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NEST CHARACTERISTICS AND BREEDING SUCCESS IN TIDAL MARSH SONG SPARROWS

Over the past 150 years, tidal salt marsh habitat has been drastically reduced in the San Francisco Bay Estuary. Recent efforts have focused on restoring tidal marsh habitat, in part for the protection and recovery of endemic species, several of which are threatened or endangered. Since 1996, PRBO has monitored nest success of two state listed species of special concern, the Suisun and San Pablo Song Sparrows, (*Melospiza melodia maxillaries* and *M. m. samuelis*). Our work is conducted at five sites in the Suisun and San Pablo Bays, including both mature tidal marshes and recently restored tidal marsh. To better understand reproductive rates and factors that may influence reproductive success, we measured a number of variables that characterize a given nest and assess the surrounding vegetation and habitat. These variables include nest dimensions, nest elevation and location, association with specific vegetation, and proximity to various landscape features (such as slough channels and habitat edges). Using survival-time analysis, we analyzed nest success in relation to these variables, taking into account cause of failure and stage of nest failure (e.g., egg vs. nestling stages). We examined whether these trends were consistent among marshes, and considered whether differences were attributable to the restoration status of the sites. The results provide information on the important habitat and landscape features necessary for sustaining breeding populations of these species of special concern. In addition, these results will be incorporated into future models that aim to predict restoration outcome and assess restoration success at marshes within the San Francisco Bay Estuary.

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GROWTH RATES OF FORSTER'S TERN CHICKS AT THREE NESTING COLONIES IN THE SAN FRANCISCO BAY

We examined growth rates of Forster's tern chicks from three nesting colonies in the San Francisco Bay as part of a CalFed-supported study to examine Hg risks to avian reproduction in 2005. Using mark-recapture methods, we captured, banded, weighed, and measured over 500 Forster's tern chicks and recaptured over 300 marked chicks within the Don Edwards San Francisco Bay National Wildlife Refuge. We captured all chicks within each breeding colony by hand every other week at two colonies (A1 and A8) and weekly at a third colony (A16). Weekly recaptures were used to develop a chick growth curve from hatching to fledging to identify ages of linear growth for mass and structure. We then examined Forster's tern growth rates among colonies using only data collected during the linear growth phases. Recapture rates were 78% at the A1 colony, 57% at the A8 colony, and 39-60% at the A16 colony, indicating possible differences in chick survival among colonies. Our results will be used to identify prosperous breeding areas for Forster's terns and help managers better predict the outcome of the South Bay Salt Pond Restoration Project. Our future studies will involve relating chick growth rates to mercury levels in their feathers to examine ecotoxicological risk to avian reproduction.

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SURVIVAL OF AMERICAN AVOCET AND BLACK-NECKED STILT CHICKS IN THE SOUTH SAN FRANCISCO BAY: VARIABLE RISKS OF GULL PREDATION

We used radio-telemetry to examine the movements and survival of American Avocet and Black-necked Stilt chicks in the San Francisco Bay as part of a CalFed-supported study to examine Hg risks to avian reproduction in 2005. We radio-marked more than 60 American Avocet and 30 Black-necked Stilt chicks within 24 hours of hatching and tracked them daily with truck-mounted telemetry systems. On average, American Avocet chicks survived for 4.5 days and Black-necked Stilt chicks survived 7.5 days. Differences in survival may have been related to nesting habitat differences. American Avocets nested primarily on exposed islands and peninsulas in former Alviso salt ponds (A8, A16) with sparse vegetation and cover, whereas Black-necked Stilts nested in dense stands of pickleweed in New Chicago Marsh. American Avocet chicks moved into vegetated areas as they matured. Recovery of transmitters from depredated chicks allowed us to determine their predators. Of 25 depredated American Avocet chicks, 52% were depredated by California Gulls, 32% by other avian predators (herons, egrets and raptors), 12% by mammals, and 4% by snakes. In contrast, Black-necked Stilts were mainly depredated by mammals (67%) and avian predators (33%) other than gulls. Our results indicate that California Gulls are a major predator of American Avocet chicks, but not Black-necked Stilt chicks, and suggest that the greatly expanding gull population in the South San Francisco Bay may have negative impacts on waterbirds nesting in exposed salt pond habitats.

