pod_index.html; James Cloern, Senior Research Scientist, U.S. Geological Survey, Historical Perspective on Human Disturbance in the Sacramento-San Joaquin Delta Ecosystem, Presentation at the National Research Council's Meeting on Sustainable Water and Environmental Management in the California Bay-Delta (July 13, 2010); Anke Mueller-Solger, IEP Lead Scientist Delta Stewardship Council, IEP Science Highlights, 2009-2010, Summary Presentation at IEP Annual Workshop (May 25, 2010), *available at* http://www.water.ca.gov/iep/docs/052510Science.pdf ; Thomson et al., *supra* note 49; Mac Nally et al., *supra* note 31.

[51] Hestir, Schoellhammer, Morgan & Ustin, *supra* note 47; Santos, Anderson & Ustin, *supra* note 47; Matthew L. Nobriga, T. Sommer, F. Feyrer & K. Fleming, *Long-Term Trends in Summertime Habitat Suitability for Delta Smelt (Hypomesus transpacificus)*, 6 SAN FRANCISCO ESTUARY & WATERSHED SCI. 1, 1 n.1 (Feb. 2008), *available at* http://repositories.cdlib.org/jmie/sfews/vol6/iss1/art1.

[52] Peter B. Moyle & W.A. Bennett, *The Future of the Delta Ecosystem and its Fish*, *in* COMPARING FUTURES FOR THE SACRAMENTO-SAN JOAQUIN DELTA (TECHNICAL APPENDIX D) (Pub. Policy Inst. of Cal. ed., 2008), *available at* http://www.ppic.org/content/pubs/other/708EHR_appendixD.pdf.

[53] LUND, *supra* note 23; Cloern *supra* note 50.

[54] VIVIAN GADDIE, MICHAEL MIERZA & JENNY MARR, LEVEE FAILURES IN THE SACRAMENTO-SAN JOAQUIN RIVER DELTA, *available at* http://www.dwr.water.ca.gov/floodmgmt/docs/DeltaLeveeFailures_FMA_200709.pdf (last visited Nov. 3, 2010).

[55] Letter from Phillip L. Isenberg, Chair, Delta Vision Blue Ribbon Task Force, to Arnold Schwarzenegger, Governor, Cal. (Mar. 24, 2008), *available at* http://deltavision.ca.gov/BlueRibbonTaskForce/Communications/SLR_Followup_Letter_To_Governor_9-4-08.pdf. (The Governor's Delta Vision Blue Ribbon Task Force estimated and adopted for its planning purposes a projected sea level rise of 55 inches by the year 2100).

[56] CAL. DEPT. OF WATER RESOURCES, MANAGING AN UNCERTAIN FUTURE: CLIMATE CHANGE ADAPTATION STRATEGIES FOR CALIFORNIA'S WATER (Oct. 2008), *available at* http://www.water.ca.gov/climatechange/docs/ClimateChangeWhitePaper.pdf.

[57] Given that 20 million Californians get some or all of their drinking water from the Bay Delta Estuary, it may seem counterintuitive that EPA is not including the Public Health Service Act, 42 U.S.C. § 300f et seq. (2006) (generally referred to as the Safe Drinking Water Act) as one of the major statutes affecting Bay Delta Estuary aquatic resources. That Act, however, focuses on water quality "at the tap" and on the activities of public water supply agencies. Although the targeted drinking water parameters at the tap are a very relevant consideration in Bay Delta Estuary resource management, the regulatory tools for protecting sources of drinking water are found primarily in the Clean Water Act.

[58] 40 C.F.R. § 131.3(i) (Dec. 14, 1994) (Under EPA regulations, a water quality standard consists of a "designated use or uses for the waters of the United States and water quality criteria for such waters based upon such uses").

[59] 40 C.F.R. § 131.2 (Dec. 22, 1992) (Under EPA regulations, "Serve the purposes of the Act" (as defined in Sections 101(a), 101(a)(2), and 303(c) of the Act) means that water quality standards should: (1) include provisions for restoring and maintaining chemical, physical, and biological integrity of state and tribal waters, (2) provide, wherever attainable, water quality for the protection and propagation of fish, shellfish, and wildlife and recreation in and on the water ("fishable/swimmable"), and (3) consider the use and value of state and tribal waters for public water supplies, propagation of fish and wildlife, recreation, agricultural and industrial purposes, and navigation).

[60] The Central Valley RWQCB incorporates any final State Board criteria into their plans.

[61] STATE WATER RES. CONTROL BD., WATER QUALITY CONTROL PLAN FOR THE SAN FRANCISCO BAY/SACRAMENTO-SAN JOAQUIN DELTA ESTUARY (Dec. 13, 2006), *available at* http://www.waterboards.ca.gov/waterrights/water_issues/programs/bay_delta/wq_control_plans/2006wqcp/docs/2006_plan_final.pdf.

[62] 33 U.S.C. § 1342(b)(1)(B) (2008).

[63] 33 U.S.C. § 1311 (a)-(b) (1995).

[64] 33 U.S.C. §§ 1311(b)(2) (1995), 1314(b) (2000), 1316 (1972), 1317(b)-(c) (1987).

[65] 33 U.S.C. §§ 1311(a)-(b) (1995), 1342 (2008).

[66] 33 U.S.C. §§ 1317(b)-(c) (1987).

[67] The major POTWs affecting the Estuary are listed in Section III.A.2.
[68] Water Board actions on these permit renewals are not solely the result of the POD issues. The Boards are required to look at a broad range of water quality issues in their permit decisions.
[69] City of Stockton's Waste Water Treatment Plant NPDES permit, Order No. R5-2002-0083 (2002).
[70] Cease and Desist Order, Order No. R5-2002-0084 (2002).
[71] 55 Fed. Reg. 47990 (Nov. 16, 1990).
[72] 64 Fed. Reg. 68721 (Dec. 8, 1999).
[73] *See* 33 U.S.C. § 402(p) (2000); 40 C.F.R. §122.26 (June 12, 2006).
[74] 40 C.F.R. § 122.26(b)(8) (June 12, 2006).
[75] 40 C.F.R. § 122.26(b)(16) (June 12, 2006).
[76] *See* Water Quality Order, Order No. 2003-0005-DWQ (2003).
[77] 40 C.F.R. § 122.26(b)(14)(x) (June 12, 2006).
[78] 40 C.F.R. § 122.26(b)(15) (June 12, 2006).
[79] California Construction General Permit, Order No. 2009-0009-DWQ (2009).
[80] 40 C.F.R. § 122.26(a)(9)(i)(C)-(D) (June 12, 2006).
[81] 40 C.F.R. § 122.35 9 (Dec. 8, 1999).
[82] 33 U.S.C. § 1313(d)(1)(A) (2000).
[83] 40 C.F.R. § 130.7(b) (Mar. 19, 2003).
[84] 40 C.F.R. § 130.7(d)(1) (Mar. 19, 2003).
[85] 33 U.S.C. §1313(d)(2) (2000).
[86] 33 U.S.C. § 1313(d)(1)(C) (2000).
[87] 40 C.F.R. § 130.2(g)-(i) (Mar. 19, 2003).
[88] *See* Dioxin/Organochlorine Ctr. v. Clarke, 57 F.3d 1517, 1520 (9th Cir. 1995).
[89] 40 C.F.R. §130.7(c)(1)(ii) (Mar. 19, 2003) (In addition to the listing process for impaired waters described above, Section 303(d)(3) requires States to identify and estimate TMDLs for waters that are not impaired. Unlike TMDLs established under Section 303(d)(1), States are not required to submit TMDLs estimated pursuant to Section 303(d)(3) to EPA. Information developed under Section 303(d)(3) may be used to protect waters to ensure they continue to meet WQS).
[90] 33 U.S.C. § 1313(d)(2) (2000).
[91] 33 U.S.C. § 1313(d)(2) (2000).
[92] 40 C.F.R. § 122.44(d)(1)(vii)(B) (Apr. 11, 2007); NRDC v. EPA, 915 F.2d 1316, 1316 (9th Cir. 1990).
[93] *See NRDC*, 915 F.2d at 1316 (noting that Clean Water Act does not "directly prohibit" release of pollutants from nonpoint sources).
[94] STATE WATER RES. CONTROL BD., 2010 INTEGRATED REPORT CLEAN WATER ACT SECTIONS 303(D) AND 305(B) (Apr. 19, 2010), *available at* http://www.waterboards.ca.gov/water_issues/programs/tmdl/integrated2010.shtml (On August 4, 2010, the State Water Resources Control Board reviewed and approved the 2010 Integrated Report, including the 303(d) listing); *See* Letter from Alexis Strauss, Water Div. Dir., U.S. EPA Region IX, to Tom Howard, Exec. Officer, State Water Res. Control Bd. (Nov. 12, 2010), *available at* http://www.epa.gov/region9/water/tmdl/303d-pdf/EPAsPartial-Approval-Partial-DisapprovLtr-Enclos-Ca2008-2010-303dList.pdf.
[95] STATE WATER RES. CONTROL BD., CENT. VALLEY REG'L WATER QUALITY CONTROL BD. & SAN FRANCISCO BAY REG'L. WATER QUALITY CONTROL BD., *supra* note 15.
[96] U.S. EPA Fact Sheet, Wetland Regulatory Authority, http://water.epa.gov/type/wetlands/outreach/upload/reg_authority_pr.pdf (last visited Nov. 3, 2010) (the Clean Water Act Section 404 program is conventionally referred to as the "Wetlands" program however, it applies to dredge and fill activities in *all* Clean Water Act jurisdictional waters. The types of waters that are jurisdictional under the Clean Water Act include, but are not limited to, streams, rivers, natural ponds, lakes, impoundments, estuaries, bays, ocean, mudflats, sloughs, and wetlands).
[97] For example, fill activities that increase water velocity (armoring stream banks, straightening streams, piping streams in culverts) also increase the ability of moving water to entrain and carry sediment and other contaminants to downstream locations and decrease the likelihood that contaminants will settle out of the water column. Fill activities like boat dock construction may have minimal direct impact to an aquatic resource, but the increased boat activity has indirect negative water quality impacts from re-suspension of sediments, loss of subtidal vegetation, and combustion engine pollution. Dredging activities that require Clean Water Act Section 404 permits can also

negatively affect water quality by digging up bottom sediments and suspending these sediments in the water column, restricting light penetration to aquatic plants and reintroducing contaminants such as pesticides into sediments.

[98] Clean Water Act 404(b)(1) Guidelines, 40 C.F.R. § 230.10 (Oct. 28, 2010).

[99] U.S. EPA Fact Sheet, Functions and Values of Wetlands, http://water.epa.gov/type/wetlands/upload/2006_08_11_wetlands_fun_val.pdf (last visited Nov. 3, 2010).

[100] Pesticides; Procedural Regulations for Registration Review, 71 Fed. Reg. 45719 (Aug. 9, 2006); 40 C.F.R. pt. 155 subpt. C (Aug. 9, 2006).

[101] The National Research Council panel currently evaluating several Bay Delta Estuary science issues may be "ranking" factors associated with the decline of ESA listed species and other at-risk species. That ranking and the associated report is not due until 2011. Similarly, the Delta Independent Science Board has initiated a process to evaluate and rank the relative importance of multiple stressors and, especially, to consider the interactive effects of these multiple stressors. *See* DELTA STRESSORS WORKSHOP, MEETING NOTICE (Dec. 30, 2010), *available at* http://www.deltacouncil.ca.gov/delta_science_program/pdf/isb/d-isb_2011_01_workshop_stressors_mtg_notice_122810.pdf.