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SPECTRAL AND PHYSIOLOGICAL UNIQUENESS OF LEPIDIUM LATIFOLIUM

Lepidium latifolium, perennial pepperweed, is an aggressive, exotic weed invading wetland and riparian areas in California, including the San Francisco Bay/Sacramento-San Joaquin Delta Estuary. Effective management of *Lepidium* will require detailed and accurate maps of its distribution. Remote sensing technologies offer the capability to map weed species over broad areas and with rapid return intervals. As a first step in assessing the potential of mapping *Lepidium* with hyperspectral remote sensing data, this study determined the spectral uniqueness of *Lepidium*.

Spectral measurements were conducted during summer drought conditions in the Sacramento-San Joaquin Delta Region. Reflectance spectra of *Lepidium*, dry grass, wild radish (*Raphanus sativus*), black mustard (*Brassica nigra*), poison hemlock (*Conium maculatum*), fennel (*Foeniculum vulgare*), yellow starthistle (*Centaurea solstitialis*), and willow (*Salix* spp.) were collected with a portable spectrometer. Nineteen physiological indices were calculated from the reflectance data. Physiological indices are sensitive to narrow spectral features and encapsulate reflectance information in ecologically relevant ways. Classification trees generated from these indices were able to discriminate both flowering and fruiting *Lepidium* from co-occurring species with high levels of cross-validated accuracy. Analyses capitalized on differences in pigment concentrations, foliar chemistry, and foliar water content as indicated by the physiological indices.

These results suggest that hyperspectral remote sensing will be a powerful tool for the mapping and monitoring of *Lepidium*. Future work will extend these analyses to image data encompassing the Sacramento-San Joaquin Delta Region, Suisun Marsh, and Petaluma Marsh.

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SEATTLE'S NATURAL DRAINAGE SYSTEMS – IMPLEMENTING GREEN INFRASTRUCTURE TO MANAGE STORMWATER ACROSS AN URBAN LANDSCAPE

In 2000, Seattle Public Utilities (SPU) completed its first comprehensive street design and bio-infiltration "make-over" for one city block draining to a sensitive creek system. SPU established the Natural Drainage System (NDS) program in 2003 based on excellent project monitoring results. The NDS program uses some of the most current thinking in stormwater management by using low impact design elements to meet objectives for flooding, flow control to creeks, water quality enhancement, and quality of life improvements. The NDS approach completely redesigns residential streets (i.e. the public right-of-way) using open, vegetated swales; deep, healthy soils; stormwater cascades; and small wetland ponds to manage stormwater runoff. Infiltration and decentralized treatment is emphasized (rather than traditional piped approaches that quickly convey stormwater to large centralized treatment or receiving water bodies) to more closely resemble natural hydrologic functions lost due to urbanization. Moreover, these systems form a living infrastructure that, unlike pipes and vaults, can increase in functional value over time. The successful implementation of the NDS program relies upon various elements including policy support; selection of the project development team; good communication with residents; marketing of NDS benefits and achievements; life-cycle cost-benefit analysis; funding; and project evaluation and monitoring. This presentation will show images of completed projects (SEA Street, 110th Cascade, Broadview Green Grid, and the High Point Project) and discuss factors that are critical to the development of a successful program.