[102] STATE WATER RES. CONTROL BD., *supra* note 94.

[103] Clean Water Act, 33 U.S.C. § 1362(13) (2006) ("The term 'toxic pollutant' means those pollutants, or combinations of pollutants, including disease-causing agents, which after discharge and upon exposure, ingestion, inhalation or assimilation into any organism, either directly from the environment or indirectly by ingestion through food chains, will, on the basis of information available to the Administrator, cause death, disease, behavioral abnormalities, cancer, genetic mutations, physiological malfunctions (including malfunctions in reproduction) or physical deformations, in such organisms or their offspring").

[104] MICHAEL L. JOHNSON ET AL., EVALUATION OF CHEMICAL, TOXICOLOGICAL, AND HISTOPATHOLOGICAL DATA TO DETERMINE THEIR ROLE IN THE PELAGIC ORGANISM DECLINE, (Apr. 20, 2010), *available at* http://www.swrcb.ca.gov/rwqcb5/water_issues/delta_water_quality/comprehensive_monitoring_program/contaminant_synthesis_report.pdf.

[105] Glibert, *supra* note 49.

[106] Erin L. Amweg, Donald P. Weston, Jing You & Michael J. Lydy, *Pyrethroid Insecticides and Sediment Toxicity in Urban Creeks from California and Tennessee*, 40 ENVTL. SCI. TECH. 1700, 1700–06 (2006).

[107] DAVID OSTRACH ET AL., THE ROLE OF CONTAMINANTS, WITHIN THE CONTEXT OF MULTIPLE STRESSORS, IN THE COLLAPSE OF THE STRIPED BASS POPULATION IN THE SAN FRANCISCO ESTUARY AND ITS WATERSHED (2009), *available at* http://www.science.calwater.ca.gov/pdf/workshops/POD/POD_yr2_Ostrach_090522_report_final_djo.pdf.

[108] U.S. ENVTL. PROT. AGENCY, 1999 UPDATE OF AMBIENT WATER QUALITY CRITERIA FOR AMMONIA (1999), *available at* http://www.epa.gov/waterscience/standards/ammonia/99update.pdf.

[109] David John Randall & T.K.N. Tsui, *Ammonia Toxicity in Fish*, 45 MARINE POLLUTION BULLETIN 17, 17-23 (2002).

[110] U.S. ENVTL. PROT. AGENCY, DRAFT 2009 UPDATE AQUATIC LIFE AMBIENT WATER QUALITY CRITERIA FOR AMMONIA – FRESHWATER (2009), *available at* http://water.epa.gov/scitech/swguidance/waterquality/standards/criteria/aqlife/pollutants/ammonia/upload/2009_12_23_criteria_ammonia_2009update.pdf; U.S. ENVTL. PROT. AGENCY, *supra* note 108.

[111] U.S. ENVTL. PROT. AGENCY, *supra* note 108.

[112] IDA FLORES AT AL., ACUTE AND CHRONIC TOXICITY OF AMMONIA ON *PSEUDODIAPTOMUS FORBESI* (2010), *available at* http://www.water.ca.gov/iep/docs/052510LesmeisterB.pdf.

[113] Randall & Tsui, *supra* note 109.

[114] Ruth Francis-Floyd, Craig Watson, Denise Petty & Deborah B. Poude, *Ammonia in Aquatic Systems*, UNIV.OF FLA. IFAS EXTENSION, FA16 (2009), *available at* http://edis.ifas.ufl.edu/fa031.

[115] U.S. EPA, National Nutrient Strategy, http://www.epa.gov/waterscience/criteria/nutrient/strategy/index.html (last visited Oct. 18, 2010).

[116] Alan Jassby, *Phytoplankton in the Upper San Francisco Estuary: Recent Biomass Trends, their Causes, and their Trophic Significance*, 6 SAN FRANCISCO ESTUARY & WATERSHED SCI. 1 (Feb. 2008), *available at* http://escholarship.org/uc/item/71h077r1.

[117] *Id.*; Frances P. Wilkerson et al., *Phytoplankton Blooms and Nitrogen Productivity in the San Francisco Bay*, 29(3) ESTUARIES & COASTS 401, 401-16 (2006).

[118] Central Valley Regional Water Quality Control Board, Ammonia Summit Summary (Aug. 18-19, 2009), http://www.swrcb.ca.gov/rwqcb5/water_issues/delta_water_quality/ambient_ammonia_concentrations/index.shtml (last visited Nov. 16, 2010); Jassby, *supra* note 116; 2010 Ammonia Update Memorandum from Christopher Foe, Cal. Reg'l Water Quality Bd. Cent. Valley Region to Jeff Bruns & Karen Taberski , Water Boards (Oct. 7, 2010), *available at* http://www.waterboards.ca.gov/centralvalley/water_issues/delta_water_quality/ambient_ammonia_concentrations/oct2010_staffupdate_ammonia.pdf.

[119] ADAM BALLARD ET AL., INTERAGENCY ECOLOGICAL PROGRAM, BACKGROUND/SUMMARY OF AMMONIA INVESTIGATIONS IN THE SACRAMENTO-SAN JOAQUIN DELTA AND SUISUN BAY (2009), *available at* http://science.calwater.ca.gov/pdf/workshops/workshop_ammonia_bckgrnd_paper_nh4-nh3_030209.pdf; August 2009 Ammonia Update Memorandum from Christopher Foe, Cal. Reg'l Water Quality Bd. Cent. Valley Region to Jeff Bruns & Sue McConnell, Water Boards (Sept. 24, 2009), *available at* http://www.waterboards.ca.gov/centralvalley/water_issues/delta_water_quality/ambient_ammonia_concentrations/ammonia_mem.pdf*;* 2010 Ammonia Update Memorandum from Christopher Foe, *supra* note 118.

[120] Glibert, *supra* note 49.

[121] David Fullerton, Metro. Water Dist., Ammonium Concentrations and the Food Chain in Suisun Bay and the Delta, Presented at the Ammonia Summit at the Central Valley Regional Water Quality Control Board (Aug. 18-19, 2009), http://www.swrcb.ca.gov/rwqcb5/water_issues/delta_water_quality/ambient_ammonia_concentrations/18aug09_ammonia_summit/fullerton_pres.pdf.

[122] Inge Werner et al., *The Effects of Wastewater Treatment Effluent Associated Contaminants on Delta Smelt*, UNIV. OF CAL. DAVIS AQUATIC TOXICOLOGY LAB. 1, 60 (2008), *available at* http://www.water.ca.gov/pubs/environment/interagency_ecological_program/ammonia/the_effects_of_wastewater_treatment_effluent-associated_contaminants_on_delta_smelt.__final_report/werner_delta_smelt_ammonia_final_report012809.pdf; Inge Werner et al., *Acute Toxicity of Ammonia/um and Wastewater Treatment Effluent-Associated Contaminants on Delta Smelt*, UNIV. OF CAL. DAVIS AQUATIC TOXICOLOGY LAB. 1, 63 (2009), *available at* http://www.science.calwater.ca.gov/pdf/workshops/POD/UCD-ATL_FINAL_REPORT_Delta%20Smelt%20Ammonia_2009.pdf; CHRISTOPHER FOE, ADAM BALLARD & STEPHANIE FONG, CENT. VALLEY REG'L WATER QUALITY CONTROL BD., NUTRIENT CONCENTRATIONS AND BIOLOGICAL EFFECTS IN THE SACRAMENTO-SAN JOAQUIN DELTA (July 2010).

[123] Werner et al., *Acute Toxicity of Ammonia/um and Wastewater Treatment Effluent-Associated Contaminants on Delta Smelt, supra* note 122, at 63.

[124] FOE, BALLARD & FONG, *supra* note 122.

[125] S.J. Teh, Univ. of Cal. Davis, Aquatic Toxicology Program., Acute Toxicity of Ammonia, Copper, and Pesticides to Key Copepods, *Pseudodiaptomus forbesi* and *Eurytemora affinis*, of the San Francisco Estuary, Presented at the Ammonia Summit at the Central Valley Regional Water Quality Control Board (Aug. 18-19, 2009), http://www.swrcb.ca.gov/rwqcb5/water_issues/delta_water_quality/ambient_ammonia_concentrations/18aug09_ammonia_summit/teh_pres.pdf.

[126] CENT. VALLEY REG'L WATER QUALITY CONTROL BD, TENTATIVE NPDES PERMIT FOR SACRAMENTO COUNTY REGIONAL SANITATION DISTRICT, REGIONAL WASTEWATER TREATMENT PLANT, ATTACHMENT K (Sept. 3, 2010).

[127] *Id.*; Teh, *supra* note 125.

[128] Teh, *supra* note 125; Randall & Tsui, *supra* note 109; F. B. Eddy, *Ammonia in Estuaries and Effects on Fish*, 67 J. OF FISH BIOLOGY 1495, 1495-1513 (2005).

[129] Jassby, *supra* note 107; Wilkerson et al., *supra* note 117.

[130] Cloern, *supra* note 50; P.W. Lehman, *The Influence of Climate on Phytoplankton Community Biomass in San Francisco Bay Estuary*, 45 LIMNOLOGY & OCEANOGRAPHY (3) 580, 580-90 (2000).

[131] Lehman, *supra* note 130; T. Brown, *Phytoplankton Community Composition: The Rise of the Flagellates*, 22IEP NEWSLETTER (3) 20, 20-27 (2009), *available at* http://www.water.ca.gov/iep/newsletters/2009/IEPNewsletter_Final2SUMMER-Fall2009%20.pdf; J. E. Cloern & R. Dufford, *Phytoplankton Community Ecology: Principles Applied in San Francisco Bay*, 258 MARINE ECOLOGY PROGRESS SERIES 11, 11-28 (2005).

[132] James Orsi, *Food Habits of Several Abundant Zooplankton Species in the Sacramento-San Joaquin Estuary,* IEP TECHNICAL REPORT No. 41 (Feb., 1995).

[133] *Id.*

[134] Michael T. Brett & Dorthe C. Muller-Navarra, *The Role of Highly Unsaturated Fatty Acids in Aquatic Foodweb Processes*, 38 FRESHWATER BIOLOGY 483, 483-99 (1997).

[135] Benni Hanson, Peter Koefoed Bjornsen & Per Juel Hansen, *The Size Ratio Between Planktonic Predators and their Prey*, 39(2) LIMNOLOGY & OCEANOGRAPHY 395, 395-403 (1994); Tom Fenchel, *Marine Plankton Food Chains*, 19 ANNUAL REVIEW OF ECOLOGY EVOLUTION & SYSTEMATICS 19, 19-38 (1988).

[136] Glibert, *supra* note 49.

[137] Gry Mine Berg et al., *Variability in Inorganic and Organic Nitrogen Uptake Associated with Riverine Nutrient Input in the Gulf of Riga, Baltic Sea,* 24 ESTUARIES 204, 204-14 (2001).

[138] Quay Dortch, *The Interaction Between Ammonium and Nitrate Uptake in Phytoplankton*, 61 MARINE ECOLOGY PROGRESS SERIES 183, 183-201(1990).

[139] Dugdale, Wilkerson, Hogue & Marchi, *supra* note 46; Wilkerson et al., *supra* note 117.

[140] Lehman, *supra* note 130; Cloern, *supra* note 50.

[141] P.W. Lehman et al., *Initial Impacts of Microcystis aeruginosa Blooms on the Aquatic Food Web in the San Francisco Estuary*, 637 HYDROBIOLOGIA 229, 229-48 (2010).

[142] P.W. Lehman, G. Boyer, C. Hall, S. Waller & K. Gehrts, *Distribution and Toxicity of a New Colonial Microcystis aeruginosa Bloom in the San Francisco Bay Estuary, California*, 541 HYDROBIOLOGIA 87, 87-99 (2005).

[143] C. E. Mioni, Does Ammonia Impact the Distribution of Harmful Algae and Phototoxins in the San Francisco Estuary?, Presented at the Ammonia Summit at the Central Valley Regional Water Quality Control Board (Aug. 18-19, 2009), http://www.swrcb.ca.gov/rwqcb5/water_issues/delta_water_quality/ambient_ammonia_concentrations/18aug09_ammonia_summit/mioni_pres.pdf.

[144] Lehman, *supra* note 130; Lehman et al., *supra* note 141; P.W. Lehman, G. Boyer, M. Satchwell & S. Waller, *The Influence of Environmental Conditions on the Seasonal Variation of Microcystis Cell Density and Microcystins Concentration in the San Francisco Estuary*, 600 HYDROBIOLOGIA 187, 187-204 (2008).

[145] SAN FRANCISCO REG'L WATER QUALITY CONTROL BD., WATER QUALITY CONTROL PLAN (BASIN PLAN) FOR THE SAN FRANCISCO BAY BASIN (2006), *available at* http://www.waterboards.ca.gov/sanfranciscobay/basin_planning.shtml.

[146] U.S. ENVTL. PROT. AGENCY, *supra* note 108.

[147] U.S. ENVTL. PROT. AGENCY, *supra* note 110.

[148] Diana Engle, Larry Walker Assoc., Total Ammonia and Un-ionized Ammonia Concentrations in the Delta: An Examination of Ambient Concentrations and Toxicity Thresholds, Presented at the Ammonia Summit at the Central Valley Regional Water Quality Control Board (Aug. 18-19, 2009), http://www.swrcb.ca.gov/centralvalley/water_issues/delta_water_quality/ambient_ammonia_concentrations/index.shtml.

[149] S Teh, *supra* note 125.

[150] Werner et al., *The Effects of Wastewater Treatment Effluent Associated Contaminants on Delta Smelt, supra* note 122, at 60.

[151] FOE, BALLARD & FONG, *supra* note 122.

[152] U.S. ENVTL. PROT. AGENCY, DRAFT 2009 UPDATE AQUATIC LIFE AMBIENT WATER QUALITY CRITERIA FOR AMMONIA – FRESHWATER FACTSHEET (2009), *available at* http://www.epa.gov/waterscience/criteria/ammonia/factsheet2.html.

[153] FOE, BALLARD & FONG, *supra* note 122.

[154] Letter from Walter Wadlow, Gen. Manager, Alameda County Water Dist. et al., to Kathleen Harder, Water Res. Control Eng'r, Cal. Reg'l Water Quality Control Bd., Cent. Valley Region, (June 1, 2010), *available at* http://www.swrcb.ca.gov/centralvalley/board_decisions/tentative_orders/aquatictox/wateragencies_aqtox_com.pdf (regarding aquatic life and wildlife preservation issues concerning Sacramento Regional Wastewater Treatment Plant NPDES Permit Renewal).

[155] CENT. VALLEY REG'L WATER QUALITY CONTROL BD., NPDES PERMIT RENEWAL ISSUES AQUATIC LIFE AND WILDLIFE PRESERVATION SACRAMENTO REGIONAL COUNTY SANITATION DISTRICT SACRAMENTO REGIONAL WASTEWATER TREATMENT PLANT (Apr. 28, 2010), *available at* http://www.swrcb.ca.gov/centralvalley/board_decisions/tentative_orders/aquatictox/aquatictox_iss_pap.pdf.

[156] Sacramento County Regional Sanitation District, Regional Wastewater Treatment Plant, NPDES Permit Order

No. R5-2010-0014 (Dec. 9, 2010), *available at* http://www.waterboards.ca.gov/centralvalley/board_decisions/adopted_orders/sacramento/r5-2010-0114_npdes.pdf.

[157] Central Valley Regional Water Quality Control Board, Adopted Orders, http://www.swrcb.ca.gov/centralvalley/board_decisions/adopted_orders/index.shtml (last visited Dec. 3, 2010) (All data come from these NPDES permits)

[158] Stockton NPDES Permit, Order No. R5-2002-0083 (2002).

[159] CENT. VALLEY REG'L WATER QUALITY CONTROL BD., WASTE DISCHARGE REQUIREMENTS AND NPDES PERMIT FOR THE CITY OF STOCKTON WASTEWATER TREATMENT CONTROL FACILITY NPDES PERMIT R5-2008-0154 (Oct. 23, 2008), *available at* http://www.swrcb.ca.gov/centralvalley/board_decisions/adopted_orders/san_joaquin/r5-2008-0154.pdf.

[160] FOE, BALLARD & FONG, *supra* note 122.

[161] The term bioaccumulation is used in this context to refer both to biomagnification (increasing concentration in a food web through trophic transfer) and bioaccumulation (build-up in an organism over time).

[162] A. Dennis Lemly, *Environmental Implications of Excessive Selenium*, 10 BIOMEDICAL & ENVTL. SCIENCES 415, 415 (1997).

[163] A. Robin Stewart et al., *Food Web Pathway Determines How Selenium Affects Ecosystems: A San Francisco Bay Case Study*, 38 ENVTL. SCI.TECH. 4519, 4519-26 (2004).

[164] PETER M. CHAPMAN ET AL., ECOLOGICAL ASSESSMENT OF SELENIUM IN THE AQUATIC ENVIRONMENT 5 (2010) (Evidence has been mounting for several decades); *See* U.S. FISH & WILDLIFE SERV./ NAT'L MARINE FISHERIES SERV. BIOLOGICAL OPINION ON THE CALIFORNIA TOXICS RULE 123 (2000) (concluded that "[N]early every major review of experimental and field data conducted over the past decade has concluded that a chronic criterion of 5 micrograms/L is not fully protective of aquatic life" and that there was an "overwhelming" weight of evidence supporting a concentration no greater than 2 microg./L); California Toxics Rule, Establishment of Numeric Criteria for Priority Toxic Pollutants for the State of California, 40 C.F.R. § 131.38 (May 18, 2000).

[165] Selenium toxicity is more a concern with wildlife and aquatic life, rather than human health. However, there are regulatory measures to protect humans. As with fish and wildlife, human exposure to selenium occurs through food and to a lesser degree, drinking water. Human health requirements (infants to adults: 15-55 micrograms/L) are generally met without supplements. Inadvertent human exposure to excessive amounts of selenium is unlikely, except through consumption of contaminated fish or meat. *See* PESTICIDE & ENVTL. TOXICOLOGY BRANCH, OFFICE OF ENVTL. HEALTH HAZARD ASSESSMENT, PUBLIC HEALTH GOAL FOR SELENIUM IN DRINKING WATER (Apr. 2010) (OEHHA has developed a fish contaminant goal for selenium and advisory levels for selenium in fish tissue. OEHHA also is responsible for issuing consumption warnings for sport or subsistence fishing sites where there is evidence of contaminated fish. At present, there are no consumption warnings for selenium in the Bay Delta Estuary watershed. The drinking water standard, or "maximum contamination level" (MCL), established by the California Department of Public Health for public water systems is 50 parts per billion (ppb) for selenium. This value may be reevaluated on the basis of recent OEHHA research on human health risk that recommends a 30 ppb goal).

[166] Under highly anoxic conditions (for example, buried sediments) selenium can be reduced to elemental selenium, but selenium does not readily return to elemental form after conversion to bioavailable forms.

[167] Andrew N. Cohen, Guide to the Exotic Species of San Francisco Bay (2005), http://www.exoticsguide.org (last visited Nov. 4, 2010).

[168] WILLIAM N. BECKON & THOMAS C. MAURER, U.S. DEP'T OF THE INTERIOR, FISH & WILDLIFE SERVICE, SPECIES AT RISK FROM SELENIUM EXPOSURE IN THE SAN FRANCISCO ESTUARY, 1, 51-52 (Mar. 2008) (Beckon and Maurer report that little is known of risk of selenium to green sturgeon).

[169] WILLIAM N. BECKON & THOMAS C. MAURER, POTENTIAL EFFECTS OF SELENIUM CONTAMINATION ON FEDERALLY-LISTED SPECIES RESULTING FROM DELIVERY OF FEDERAL WATER TO THE SAN LUIS UNIT (Mar. 2008), *available at* http://wwwrcamnl.wr.usgs.gov/Selenium/Library_articles/Beckon_and_Maurer_Effects_of_Se_on_Listed_Species_SLD_2008.pdf.

[170] SAN FRANCISCO ESTUARY INSTITUTE FOR THE GRASSLAND BYPASS PROJECT OVERSIGHT COMMITTEE, GRASSLAND BYPASS PROJECT ANNUAL REPORT 2006-2007 14 (2010), *available at* http://www.sfei.org/sites/default/files/GBP%20Annual%20Report%200607%20for%20web_1.pdf (Loading from the Grassland Bypass Project was over 8,000 lbs/year between 1986-96 (pre-project), compared with 3,300/year a decade into the Project (2005-07). Subsequently, loads have continued to decline, but at a slower rate); SAN

FRANCISCO BAY REG'L WATER QUALITY CONTROL BD., TECHNICAL MEMORANDUM 2: NORTH BAY SELENIUM DATA SUMMARY AND SOURCE ANALYSIS 3-29 (July 2008), *available at* http://www.swrcb.ca.gov/rwqcb2/water_issues/programs/TMDLs/northsfbayselenium/TMDL_TM2_July2008.pdf (The refinery discharges have also shifted from selenite to selenate (the less bioavailable form)).

[171] *Id.*

[172] National Toxics Rule, 40 C.F.R. § 131.36 (Dec. 22, 1992); California Toxics Rule, Establishment of Numeric Criteria for Priority Toxic Pollutants for the State of California, 40 C.F.R. § 131.38 (May 18, 2000) (On May 18, 2000, the EPA promulgated numeric water quality criteria for priority toxic pollutants and other provisions for water quality standards to be applied to waters in the State of California. The rule filled a gap in California water quality standards that was created in 1994 when a state court overturned the state's water quality control plans containing water quality criteria for priority toxic pollutants. The criteria became legally applicable in the State of California for inland surface waters, enclosed bays and estuaries for all purposes and programs under the Clean Water Act).

[173] California Toxics Rule, 40 C.F.R. § 131.38 (May 18, 2000); National Toxics Rule, 40 C.F.R. § 131.36 (Dec. 22, 1992).

[174] *See* CENT. VALLEY REG'L WATER QUALITY CONTROL BD., STAFF REPORT: TMDL FOR SELENIUM IN THE LOWER SAN JOAQUIN RIVER 1, 2-3 (Aug. 2001) (In 1996 the Central Valley RWQCB adopted the 5 micrograms/L chronic value, incorporating it into the Basin Plan. This objective still applies to Mud Slough and the San Joaquin River from Sack Dam to Vernalis. This action also set a 2 micrograms/L chronic value for the Grasslands channels and Salt Slough); *See* CENT. VALLEY REG'L WATER QUALITY CONTROL BD., 1996 BASIN PLAN AMENDMENT (1996), *available at* http://www.swrcb.ca.gov/rwqcb5/water_issues/water_quality_studies/surface_water_ambient_monitoring/historic_reports_and_faq_sheets/index.shtml#1996bpa (The site-specific objectives adopted by the Regional Board for the Grasslands Marshes and Salt Slough were based in part on consideration of the lentic conditions, but this approach has not been applied consistently throughout the watershed).