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LOCATING A REMNANT CENTRAL VALLEY LANDSCAPE: FREQUENTLY-FLOODED FLOODPLAINS

Anthropogenic change has radically changed the nature and extent of California's Central Valley floodplains. Yet little is known about the extent and character of Central Valley floodplains that routinely provide benefit to ecosystem processes through regular inundation and interaction with the river. We developed and tested a simple methodology to apply existing data sets to address this question. For our pilot assessment, we evaluated the current extent of one particular type of floodplain – that which is inundated during frequent, extended, spring floods – along selected reaches of the Sacramento River and the Yolo Bypass. The existing amount of this type of floodplain in the Central Valley is probably quite small, though its value in supporting certain ecosystem processes has been established. Because this type of floodplain supports a broad spectrum of ecosystem benefits through its regular, extended seasonal presence, we have termed the flood event that creates it the Ecological Threshold Flood, or ETF. It represents a threshold because it conceptually represents the smallest flood (flow that creates inundation of a geomorphic floodplain) that nonetheless yields significant ecosystem benefits.

Our methodology applies criteria for conceptual ETF characteristics to stage or discharge data to identify qualifying ETF events and then uses this stage information to estimate the areal extent of ETF floodplain within a given reach. For our pilot study, we selected several reaches along the Sacramento River (Vina to Freeport) and the Yolo Bypass (Woodland to Lisbon) that had suitable data sets. Next we analyzed stage-discharge data to determine hydrological events that qualified as an ETF given certain criteria for timing, duration, and frequency. These data were then correlated with stages at adjacent stations to create a simple linear water surface profile representing the ETF. Lastly, we compared the identified ETF water surface profile to adjacent topography to estimate floodplain areas inundated by this flood stage.

Our analysis identified only a small amount of ETF floodplain along the evaluated reaches of the Sacramento River, but considerably more in the Yolo Bypass. A visual comparison of stage to floodplain elevations behind adjacent levees also suggests the infeasibility in many locations of restoring ETF floodplain through levee modifications alone. The pilot study suggests that the amount of this particular type of ecologically-significant floodplain may be quite limited in the Central Valley, and there may be only select locations in which it can be readily re-created. Significant value in prioritizing and planning large-scale floodplain restoration could be derived from applying existing data sets and knowledge of ecosystem processes to mapping existing floodplains and evaluating priority restoration areas.

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CONTINUOUS IN-SITU MONITORING OF EASTERN SAN FRANCISCO BAY

CSU East Bay has deployed continuous-recording data loggers at San Leandro and Berkeley, as part of California State University's Center for Integrative Coastal Research and Education (CICORE). CICORE is a consortium consisting mainly of California State University partners with a focus on coastal monitoring.

Based on data from YSI 6600 Sondes, we will report continuous monitoring results for temperature, salinity, turbidity, DO, pH and chlorophyll. We will also report results of water and sediment sampling for trace metals at these locations, collected to verify and supplement continuously-monitored data. Data from these stations are needed to address regional issues concerning wetlands restoration, climate change, water quality, sediment toxicity, and dredging. Spatial and temporal variation in these physical parameters will supplement the body of monitoring data collected by various agencies monitoring in San Francisco Bay.

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A CENTER FOR ENVIRONMENTAL RESEARCH, EDUCATION AND COMMUNITY OUTREACH ON SF BAY

The Romberg Tiburon Center for Environmental Studies (RTC) is the off-campus marine and estuarine research and teaching facility of San Francisco State University (SFSU) located 30 minutes north of San Francisco on a stunning, historically rich stretch of coastline in Tiburon. The Center is the only academic research facility situated on San Francisco Bay, one of the largest and most urbanized estuaries on the west coast of the United States. Research scientists, SFSU faculty, and students at RTC have contributed significantly to the body of knowledge of marine and estuarine environments, as well as to the future health of the Bay's waters and wetlands.

RTC is associated with the California State University system, and our faculty researchers have a strong focus on teaching and mentoring graduate students in the Master of Science program at SFSU. Our research scientists train and support students in their laboratories, in the field, and through collaborations with fellow scientists at universities, institutions, and environmental agencies around the state and nation. Courses are taken at RTC and on the main campus to fulfill SFSU undergraduate and graduate degree requirements. Courses offered at the center encompass the subject areas of restoration and wetlands ecology, biological oceanography, marine plants and animals, limnology, marine microbial ecology, ecological and environmental modeling, food web structures, remote sensing and GIS, physical oceanography, and many others.