[175] U.S. FISH & WILDLIFE SERV., *supra* note 164(The Services found that "the chronic aquatic life criterion for selenium proposed in the CTR does not protect listed fish and wildlife dependent on the aquatic ecosystem for development and/or foraging").

[176] THERESA S. PRESSER & SAMUEL N. LUOMA, FORECASTING SELENIUM DISCHARGES TO THE SAN FRANCISCO BAY-DELTA ESTUARY, U.S. GEOLOGICAL SURVEY PROFESSIONAL PAPER 1646, 55, 55-63 (2006), *available at* http://pubs.usgs.gov/pp/p1646.

[177] Theresa Presser & Samuel N. Luoma, *A Methodology for Ecosystem-Scale Modeling of Selenium*, 6 INTEGRATED ENVTL. ASSESSMENT & MGMT. 685, 685-710 (2010), *available at* http://onlinelibrary.wiley.com/doi/10.1002/ieam.101/abstract.

[178] AMY E. KLECKNER ET AL., U.S. GEOLOGICAL SURVEY OPEN-FILE REPORT 2010-1252, SELENIUM CONCENTRATIONS AND STABLE ISOTOPIC COMPOSITIONS OF CARBON AND NITROGEN IN THE BENTHIC CLAM CORBULA AMURENSIS FROM NORTHERN SAN FRANCISCO BAY, CALIFORNIA: MAY 1995-FEBRUARY 2010 (2010), *available at* http://pubs.usgs.gov/of/2010/1252/.

[179] Presser & Luoma, *supra* note 177 at 685-710 (This work is pursuant to two agreements reached following an ESA consultation and Biological Opinion on the California Toxics Rule; U.S. EPA agreed to develop and promulgate as part of the California Toxics Rule aquatic life criteria for listed species).

[180] STATE WATER RES. CONTROL BD., *supra* note 94.

[181] STATE WATER RES. CONTROL BD., WATER QUALITY CONTROL POLICY FOR DEVELOPING CALIFORNIA'S CLEAN WATER ACT SECTION 303(D) LIST (Sept. 2004), *available at* http://www.swrcb.ca.gov/water_issues/programs/tmdl/docs/ffed_303d_listingpolicy093004.pdf.

[182] STATE WATER RES. CONTROL BD., *supra* note 94; *See* Letter from Alexis Strauss, *supra* note 94.

[183] The permits are: Chevron Products Company, Richmond Refinery, CA0005134 (expires 6/13/2011); ConocoPhillips, San Francisco Refinery, CA0005053 (expires 6/15/2011); Shell Oil U.S. and Equilon Enterprises LLC, Shell Martinez Refinery, CA0005789 (expires 10/31/2011); Tesoro Refining and Marketing Co., Golden Eagle Refinery, CA0004961 (expires 6/30/2015); and Valero Refining Company, CA, Valero Benicia Refinery, CA0005550 (expires 11/31/2014).

[184] SAN FRANCISCO BAY REG'L WATER QUALITY CONTROL BD., *supra* note 170, at 3-61.

[185] San Francisco Bay Regional Water Quality Control Board, Amendment of Waste Discharge Requirements for San Francisco Bay Region Refineries, Order No. R2-2010-0057 (2010).

[186] U.S. BUREAU OF RECLAMATION, SAN LUIS UNIT DRAINAGE FEATURE RE-EVALUATION, FINAL ENVIRONMENTAL

IMPACT STATEMENT & RECORD OF DECISION 7 (Mar. 2007).

[187] In this area a strict distinction between surface and groundwater, or focus only on surface water, is misplaced. Water management in the Basin mixes both sources. Also, there is evidence that subsurface flow from areas that do not discharge to surface waters may affect the shallow groundwater in areas near the San Joaquin River, where surface-groundwater interchange is active.

[188] U.S. EPA List of Approved Selenium TMDLs, http://oaspub.epa.gov/tmdl/waters_list.tmdls?region=9&polid=20&pollutant=SELENIUM (last visited Nov. 4, 2010) (includes TMDLs for Selenium in the Lower San Joaquin River (2002), Grasslands Marshes (2000), and Salt Slough (1999)); *See also* Central Valley Regional Water Quality Control Board, San Joaquin River Selenium TMDL, http://www.swrcb.ca.gov/rwqcb5/water_issues/tmdl/central_valley_projects/san_joaquin_se/index.shtml (last visited Nov. 4, 2010).

[189] In the future, this current framework may be augmented by, or coordinated more closely with, related programs. One example is tracking with the Irrigated Lands Regulatory Program, which has recently proposed significant changes in program scope and approach, including covering discharges to groundwater. The Grasslands Bypass Project area has not been required to participate directly in the ILRP because the Grasslands Bypass Project is considered generally equivalent to the ILRP requirements. Closer ties are also anticipated between the Grasslands Bypass Project and the Long Term Sustainability Initiative (CV-SALTS) to develop a comprehensive regional salt management plan.

[190] The Use Agreement sets out an incentive fee structure to promote compliance with target load reductions and defines multi-agency oversight (in which EPA participates) and technical groups. The Grasslands Bypass Project also has a relatively comprehensive surface water monitoring program with results posted at http://www.sfei.org/gbp (last visited Nov. 16, 2010).

[191] SAN FRANCISCO ESTUARY INSTITUTE FOR THE GRASSLAND BYPASS PROJECT OVERSIGHT COMMITTEE, *supra* note 170 (To some extent, the drainers can avoid discharges of selenium to surface waters by storing or placing it elsewhere—notably in shallow groundwater of reuse areas and in uses such as road wetting (termed 'displacement' in the Grasslands Report). Reduction in drainage volume in reuse areas facilitates use of this 'storage' in lieu of surface discharges, but can concentrate selenium).

[192] CENT. VALLEY REG'L WATER QUALITY CONTROL BD., AMENDMENTS TO THE WATER QUALITY CONTROL PLAN FOR THE SACRAMENTO RIVER AND SAN JOAQUIN RIVER BASINS TO ADDRESS SELENIUM CONTROL IN THE SAN JOAQUIN RIVER BASIN FINAL STAFF REPORT 6 (May 2010).

[193] In May 2010, the Central Valley Regional Water Quality Control Board gave its approval for extended time through a Basin Plan Amendment; the State Board approved it on October 5, 2010. The action will be followed by revised waste discharge requirements.

[194] PRESSER & LUOMA, *supra* note 176 at 20 (This selenium reservoir is such that increased applied irrigation water does not dilute selenium concentration; rather, concentration increases).

[195] Analysis of San Joaquin Basin selenium has a long history. *See* U.S. DEP'T OF THE INTERIOR & CAL. RES. AGENCY, A MANAGEMENT PLAN FOR AGRICULTURAL SUBSURFACE DRAINAGE AND RELATED PROBLEMS ON THE WESTSIDE SAN JOAQUIN VALLEY (Sept. 1990); U.S. BUREAU OF RECLAMATION, *supra* note 186; San Joaquin Valley Drainage Documents, http://www.archive.org/search.php?query=San%20Joaquin%20Valley%20Drainage (last visited Oct. 21, 2010); Kesterson Reservoir Documents, http://www.archive.org/search.php?query=kesterson (last visited Oct. 21, 2010).

[196] U.S. EPA, About Pesticides, www.epa.gov/pesticides/about/index.htm (last visited Oct. 21, 2010).

[197] U.S. GEOLOGICAL SURVEY, PESTICIDES IN SURFACE AND GROUND WATER OF THE UNITED STATES: SUMMARY OF THE RESULTS OF THE NATIONAL WATER QUALITY ASSESSMENT PROGRAM (NAWQA) (2006), *available at* http:/pubs.usgs.gov/circ/2005/1291.

[198] STATE WATER RES. CONTROL BD., *supra* note 94.

[199] CHRISTOPHER FOE & VALERIE CONNOR, STAFF REPORT CENT. VALLEY REG'L WATER QUALITY CONTROL BD., 1989 RICE SEASON TOXICITY MONITORING RESULTS (1991), *available at* http://www.calwater.ca.gov/Admin_Record/C-029766.pdf.

[200] CHRISTOPHER FOE & VALERIE CONNOR, STAFF REPORT CENT. VALLEY REG'L WATER QUALITY CONTROL BD., SAN JOAQUIN WATERSHED BIOASSAY RESULTS, 1988-1990 (1991).

[201] Kathryn Kuivila & Christopher Foe, *Concentrations, Transport and Biological Effects of Dormant Spray Pesticides in the San Francisco Estuary, California*, 14 ENVTL. TOXICOLOGY & CHEMISTRY 1141, 1141-50 (1995).

[202] Howard C. Bailey et al., *Diazinon and Chlorpyrifos in Urban Waterways in Northern California, USA*, 19

ENVTL. TOXICOLOGY & CHEMISTRY 82, 82-87 (2000); VALERIE CONNOR, STAFF MEMORANDUM STATUS OF URBAN STORM RUNOFF PRODUCTS, ALGAL TOXICITY AND HERBICIDE LEVELS ASSOCIATED WITH URBAN STORM RUNOFF, DIAZINON AND CHLORPYRIFOS DETECTIONS IN THE SAN FRANCISCO BAY AREA, *as reported in* CHRISTOPHER FOE, STAFF REPORT CENT. VALLEY REG'L WATER QUALITY CONTROL BD., EVALUATION OF THE POTENTIAL IMPACT OF CONTAMINANTS ON AQUATIC RESOURCES IN THE CENTRAL VALLEY AND SACRAMENTO-SAN JOAQUIN DELTA ESTUARY (1995).

[203] CHRISTOPHER FOE, LINDA DEANOVIC & DAVE HINTON, STAFF REPORT CENT. VALLEY REG'L WATER QUALITY CONTROL BD. TOXICITY IDENTIFICATION EVALUATIONS OF ORCHARD DORMANT SPRAY RUNOFF (1998).

[204] CHRISTOPHER FOE & R. SHEIPLINE, STAFF REPORT CENT. VALLEY REG'L WATER QUALITY CONTROL BD., PESTICIDES IN SURFACE WATER FROM APPLICATIONS ON ORCHARDS AND ALFALFA DURING THE WINTER AND SPRING OF 1991-1992 (1993).

[205] Donald Weston & Michael J. Lydy, *Pyrethroid Insecticides to the Sacramento-San Joaquin Delta of California*, 44 ENVTL. SCI. & TECH. 1833, 1833-40 (2010).

[206] STATE WATER RES. CONTROL BD., *supra* note 94.

[207] *Id.*

[208] "Unknown toxicity" is an impairment category that documents toxic events (widespread aquatic organism mortality in one location) that results from unidentified contaminants and their unidentified sources.

[209] FOE & CONNOR, *supra* note 200; FOE & SHEIPLINE, *supra* note 204; Weston & Lydy, *supra* note 205.