The Romberg Tiburon Center is also committed to educating the local community about San Francisco Bay ecosystems and the organisms that call the bay home. Partnerships with other local environmental organizations, such as the Bay Area Discovery Museum and the Bay Model Association, allow RTC to bring its scientific expertise to the public. Programs conducted by RTC scientists and graduate students focus on inquiry based learning for children, families and K through 12 students. We continue to pursue new partnerships, and to develop new programs. In 2003 RTC became the headquarters of the SF Bay National Estuarine Research Reserve, with designated wetland sites Rush Ranch and China Camp. In 2006, look for the launch of a three week Tall Ship Marine Biology experience for high school students, presented in partnership with the Tall Ship Education Academy. From guest lectures and presentations to field trips on the Bay, to our annual Discovery Day open house, the RTC community hopes to promote a strong interest estuarine science and stewardship of the San Francisco Estuary.

For more information, please see our website at http://rtc.sfsu.edu.

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MAPS INDICATING HISTORICAL DISTRIBUTION AND CURRENT STATUS OF ONCORHYNCHUS MYKISS IN STREAMS OF THE SAN FRANCISCO ESTUARY, CALIFORNIA

In our multi-year study of anadromous rainbow trout, or steelhead (*Oncorhynchus mykiss*), in streams tributary to the San Francisco Estuary we could not find geographic presentations of historical distribution and current status of the species. Since this information will be useful to all interested in steelhead restoration, we have prepared maps of our results using a geographic information system (GIS). Our maps include watershed and streams delineations, elevation information, and precise naming conventions. We believe this map collection to be one of the most comprehensive, accurate, and easily interpreted depictions of streams and watersheds of the San Francisco Estuary.

The maps utilize a comprehensive, standardized data format based on the National Hydrography Dataset of the USGS. The drainages of the mainstem streams and their tributaries were taken from the CalWater 2.2 database and checked for consistency against USGS Hydrologic Unit Codes and a 7.5° Digital Elevation Model from *National Geographic TOPO!* In some instances, the CalWater boundaries were either inaccurate or insufficient, and in these cases the boundaries were modified by hand based on local topography. The maps were generated with ESRI's *ArcMap 9.0*, and based on the North American Datum of 1927 (NAD27).

The product is 16 separate maps, one showing historical distribution and one current population status for rainbow trout/steelhead in each Bay Area county. A stream and its watershed are assigned to a county based on where the stream enters the Bay, and thus the county maps do not follow political boundaries as larger watersheds frequently include land from more than one county. The maps classify entire streams, and do not depict specific habitat use within a watershed. The map collection is included in a recent report (available at www.cemar.org) and can be viewed electronically using PDF readers.

The report concludes that more than 70 percent of the 277 streams examined were formerly "steelhead streams." The current distribution status of anadromous and/or resident *O. mykiss* (within the last ten years) is as follows: 150 San Francisco Estuary streams (or 54 percent of our study streams) definitely contain a rainbow trout or steelhead population, seven streams (three percent) probably contain these fish, and another 12 streams (four percent) possibly have a population. Eighty-three of the study streams (30 percent) appear to have no run or population currently.

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MONITORING OF MIGRATING STEELHEAD (ONCORHYNCHUS MYKISS) WITH AN INTERNET-BASED VIDEO CAMERA

As part of an overall strategy to restore a viable steelhead trout run to Alameda Creek, the largest local tributary to San Francisco Bay, a multi-stakeholder group is collaborating to move in-migrating fish upstream of a total passage barrier in the lower watershed. These efforts had been hampered by the logistical constraint of getting knowledgeable observers to the site at the right time to observe steelhead attempting to ascend the sloping concrete drop structure (known as the "BART weir"). It was hypothesized that efforts to move fish would be more successful with a more efficient method to detect their presence.

To test this hypothesis we installed a Java™ based pan/tilt/zoom video camera (Canon, Inc.) at the site that can be viewed and controlled from any computer connected to the internet using a standard browser interface. A web server is located within the camera housing, providing for a compact design and minimal external hardware. Neither electricity nor internet access is available at the site, so the system is powered by batteries recharged from a photovoltaic array and communications to and from the web server are directed through a wireless bridge.

The self-contained power system consists of two 85 watt photovoltaic panels (Shell, Inc), two 6-volt, 224 amp-hour, sealed gel-type batteries (Concorde, Inc.), a 12-volt timer, and a charge controller (ProStar). A housing for the system was fashioned from a waterproof box (Pelican, Inc.), and the entire system was mounted on the flood control channel wall adjacent to the migration barrier to minimize the chances of theft or vandalism.

The wireless bridge consists of two 18 dBi gain flat panel directional antennas (Terabeam Wireless) with built-in 802.11b wireless devices operating at 2.4 GHz. The antennae operate at 11 Mbps and are horizontally polarized, minimizing interference from other Wi-Fi installations. The system connects to the internet via an ADSL gateway access point located nearly a mile away.

While the monitoring system was not installed until the end of the 2004-05 migration period, two late-season storms provided an opportunity to test the system. In both instances steelhead were seen by observers on-line, fish capture crews mobilized, and a wild steelhead was captured and taken upstream to continue its migration. These preliminary results suggest that increased detection efficiency will allow more fish to be captured, facilitating efforts to restore a steelhead trout run in Alameda Creek.

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NAPA-SONOMA MARSHES POND 3, HYDROLOGIC AND BIOTIC CHANGES IN A SALT POND FOLLOWING BREACHING

The California Department of Fish and Game purchased the former Cargill salt evaporation ponds west of the Napa River for their wildlife value in 1994. In 1998, the Napa River Marsh Feasibility Study was initiated to study alternatives to maximize wildlife values on the salt ponds, and the U.S. Geological Survey initiated a monitoring and research program to provide scientific support for understanding the physical and biological characteristics of salt ponds to assist in restoration planning.

In August of 2002, an unauthorized levee breach occurred on Pond 3 of the Napa-Sonoma Marshes Wildlife Area. Because the breaches were viewed as a unique opportunity to study physical and biological changes that result during salt pond restoration, management agencies retained the breach next to South Slough and opened a second breach near the mouth of Dutchman Slough on the Napa River. Changes in hydrology and water quality following the breach precipitated changes in invertebrate, fish, and bird communities. As salinity decreased, macrobenthic invertebrate and fish species richness increased. Additionally, increased tidal action in Pond 3 created a foraging environment for a diverse assemblage of shorebird species, with continued increase in avian diversity since the 2002 breaching. However, increased vegetation establishment in the pond may bring about future changes in hydrology and habitat value.

The restoration of impounded lands, such as these salt ponds, not only recovers lost natural habitat but also provides better understanding of existing salt pond biological and physical characteristics that can further improve restoration planning and future management.

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MERCURY IN THE GUADALUPE RIVER WATERSHED: CONCEPTUAL MODEL AND REGULATORY APPROACH

The Guadalupe River Watershed is a large (440 sq. km.) complex hydrologic system, comprised of six major reservoirs and over 130 km of streams and rivers. The upper portion of the watershed contains the New Almaden mercury-mining district, the largest mercury producer in North America. From 1846 to 1975 over 38.4 million kilograms of elemental mercury were produced.

Most of the mercury remaining in the watershed exists as relatively insoluble mercury sulfides in mine wastes that have accumulated in reservoir deltaic deposits and sediments, and in stream bottoms, banks and flood plains. Like most deep-water bodies, Almaden and Guadalupe reservoirs become thermally stratified in the dry season (May – October). The water in the lower layer (hypolimnion) is cold and the dissolved oxygen becomes depleted by the bacterial decomposition of organic matter. Under these anoxic conditions naturally occurring sulfate reducing bacteria convert inorganic mercury to methylmercury. In Guadalupe and Almaden reservoirs, the increase in the concentration of methylmercury in the hypolimnion is pronounced, increasing from concentrations of less than 1 ng/L to greater than 10 ng/L.