[210] URBAN PESTICIDE POLLUTION PREVENTION PROJECT, PESTICIDES OF INTEREST FOR URBAN SURFACE WATER QUALITY, URBAN PESTICIDES USE TRENDS ANNUAL REPORT (2008), *available at* http://www.up3project.org/documents/UP3UseTrendsReport2008.pdf.

[211] Including the Sacramento and San Joaquin River Basins, Bay Delta Estuary, and San Francisco Bay watersheds.

[212] Reported for pesticides applied in amounts greater than 500 kg (0.5 tons or ~1100 pounds).

[213] Kathryn Kuivila & Michelle Hladik, *Understanding the Occurrence and Transport of Current-Use Pesticides in the San Francisco Estuary Watershed*, 6(3) SAN FRANCISCO ESTUARY & WATERSHED SCI. 1, 1-19 (2008).

[214] URBAN PESTICIDE POLLUTION PREVENTION PROJECT, *supra* note 210.

[215] JOHNSON, *supra* note 104; Nathaniel Schloz, *Pesticides and the Decline of Pelagic Fishes in Western North America's Largest Estuarine Ecosystem* CONSERVATION LETTERS (forthcoming 2011); NATIONAL RESEARCH COUNCIL, COMMITTEE ON SUSTAINABLE WATER AND ENVIRONMENTAL MANAGEMENT IN THE CALIFORNIA BAY-DELTA, A SCIENTIFIC ASSESSMENT OF ALTERNATIVES FOR REDUCING WATER MANAGEMENT EFFECTS ON THREATENED AND ENDANGERED FISHES IN CALIFORNIA'S BAY DELTA (2010), *available at* http://www.nap.edu/catalog.php?record_id=12881.

[216] Kuivila & Moon, *supra* note 44.

[217] CENT. VALLEY REG'L WATER QUALITY CONTROL BD., WATER QUALITY CONTROL PLAN FOR THE SACRAMENTO AND SAN JOAQUIN RIVER BASINS (2009), *available at* http://www.swrcb.ca.gov/centralvalley/water_issues/basin_plans/index.shtml.

[218] Inge Werner et al., *Insecticide-Caused Toxicity to Ceriodaphnia dubia (Cladocera) in the Sacramento–San Joaquin River Delta, California, USA*, 19 ENVTL. TOXICOLOGY & CHEMISTRY 215, 215-27 (2000); Kuivila & Moon, *supra* note 44.

[219] Kuivila & Moon, *supra* note 44.

[220] Bennett, *supra* note 38.

[221] David Ostrach et al., *Maternal Transfer of Xenobiotics and Effects on Larval Striped Bass in the San Francisco Estuary*,105 PROCEEDINGS OF THE NAT'L ACAD. OF SCI. 19354, 19354-59 (2008).

[222] DANIEL OROS & INGE WERNER, WHITE PAPER FOR THE INTERAGENCY ECOLOGICAL PROGRAM, SFEI CONTRIBUTION 415, PYRETHROID INSECTICIDES: AN ANALYSIS OF USE PATTERNS, DISTRIBUTIONS, POTENTIAL TOXICITY AND FATE IN THE SACRAMENTO-SAN JOAQUIN DELTA AND CENTRAL VALLEY (2005), *available at* http://www.science.calwater.ca.gov/pdf/workshops/POD/CDFG_POD_Pyrethroids_White_Paper_Final_PDF.pdf.

[223] PETER MOYLE, INLAND FISHES OF CALIFORNIA 405 (1976) *as reported in* OROS & WERNER, *supra* note 222.

[224] S. OBREBSKI, J.J. ORSI & W. KIMMERER, IEP TECHNICAL REPORT NO. 32, LONG TERM TRENDS IN ZOOPLANKTON DISTRIBUTION AND ABUNDANCE IN THE SACRAMENTO-SAN JOAQUIN ESTUARY (1992).

[225] CENT. VALLEY REG'L WATER QUALITY CONTROL BD., DELTA DIAZINON AND CHLORPYRIFOS TMDL-FINAL BASIN PLAN AMENDMENT STAFF REPORT (June 2006), *available at* http://www.swrcb.ca.gov/centralvalley/water_issues/tmdl/central_valley_projects/delta_op_pesticide/final_staff_report/index.shtml; OROS & WERNER, *supra* note 222.

[226] STATE WATER RES. CONTROL BD., *supra* note 94.
[227] URBAN PESTICIDE POLLUTION PREVENTION PROJECT, *supra* note 210.
[228] OROS & WERNER, *supra* note 222.
[229] Kuivila & Hladik, *supra* note 213.
[230] Bailey et al., *supra* note 202; Howard Bailey et al., *Joint Acute Toxicity of Diazinon and Chlorpyrifos to Ceriodaphnia dubia*, 16 ENVTL. TOXICOLOGY & CHEMISTRY 2304, 2304-08 (1997); Michael Lydy & K. R. Austin, *Toxicity Assessment of Pesticide Mixtures Typical of the Sacramento–San Joaquin Delta using Chironomus tentans*, 48 ARCHIVES OF ENVTL. CONTAMINATION & TOXICOLOGY 49, 49–55 (2004).
[231] M. Faust et al., *Additive Effects of Herbicide Combinations on Aquatic Non-Target Organisms*, 134 SCI. OF THE TOTAL ENV'T (Supplement 2) 941, 941-52 (1993).
[232] Teresa Norberg-King et al., *Application of Toxicity Identification Evaluation Procedures to the Ambient Waters of the Colusa Basin Drain, California*, 10 ENVTL. TOXICOLOGY & CHEMISTRY 891, 891-900 (1991).
[233] Debra Denton et al., *Joint Acute Toxicity of Esfenvalerate and Diazinon to Larval Fathead Minnows* (*Pimephales promelas*), 22 ENVTL. TOXICOLOGY & CHEMISTRY 336, 336-41 (2003).
[234] Lydy & Austin, *supra* note 230.
[235] OROS & WERNER, *supra* note 222.
[236] URBAN PESTICIDE POLLUTION PREVENTION PROJECT, *supra* note 210.
[237] Kuivila & Hladik, *supra* note 213.
[238] ZHIMIN LU & GENE DAVIS, CENT. VALLEY REG'L WATER QUALITY CONTROL BD. STAFF REPORT, RELATIVE-RISK EVALUATION FOR PESTICIDES USED IN THE CENTRAL VALLEY PESTICIDES BASIN PLAN AMENDMENT PROJECT AREA (2010), *available at* http://www.swrcb.ca.gov/centralvalley/water_issues/tmdl/central_valley_projects/central_valley_pesticides/risk_evaluation/rre_stff_rpt_feb2009_final.pdf.
[239] Weston & Lydy, *supra* note 205; Ostrach et al., *supra* note 221.
[240] Schloz, *supra* note 215; Michael J. Lydy et al., *Challenges in Regulating Pesticide Mixtures*, 9 ECOLOGY & SOC'Y (6) 1, 1-15 (2004), *available at* http://www.ecologyandsociety.org/vol9/iss6/art1.
[241] Wash. Toxics Coal. v. E.P.A., No. C-01-0132C (W.D. Wash. Jan. 22, 2004).
[242] National Marine Fisheries Services, Pesticide Consultations with U.S. EPA, http://www.nmfs.noaa.gov/pr/consultation/pesticides.htm (last visited Dec. 21, 2010) (Contains links to three NMFS biological opinions spanning from 2008-2010 on 18 active ingredients, as well as consultation correspondence. These cases and consultations are very active, with related court filings and agency exchanges occurring regularly. The next two sets of NMFS biological opinions (on carbaryl, carbofuran and methormyl (2008), and on azinphos methyl, bensulide, dimethoate, disulfoton, ethoprop,fenamiphos, laled, mathamidophos, methyl parathion, phorate and phosmet (2010) have also been issued); U.S. EPA, Pesticides: Endangered Species Protection Program, http://www.epa.gov/espp/ (last visited Jan. 7, 2011) (An updated status of the litigation, consultations, and current pesticide restrictions, along with links to the relevant administrative and court documents).
[243] U.S. EPA, *supra* note 242 (use restrictions and other documents associated with this consultation process).
[244] These cases and consultations are very active, with related court filings and agency exchanges occurring regularly. An updated status of the litigation, consultations, and current pesticide restrictions, along with links to the relevant administrative and court documents, is available at http://www.epa.gov/espp/.
[245] Ctr. for Biological Diversity v. EPA, No. 07-2794-JCS (N.D. Cal. May 17, 2010) (stipulated injunction), *available at* http://www.epa.gov/espp/litstatus/stipulated-injuc.html.
[246] CENT. VALLEY REG'L WATER QUALITY CONTROL BD., *supra* note 217.
[247] SAN FRANCISCO REG'L WATER QUALITY CONTROL BD., SAN FRANCISCO BAY BASIN WATER QUALITY CONTROL PLAN (2007), *available at* http://www.swrcb.ca.gov/sanfranciscobay/water_issues/programs/basin_plan/docs/basin_plan07.pdf.
[248] STATE WATER RES. CONTROL BD., *supra* note 61.
[249] STATE WATER RES. CONTROL BD., DRAFT POLICY FOR TOXICITY ASSESSMENT AND CONTROL (2010), *available at* http://www.waterboards.ca.gov/water_issues/programs/state_implementation_policy/docs/tox_policy.pdf.
[250] STATE WATER RES. CONTROL BD., DRAFT STAFF REPORT POLICY FOR TOXICITY ASSESSMENT AND CONTROL (2010), *available at* http://www.waterboards.ca.gov/water_issues/programs/state_implementation_policy/docs/stff_rpt_tox_policy.pdf.
[251] CENT. VALLEY REG'L WATER QUALITY CONTROL BD., *supra* note 217.
[252] *Id.*

[253] *Id.*

[254] CENT. VALLEY REG'L WATER QUALITY CONTROL BD., SACRAMENTO AND SAN JOAQUIN RIVER WATERSHEDS PESTICIDE BASIN PLAN AMENDMENT FACT SHEET (2006), *available at* http://www.swrcb.ca.gov/centralvalley/water_issues/tmdl/central_valley_projects/central_valley_pesticides/att2_fact.pdf.

[255] CENT. VALLEY REG'L WATER QUALITY CONTROL BD., RELATIVE-RISK EVALUATION FOR PESTICIDES USED IN THE CENTRAL VALLEY PESTICIDE BASIN PLAN AMENDMENT PROJECT AREA (Feb. 2009), *available at* http://www.swrcb.ca.gov/centralvalley/water_issues/tmdl/central_valley_projects/central_valley_pesticides/risk_evaluation/rre_stff_rpt_feb2009_final.pdf.

[256] Central Valley Regional Water Quality Control Board, Central Valley Pesticide TMDL and Basin Plan Amendment - Water Quality Criteria Method Development, http://www.swrcb.ca.gov/centralvalley/water_issues/tmdl/central_valley_projects/central_valley_pesticides/criteria_method/index.shtml (last visited Nov. 4, 2010).

[257] CENT. VALLEY REG'L WATER QUALITY CONTROL BD., CENTRAL VALLEY PESTICIDE TMDL AND BASIN PLAN AMENDMENT - JULY 2010 PROJECT STATUS UPDATE (2010), *available at* http://www.swrcb.ca.gov/centralvalley/water_issues/tmdl/central_valley_projects/central_valley_pesticides/pest_bpa_status_jul2010.pdf.

[258] STATE WATER RES. CONTROL BD., *supra* note 94.

[259] Letter from Fred Kizito, Envtl. Sci., Cent. Valley Reg'l Water Quality Control Bd., to interested parties (May 11, 2009) (Supplemental Information to the Notice of Public Workshop/CEQA Scoping Meeting for a Proposed Basin Plan Amendment to Address OC Pesticides in Several Central Valley Waterbodies), *available at* http://www.swrcb.ca.gov/centralvalley/water_issues/tmdl/central_valley_projects/central_valley_organochlorine_pesticide/2009jul07_ceqa_scoping_mtg/oc_ceqa_supscoping.pdf.

[260] Central Valley Regional Water Quality Control Board, Conditional Waivers of Waste Discharge Requirements for Discharges from Irrigated Lands within the Central Valley Region, Resolution No. R5-2005-107 (2005), *available at* http://www.swrcb.ca.gov/centralvalley/board_decisions/adopted_orders/waivers/r5-2005-0107.pdf.

[261] CENT. VALLEY REG'L WATER QUALITY CONTROL BD., DRAFT ENVIRONMENTAL IMPACT REPORT IRRIGATED LANDS REGULATORY PROGRAM (2010), *available at* http://www.swrcb.ca.gov/centralvalley/water_issues/irrigated_lands/long_term_program_development/draft_program_eir_july2010/peir_exec_summ.pdf.

[262] Central Valley Regional Water Quality Control Board, Coalition Group Conditional Waiver of Waste Discharge Requirements for Discharges from Irrigated Lands, Order No. R5-2006-0053 (2006), *available at* http://www.swrcb.ca.gov/centralvalley/board_decisions/adopted_orders/waivers/r5-2006-0053_24apr08_amend.pdf.

[263] CENT. VALLEY REG'L WATER QUALITY CONTROL BD., DRAFT ENVIRONMENTAL IMPACT STATEMENT IRRIGATED LANDS REGULATORY PROGRAM (2010), *available at* http://www.swrcb.ca.gov/centralvalley/water_issues/irrigated_lands/long_term_program_development/draft_program_eir_july2010/index.shtml.

[264] CENT. VALLEY REG'L WATER QUALITY CONTROL BD., LONG TERM ILRP DEVELOPMENT SUMMARY (Sept. 2010), *available at* http://www.swrcb.ca.gov/centralvalley/water_issues/irrigated_lands/long_term_program_development/sept2010_pub_wkshps/ilrp_handout.pdf.

[265] Weston & Lydy, *supra* note 205.

[266] The existing MS4 permits potentially affecting the Bay Delta Estuary, along with their respective service areas and expiration (if any) are: (1) East Contra Costa County MS4 Permit, Order No. 5-00-120 (Sept. 22, 2010) (City of Antioch, City of Brentwood, City of Oakley, Contra Costa County, and Contra Costa County Flood Control and Water Conservation District); (2) Sacramento County MS4 Permit, Order No. R5-2008-0142 (2008) (County of Sacramento and Cities of Citrus Heights, Elk Grove, Folsom, Galt, and Sacramento Stormwater Discharges From Municipal Separate Storm Sewer Systems); (3) City of Stockton/San Joaquin County MS4 Permit (City of Stockton and County of San Joaquin Storm Water Discharges from Municipal Separate Storm Sewer System); (4) Port of Stockton MS4 Permit, Order No. R5-2004-0136 (Expired Oct. 2009) (Stockton Port District); (5) City of Modesto MS4 Permit (City of Modesto); and (6) Fresno MS4 Permit, Order No. 5-00-148 (Expired Mar. 2006) (Fresno County, Fresno Metropolitan Flood Control District, City of Fresno, City of Clovis, and California State University of Fresno). In addition, the State Water Resources Control Board adopted a General Permit for the Discharge of Storm Water from Small MS4s (WQ Order No. 2003-0005-DWQ (2003)) to provide permit coverage for smaller

municipalities, including non-traditional Small MS4s, which are governmental facilities such as military bases, public campuses, and prison and hospital complexes.

[267] California Construction General Permit, Water Quality Order No. 2009-0009-DWQ (2009).

[268] 40 C.F.R. § 450.21(d)(2) (Feb. 1, 2010) (emphasis added).

[269] *See* 40 C.F.R. §§ 122.43-44 (Apr. 11, 2007).

[270] California Industrial Stormwater General Permit, Water Quality Order No. 97-03-DWQ (1997).

[271] *See* 40 C.F.R. § 122.35 (Dec. 8, 1999); 40 C.F.R. § 122.26(a)(9)(i)(C)-(D) (June 12, 2006).

[272] For example, the Lahontan Regional Water Quality Control Board designated all jurisdictional areas of the City of South Lake Tahoe, El Dorado County, and Placer County that fall within the Lake Tahoe Hydrologic Unit as Phase I MS4, even though this area does not meet the population threshold requirements of a Phase I MS4.

[273] U.S. ENVTL. PROT. AGENCY, DRAFT GENERAL PERMIT FOR RESIDUALLY DESIGNATED DISCHARGES IN MILFORD, BELLINGHAM, AND FRANKLIN, MASSACHUSETTS (2010), *available at* http://www.epa.gov/region1/npdes/charlesriver/index.html (last visited Nov. 4, 2010)(emphasis added).

[274] *See* Chesapeake Bay Executive Order, Restoring and Protecting a Natural Treasure, Reports & Documents, http://executiveorder.chesapeakebay.net/category/Reports-Documents.aspx (last visited Oct. 27, 2010).

[275] *See* U.S. EPA, Proposed National Rulemaking to Strengthen the Stormwater Program, http://cfpub.epa.gov/npdes/stormwater/rulemaking.cfm (last visited Oct.27, 2010).

[276] Headwaters, Inc. v. Talent Irrigation Dist., 243 F.3rd 526 (9th Cir. 2001).

[277] Water Quality Order No. 2004-0008-DWQ (2004).

[278] Water Quality Order No. 2004-0009-DWQ (2004). In 2006, EPA promulgated a final rule (Pesticides Rule) that exempted FIFRA-compliant pesticide application from needing an NPDES permit for: (1) the application of pesticides directly to water to control pests; and (2) the application of pesticides to control pests that are present over or near water, where a portion of the pesticides will unavoidably be deposited to the water to target the pests. *See* 71 Fed. Reg. 68,483 (Nov. 27, 2006). On January 9, 2009 the Sixth Circuit Court of Appeals, in National Cotton Council of America v. EPA, 553 F.3d 927 (6th Cir. 2009)(National Cotton), vacated EPA's 2006 Pesticides Rule holding that the Clean Water Act unambiguously includes "biological pesticides" and "chemical pesticides" with residuals within its definition of "pollutant." The Sixth Circuit granted a two-year stay of its mandate; however, by April 2011, NPDES permits will be required nationwide for discharges of pesticides to waters of the U.S. In response to the National Cotton decision, EPA has proposed a Pesticides General Permit (PGP) to cover discharges of pesticides to waters of the U.S. *See* 75 Fed. Reg. 31,775 (June 4, 2010). While the National Cotton decision applies nationally, the PGP will not apply in California since EPA is not the NPDES permitting authority for the State of California.

[279] STATE WATER RES. CONTROL BD., NOTICE OF OPPORTUNITY TO PROVIDE INFORMAL COMMENTS ON PRELIMINARY DRAFT ADULTICIDES PERMIT (Nov. 16, 2009), *available at* http://www.swrcb.ca.gov/water_issues/programs/npdes/docs/adulticides/111609notice4comment.pdf.

[280] P.J.M. Rejinders & S.M.J.M. Brasseur, *Xenobiotic Induced Hormonal and Associated Development Disorders in Marine Organisms and Related Effects in Human; an Overview, in* CHEMICALLY INDUCED ALTERATIONS IN SEXUAL AND FUNCTIONAL DEVELOPMENT: THE WILDLIFE/HUMAN CONNECTION 159, 159-74 (T. Colborn & C. Clement eds., 1992).

[281] C.E. Purdom et al., *Estrogenic Effects of Effluents from Sewage Treatment Works,* 8 CHEM. ECOLOGY 275, 275-85 (1994); Susan Jobling et al., *A Variety of Environmentally Persistent Chemicals, including some Phthalate Plasticizers, are Weakly Estrogenic*, 103 ENVTL. HEALTH PERSPECTIVES 582, 582-87 (1995).

[282] Susan Klosterhaus, San Francisco Estuary Inst., Update on Contaminants of Emerging Concern, Presentation at RMP Annual Meeting (Oct. 5, 2010), *available at* www.sfei.org/rmp/2010-Annual-Meeting.

[283] M. SCHAEFER & M.L. JOHNSON, UC DAVIS AQUATIC ECOSYSTEMS ANALYSIS LABORATORY, PHARMACEUTICAL AND PERSONAL CARE PRODUCTS IN SURFACE WATER – OCCURRENCE, FATE AND TRANSPORT, AND EFFECT ON AQUATIC ORGANISMS (Oct. 2009).

[284] R. Lavado et al., *Site-Specific Profiles of Estrogenic Activity in Agricultural Areas of California's Inland Waters*, 43 ENVTL. SCI. & TECH. 9110, 9110-16 (2009).

[285] D.G. Joakim Larsson & L. Förlin, *Male-Biased Sex Ratios of Fish Embryos Near a Pulp Mill: Temporary Recovery after a Short-Term Shutdown*, 110 ENVTL. HEALTH PERSPECTIVES 739, 739-42 (2002); Susan Jobling et al., *Predicted Exposures to Steroid Estrogens in U.K. Rivers Correlate with Widespread Sexual Disruption in Wild Fish Populations,* 114 ENVTL. HEALTH PERSPECTIVES (Supplement 1) 32, 32-39 (2006).

[286] Ted Sommer, Cal. Dep't of Water Res., An Introduction to the Pelagic Organism Decline, Presentation at the 5th

Biennial CALFED Science Conference (Oct. 22-24, 2008).
[287] BENNETT, HOBBS & TEH, *supra* note 42.
[288] *Id.*
[289] U.S. EPA, Strategy for Addressing Pharmaceuticals and Personal Care Products in Water, http://water.epa.gov/scitech/swguidance/ppcp/basic.cfm (last visited Nov. 4, 2010)
[290] U.S. EPA, Pharmaceuticals and Personal Care Products as Pollutants, http://www.epa.gov/ppcp/ (last visited Dec. 3, 2010) (EPA is also working to better understand and evaluate potential risks to human health of CECs in drinking water. This is not within the scope of this ANPR).
[291] U.S. ENVTL. PROT. AGENCY, GUIDELINES FOR DERIVING NUMERICAL NATIONAL WATER QUALITY CRITERIA FOR THE PROTECTION OF AQUATIC ORGANISM AND THEIR USES (1985), *available at* http://water.epa.gov/scitech/swguidance/waterquality/standards/current/upload/2009_01_13_criteria_85guidelines.pdf.
[292] U.S. ENVTL. PROT. AGENCY, OW/ORD EMERGING CONTAMINANTS WORKGROUP, AQUATIC LIFE CRITERIA FOR CONTAMINANTS OF EMERGING CONCERN: GENERAL CHALLENGES AND RECOMMENDATIONS (June 3, 2008).
[293] Letter from EPA's Science Advisory Board to EPA (Dec. 18, 2008) (Review of EPA White Paper on Aquatic Life Criteria for Contaminants of Emerging Concern).
[294] U.S. EPA, Analytical Methods: Contaminants of Emerging Concern, Pharmaceuticals and Personal Care Products (PPCPs) Methods Development, http://water.epa.gov/scitech/swguidance/methods/ppcp/index.cfm (last visited Dec. 6, 2010).
[295] CAL. OCEAN PROT. COUNCIL, CAL. OCEAN SCI. TRUST, NWRI, SAN FRANCISCO ESTUARY INST., S. CAL. COASTAL WATER RES. PROJECT & URBAN WATER RES. CTR. AT THE UNIV. OF CAL., IRVINE, MANAGING CONTAMINANTS OF EMERGING CONCERN IN CALIFORNIA: DEVELOPING PROCESSES FOR PRIORITIZING, MONITORING, AND DETERMINING THRESHOLDS OF CONCERN (Sept. 2009), *available at* http://www.sfei.org/node/2838 (based on a workshop held on April 28-29, 2009, in Costa Mesa, California.
[296] State Water Resources Control Board, Recycled Water – Constituents of Emerging Concern, http://www.waterboards.ca.gov/water_issues/programs/water_recycling_policy/recycledwater_cec.shtml (last visited Dec. 3, 2010).
[297] STATE WATER RES. CONTROL BD., MONITORING STRATEGIES FOR CHEMICALS OF EMERGING CONCERN (CECS) IN RECYCLED WATER – RECOMMENDATIONS OF A SCIENTIFIC ADVISORY PANEL (June 25, 2010), *available at* http://www.waterboards.ca.gov/water_issues/programs/water_recycling_policy/docs/cec_monitoring_rpt.pdf.
[298] STATE WATER RES. CONTROL BD., CONSTITUENTS OF EMERGING CONCERN (CEC) MONITORING FOR RECYCLED WATER, STAFF REPORT (Nov. 8, 2010), *available at* http://www.waterboards.ca.gov/water_issues/programs/water_recycling_policy/docs/cec111610/staffreport.pdf (presenting the recommendations for monitoring CECs in municipal recycled water).
[299] Southern California Coastal Water Research Project, Project: Advisory Panel for CECs in Coastal and Marine Ecosystems, http://www.sccwrp.org/ResearchAreas/Contaminants/ContaminantsOfEmergingConcern/EcosystemsAdvisoryPanel.aspx (last visited Dec. 3, 2010).
[300] Cloern et al., *supra* note 40.
[301] Alan D. Jassby et al., *Isohaline Position as a Habitat Indicator for Estuarine Populations*, 5 ECOLOGICAL APPLICATIONS 272, 272-89 (1995); SAN FRANCISCO ESTUARY PROJECT, MANAGING FRESHWATER DISCHARGE TO THE SAN FRANCISCO BAY/SACRAMENTO SAN JOAQUIN DELTA ESTUARY: THE SCIENTIFIC BASIS FOR AN ESTUARINE STANDARD, 127 (1993); PRINCIPLES FOR AGREEMENT ON BAY-DELTA STANDARDS BETWEEN THE STATE OF CALIFORNIA AND THE FEDERAL GOVERNMENT (Dec. 12, 1994) (Bay Delta Accord) (The X2 standard evolved out of a series of facilitated workshops involving agency and academic biologists in 1991. These workshops concluded that changes in the salinity gradient were strongly associated with both the distribution of most species in the San Francisco Bay and with the abundance of many species of the upper estuary. As an index of the Estuary's salinity gradient, the workshop used the location of the low salinity zone, where average daily salinity at the bottom was 2 ppt. This index of the salinity gradient was stated in terms of the distance in kilometers from the Golden Gate to the low salinity zone. The workshop coined the term X2 to represent this index. In times of high outflow, the low salinity zone is downstream and X2 is a smaller number. When outflow is reduced, the low salinity zone is further upstream and X2 is a higher number. The group recommended the use of X2 as a management tool. The approach was refined over several years of discussions and was incorporated into the Bay Delta Accord. Consistent with the Bay Delta Accord, the State Board reviewed this approach and adopted a standard based on it as part of the WQCP

in 1995).

[302] Thomson et al., *supra* note 49 (Increased water use upstream has increased salinity in the western Delta and Suisun Bay for as long as records exist); THE BAY INST. OF SAN FRANCISCO, FROM THE SIERRA TO THE SEA: AN ECOLOGICAL HISTORY OF THE SAN FRANCISCO BAY DELTA ESTUARY 175 (1998), *available at* http://www.bay.org/publications/from-the-sierra-to-the-sea-the-ecological-history-of-the-san-francisco-bay-delta-waters (With the development of major reservoirs in the mid-20th century, springtime X2 changed through time in ways that reduced the survival and abundance of desired aquatic organisms); Jassby & Powell, *supra* note 30.

[303] Mac Nally et al., *supra* note 50.

[304] Kimmerer, *supra* note 30.

[305] *Id.* (Not all species relying on low salinity habitat show this statistical relationship between the location of spring X2 and overall abundance. The delta smelt, for example, lives primarily in low salinity habitat for a large part of its life cycle, but shows no consistent pattern in abundance from year to year with springtime values of X2); W.J. Kimmerer, E.S. Gross & M.L. MacWilliams, *Is the Response of Estuarine Nekton to Freshwater Flow in the San Francisco Estuary Explained by Variation in Habitat Volume?*, 32 Estuaries & Coasts 375, 375-89 (2009).

[306] Adam Paganini et al., *Metabolic Responses to Environmental Salinity in the Invasive Clam Corbula amurensis*, AQUATIC BIOLOGY (forthcoming 2011).

[307] Jassby & Powell, *supra* note 30.

[308] SAN FRANCISCO ESTUARY PROJECT, MANAGING FRESHWATER DISCHARGE TO THE SAN FRANCISCO BAY/SACRAMENTO SAN JOAQUIN DELTA ESTUARY: THE SCIENTIFIC BASIS FOR AN ESTUARINE STANDARD, 127 (1993); Jassby & Powell, *supra* note 30; STATE WATER RES. CONTROL BD., WATER QUALITY CONTROL PLAN FOR THE SAN FRANCISCO BAY/SACRAMENTO-SAN JOAQUIN DELTA ESTUARY (May 1995), *available at* http://www.waterboards.ca.gov/waterrights/water_issues/programs/bay_delta/wq_control_plans/1995wqcp/1995_plan.shtml.

[309] Frederick Feyrer et al., *Modeling the Effects of Future Outflow on the Abiotic Habitat of an Imperiled Estuarine Fish*, ESTUARIES & COASTS (2010), *available at* http://www.springerlink.com/content/d22u618x244n7j46/fulltext.pdf.

[310] WATER RESOURCES DEPARTMENT, CONTRA COSTA WATER DISTRICT, HISTORICAL FRESH WATER AND SALINITY CONDITIONS IN THE WESTERN SACRAMENTO-SAN JOAQUIN DELTA AND SUISUN BAY: A SUMMARY OF HISTORICAL REVIEWS, REPORTS, ANALYSES AND MEASUREMENTS (Feb. 2010), *available at* http://www.ccwater.com/salinity/HistoricalSalinityReport-2010Feb.pdf; U.S. FISH & WILDLIFE SERV., 2008 BIOLOGICAL OPINION ON THE PROPOSED COORDINATED OPERATIONS OF THE CENTRAL VALLEY PROJECT AND STATE WATER PROJECT (Dec. 12, 2008), *available at* http://www.fws.gov/sacramento/es/documents/SWP-CVP_OPs_BO_12-15_final_OCR.pdf .

[311] U.S. FISH & WILDLIFE SERV., *supra* note 310.

[312] Heather Peterson & M. Vayssières, *Benthic Assemblage Variability in the Upper San Francisco Estuary: a 27-year Retrospective*, 8 SAN FRANCISCO ESTUARY &WATERSHED SCI. 1, 1-27 (2010), *available at* http://www.escholarship.org/uc/item/4d0616c6; Janet Thompson, U.S. Geological Survey, Clams, Shrimp, Fish, Birds and Phyoplankton: Causes and Effects of Seasonal and Interannual Variation in Clam Biomass and Grazing in the Northern San Francisco Estuary, Presentation at 2010 Bay Delta Science Conference (2010), *available at* http://www.baydeltascienceconf.com/.

[313] ROBERT SCHROETER, BIOLOGY AND LONG-TERM TRENDS OF ALIEN HYDROMEDUSAE AND STRIPED BASS IN A BRACKISH TIDAL MARSH IN THE SAN FRANCISCO ESTUARY, PH.D. DISSERTATION, UNIV.OF CAL., DAVIS (2008).

[314] Feyrer, Sommer & Slater, *supra* note 38; Feyrer, Nobriga & Sommer, *supra* note 37; Feyrer et al., *supra* note 309.

[315] Telephone interview with Frederick Feyrer, U.S. Bureau of Reclamation (Sept. 21, 2010) (The years since 2000 include years that have large values for X2 (that is, the salinity gradient has moved upstream) as well as some of the lowest abundances for delta smelt on record, so these recent years may drive the overall relationship. Nevertheless, even when excluding the most recent 10 years, data still show that fall X2 conditions and adult population size predict subsequent young smelt abundance).

[316] As noted above, water years in California are defined as October 1 through the following September 30. Water years in California are categorized based on the particular rainfall that year.

[317] 40 C.F.R. § 131.5 (Mar. 23, 1995).

[318] *See* Water Quality Standards for the Sacramento River, San Joaquin River, and San Francisco Bay and Delta of the State of California,60 Fed. Reg. 4664 (Jan. 24, 1995).

[319] Kimmerer, *supra* note 30 (The X2 standard has received continued review over the past 15 years. Although some of the individual species correlations had shifted over the years, the overall correlations were still valid); STATE WATER RES. CONTROL BD., *supra* note 61 (The State Board reviewed the X2 standard in 2006 and declined to pursue any changes to the operative criteria).

[320] Kimmerer, *supra* note 30; Kimmerer, Gross & MacWilliams, *supra* note 305; BAXTER ET AL., *supra* note 34.

[321] U.S. FISH & WILDLIFE SERV., RECOVERY PLAN FOR THE SACRAMENTO/SAN JOAQUIN DELTA NATIVE FISHES (1996), *available at* http://ecos.fws.gov/docs/recovery_plan/961126.pdf.

[322] *See* historic graphs of abundance on pages 9-10.

[323] Sommer et al., *supra* note 25.

[324] U.S. FISH & WILDLIFE SERV., *supra* note 310; Feyrer, *supra* note 309; Nobriga & Herbold, *supra* note 38.

[325] *Id.*

[326] Memorandum from the Reg'l Dir., Fish & Wildlife Serv., Region 8 to the Operation Manager, Bureau of Reclamation, Cent. Valley Operations Office, 283-84 (Dec. 12, 2008) (Water years in California are categorized based on the particular rainfall that year. The categories are wet, above normal, below normal, dry, and critically dry).

[327] U.S. FISH & WILDLIFE SERV., *supra* note 310.

[328] PBS&J, INDEPENDENT EXPERT PANEL REVIEW OF THE FAMILY FARM ALLIANCE'S INFORMATION QUALITY ACT CORRECTION REQUESTS (Oct. 21, 2009), *available at* http://www.fws.gov/informationquality/topics/FY2009/Family_Farm_Alliance/OCAP-IQA-APPEAL-response-expert-review.pdf; COMM. ON SUSTAINABLE WATER & ENVTL. MGMT. IN THE CAL. BAY DELTA, A SCIENTIFIC ASSESSMENT OF ALTERNATIVES FOR REDUCING WATER MANAGEMENT EFFECTS ON THREATENED AND ENDANGERED FISHES IN CALIFORNIA'S BAY DELTA (2010), *available at* http://www.nap.edu/catalog.php?record_id=12881#toc.

[329] Delta Smelt Consolidated Cases, No. 1:09-cv-00407 OWW DLB (E.D. Cal. Dec. 14, 2010) (The Memorandum Decision found that, while X2 is a valid surrogate for delta smelt habitat, the particular requirements for the location of X2 set forth in the 2008 Delta Smelt Biological Opinion are not legally valid and must be reconsidered by USFWS).

[330] STATE WATER RES. CONTROL BD., FINAL REPORT ON DEVELOPMENT OF FLOW CRITERIA FOR THE SACRAMENTO-SAN JOAQUIN DELTA ECOSYSTEM 190 (Aug. 3, 2010), *available at* http://www.waterboards.ca.gov/waterrights/water_issues/programs/bay_delta/deltaflow/final_rpt.shtml.

[331] CAL. DEPT. OF FISH & GAME, QUANTIFIABLE BIOLOGICAL OBJECTIVES AND FLOW CRITERIA FOR AQUATIC AND TERRESTRIAL SPECIES OF CONCERN DEPENDENT ON THE DELTA (Nov. 23, 2010), *available at* http://www.dfg.ca.gov/water/water_rights_docs.html.

[332] Central Valley Project Improvement Act (CPVIA), Pub. L. 102-575 (1992); Omnibus Public Land Management Act of 2009, Pub. L. 111-11(2009).

[333] U.S. Fish & Wildlife Serv., Stockton Fish & Wildlife Office, http://www.fws.gov/stockton/afrp/index.cfm (last visited Oct. 26, 2010).

[334] SAN JOAQUIN RIVER GROUP AUTHORITY, 2009 ANNUAL TECHNICAL REPORT, SAN JOAQUIN RIVER AGREEMENT & VERNALIS ADAPTIVE MANAGEMENT PLAN, *available at* http://www.sjrg.org/ (last visited Oct. 26, 2010).

[335] California Department of Fish & Game, Grandtab, *available at* http://www.calfish.org/Programs/AdditionalPrograms/CDFGFisheriesBranch/tabid/104/Default.aspx (last visited Nov. 30, 2010).

[336] WILLIAM FLEENOR ET AL., ON DEVELOPING PRESCRIPTIONS FOR FRESHWATER FLOWS TO SUSTAIN DESIRABLE FISHES IN THE SACRAMENTO-SAN JOAQUIN DELTA 43 (2010) (Submitted to the State Water Resources Control Board regarding flow criteria for the Delta necessary to protect public trust resources).

[337] Carl Mesick, *The Effects of San Joaquin River Flows and Delta Export Rates During October on the Number of Adult San Joaquin Chinook Salmon that Stray*, 179 FISH BULLETIN 139, 139-62 (2001).

[338] Richard J. Hallock et al., *Migrations of Adult King Salmon Oncorhynchus tshawytscha in the San Joaquin Delta as Demonstrated by the use of Sonic Tags*, 151 FISH BULLETIN (1970), *available at* http://content.cdlib.org/ark:/13030/kt1p3001mh/.

[339] Mesick, *supra* note 337.

[340] California Department of Water Resources, Dayflow, http://www.water.ca.gov/dayflow/ (last visited Nov. 17, 2010).

[341] Mesick, *supra* note 337.

[342] CENT. VALLEY REG'L WATER QUALITY CONTROL BD., BASIN PLAN (2009), *available at*

http://www.waterboards.ca.gov/rwqcb5/water_issues/basin_plans/.

[343] STATE WATER RES. CONTROL BD., *supra* note 61 at 14 (The narrative criteria states: "Water quality conditions shall be maintained, together with other measures in the watershed, sufficient to achieve a doubling of natural production of Chinook salmon from the average production of 1967-1991, consistent with the provisions of state and federal law"); CENT. VALLEY REG'L WATER QUALITY CONTROL BD., *supra* note 342 (The Central Valley Regional Water Quality Control Board's Basin Plan for the Sacramento and San Joaquin Basins also includes a narrative temperature objective as well as a numeric objective for aquatic life species, which states: "The natural receiving water temperature of intrastate waters shall not be altered unless it can be demonstrated to the satisfaction of the Regional Water Board that such alteration in temperature does not adversely affect beneficial uses....At no time or place shall the temperature of COLD or WARM intrastate waters be increased more than 5°F above natural receiving water temperature. … In determining compliance with the water quality objectives for temperature, appropriate averaging periods may be applied provided that beneficial uses will be fully protected").

[344] CENT. VALLEY REG'L WATER QUALITY CONTROL BD., AMENDMENTS TO THE 1994 WATER QUALITY CONTROL PLAN FOR THE SACRAMENTO RIVER AND SAN JOAQUIN RIVER BASINS III-5.0 (2005), *available at* http://www.swrcb.ca.gov/rwqcb5/water_issues/basin_plans/newpages200702.pdf ("Within the legal boundaries of the Delta, the dissolved oxygen concentration shall not be reduced below: 7.0 mg/l in the Sacramento River (below the I Street Bridge) and in all Delta waters west of the Antioch Bridge; 6.0 mg/l in the San Joaquin River (between Turner Cut and Stockton, 1 September through 30 November); and 5.0 mg/l in all other Delta waters except for those bodies of water which are constructed for special purposes and from which fish have been excluded").

[345] CENT. VALLEY REG'L WATER QUALITY CONTROL BD., TMDL AND BASIN PLAN AMENDMENT ON DISSOLVED OXYGEN IN THE STOCKTON DEEP WATER SHIP CHANNEL (2005), *available at* http://www.swrcb.ca.gov/centralvalley/water_issues/tmdl/central_valley_projects/san_joaquin_oxygen/index.shtml.

[346] CENT. VALLEY REG'L WATER QUALITY BD., SAN JOAQUIN RIVER DISSOLVED OXYGEN TMDL – FINAL STAFF Report (Feb. 2005), *available at* http://www.swrcb.ca.gov/rwqcb5/water_issues/tmdl/central_valley_projects/san_joaquin_oxygen/final_staff_report/index.shtml.

[347] CARL MESICK ET AL., ANADROMOUS FISH RESTORATION PROGRAM, U.S. FISH & WILDLIFE SERV., OFFICE OF THE NAT'L MARINE FISHERIES SERV., LIMITING FACTOR ANALYSES & RECOMMENDED STUDIES FOR FALL-RUN CHINOOK SALMON AND RAINBOW TROUT IN THE TUOLUMNE RIVER (2008).

[348] CENT. VALLEY REG'L WATER QUALITY CONTROL BD., *supra* note 342 at III-8 ("The natural receiving water temperature of intrastate waters shall not be altered unless it can be demonstrated to the satisfaction of the Regional Water Board that such alteration in temperature does not adversely affect beneficial uses…..At no time or place shall the temperature of [waters with a 'migration of aquatic organisms' designated use] be increased more than 5 degrees F above natural receiving water temperature….").

[349] CAL. DEPT. OF FISH & GAME, EFFECTS OF WATER TEMPERATURE ON ANADROMOUS SALMONIDS IN THE SAN JOAQUIN RIVER BASIN (Feb. 2010), *available at* http://www.nrm.dfg.ca.gov/FileHandler.ashx?DocumentID=17962; U.S. ENVTL. PROT. AGENCY, REGION 10 GUIDANCE FOR PACIFIC NORTHWEST STATE AND TRIBAL TEMPERATURE WATER QUALITY STANDARDS 49 (2003), *available at* http://yosemite.epa.gov/R10/water.nsf/6cb1a1df2c49e4968825688200712cb7/b3f932e58e2f3b9488256d16007d3bca/$FILE/TempGuidanceEPAFinal.pdf.

[350] Letter from Alexis Strauss, *supra* note 94.

[351] Letter from Maria Rea, Sacramento Area Office Supervisor, NOAA to Alexis Strauss, Water Div. Dir., U.S. EPA Region IX (Nov. 12, 2010).

[352] STATE WATER RES. CONTROL BD., DRAFT TECHNICAL REPORT ON THE SCIENTIFIC BASIS FOR ALTERNATIVE SAN JOAQUIN RIVER FLOW AND SOUTHERN DELTA SALINITY OBJECTIVES (Oct. 31, 2010), *available at* http://www.swrcb.ca.gov/waterrights/water_issues/programs/bay_delta/bay_delta_plan/water_quality_control_planning/docs/techrpt102910.pdf.

[353] These proposed dates may be delayed given resource constraints at the State Board. *See* STATE WATER RES. CONTROL BD., STRATEGIC WORKPLAN FOR THE BAY-DELTA, SCHEDULE OF ELEMENT ACTIONS TABLE (Jan. 14, 2010), *available at* http://www.waterboards.ca.gov/waterrights/water_issues/programs/bay_delta/element_actions/docs/timeline2009qtr4.pdf.

[354] STATE WATER RES. CONTROL BD., *supra* note 352 at 65.

[355] STATE WATER RES. CONTROL BD., *supra* note 330 at 121 (The recommendations in this report do not take effect

unless and until the Water Boards review and adopt them as part of their water quality control plans, basin plans, or water rights orders).

[356] NAT'L MARINE FISHERIES SERV., BIOLOGICAL OPINION AND CONFERENCE OPINION ON THE LONG-TERM OPERATIONS OF THE CENTRAL VALLEY PROJECT AND STATE WATER PROJECT (JUNE 4, 2009).

[357] *Id.* at 623-24.

[358] DELTA STEWARDSHIP COUNCIL, DELTA SCIENCE PROGRAM, THE VERNALIS ADAPTIVE MANAGEMENT PROGRAM (VAMP): REPORT OF THE 2010 REVIEW PANEL (MAY 13, 2010), *available at* http://www.deltacouncil.ca.gov/delta_science_program/pdf/review_vamp_panel_report_final_051110.pdf.

[359] Central Valley Project Improvement Act (CPVIA), Pub. L. 102-575 (1992); Omnibus Public Land Management Act of 2009, Pub. L. 111-11(2009) (Planning and environmental studies are currently being completed under the authority and funding of the CVPIA. The CVPIA included provisions for developing a restoration plan for the San Joaquin River and instituted a fee structure of Friant Division contractors for such activities. With the passage of Omnibus Public Land Management Act of 2009, the Settlement establishes the San Joaquin River Restoration Fund. Approximately $17 million per year from the Central Valley Project Friant Division would be deposited into the Fund to be available without further appropriations to implement the provisions of the Settlement).

[360] DELTA STEWARDSHIP COUNCIL, *supra* note 358.

[361] THE BAY INST. OF SAN FRANCISCO, *supra* note 302.

[362] *Id.*

[363] WILLIAM J. MITSCH & JAMES G. GOSSELINK, WETLANDS 561-64 Second Edition (2nd ed. 1993).

[364] LUND, *supra* note 23.

[365] DELTA VISION, DELTA HISTORY AND MANAGEMENT ISSUES (Nov. 27, 2006), *available at* http://deltavision.ca.gov/DeltaVisionMeetingMaterials.shtml.

[366] CAL. NATURAL RES. AGENCY, STATE OF THE STATE'S WETLAND RESOURCES: 10 YEARS OF CHALLENGES AND PROGRESS (June 2010), *available at* http://www.resources.ca.gov/docs/SOSW_report_with_cover_memo_10182010.pdf.