Fish mercury concentrations are also elevated, particularly in Guadalupe Creek and Reservoir where they are as high as (average total mercury, wet weight):

0.39 mg/kg in California roach, age-1 (45 - 55 mm FL)	Guadalupe Creek
0.83 mg/kg in largemouth bass, age-1 (7.7 – 9.7 cm TL) 1.9 mg/kg in black crappie, adult (13 – 17 cm TL) 6.1 mg/kg in largemouth bass, adult (27 – 50 cm TL)	Guadalupe Reservoir

Due to such high fish mercury concentrations, and in accordance with the Clean Water Act, the San Francisco Bay Regional Water Quality Control Board is developing a Total Maximum Daily Load (TMDL) for mercury in the Guadalupe River watershed. The regulatory approach includes establishing fish tissue mercury concentration targets protective of human health and wildlife. Actions necessary to achieve these targets range from one-time actions modeled after hazardous waste clean-ups (e.g., excavation of mine waste from streams, re-contouring mine waste piles for stability), to annual maintenance operations (e.g., removal of accumulated sediments in storm drains, and maintaining vegetation for erosion control on mine waste piles), and to adapt engineering approaches used to control nutrients in reservoirs to control mercury methylation (e.g., hypolimnetic aeration to maintain oxic conditions).

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FIELD METHODS AND IMPLICATIONS FOR THE PLANNING AND MANAGEMENT OF THE SEARS POINT RESTORATION PROJECT

The Sears Point Restoration Project, located in southern Sonoma County on the edge of San Pablo Bay between the mouth of the Petaluma River and Tolay Creek, includes diked agricultural baylands, alluvial fans, hillslopes, and numerous small drainages. The Sonoma Land Trust's recent acquisitions for this project represents the largest land acquisition since the State of California's purchase of the Cargill salt ponds in 2003 and the rare opportunity to restore a complete transition from uplands to tidal salt marsh. The overarching vision for this restoration is to restore tidal, diked, and riparian wetlands, streams, and upland habitats for a wide range of native species, to protect open space, and to develop public access and educational opportunities.

Between December 2004 and June 2005 a myriad of data collection activities have provided numerous data including assessment and analysis of weather patterns, surface hydrology, tides, topography using LiDAR and survey-grade GPS surveys, the bathymetry of adjacent Tolay Creek and nearby San Pablo Bay mudflats, infrastructure (including levees) and utilities. In addition, detailed characterizations of the plant communities, bird use, and incidental wildlife have been performed.

Herein, we present various representative data and discuss the multiple ways in which they have been collected and quality control ensured. We describe these data in relation to planning and implementation of the restoration activities at Sears Point. These integrated procedures, properly tested and quality controlled, have significant applications for future restoration projects in the San Francisco Bay-Delta Region.

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CAULERPA: A THREAT TO THE SAN FRANCISCO BAY ECOSYSTEM

Many scientists and natural resource managers have raised concerns about the impacts that introduced *Caulerpa* species could have on the marine ecosystem of the San Francisco Bay due to the wide commercial availability of *Caulerpa* and some species capacity to establish in temperate waters.

Potential impacts of invasive *Caulerpa* introductions in the San Francisco Bay include:

- Vigorous competition with native bay plants
- Alteration of predator-prey interactions
- Direct toxicity to herbivores
- Indirect toxicity to invertebrates due to dispersal of degraded compounds

Caulerpa is one of the most distinctive algal genera, being identifiable solely on the basis of its habit (growth form) and internal morphology. All species of *Caulerpa* live in marine environments. Reports vary on the number of *Caulerpa* species from 70 to approximately 100, most of which inhabit warm waters.

A cold tolerant strain of *Caulerpa taxifolia*, the Mediterranean strain, was first noticed in the wild, off the Mediterranean coast, in 1984. Since its detection *C. taxifolia* (Mediterranean strain) has steadily spread throughout the northwestern Mediterranean Sea colonizing over 130 km^2 (50 mi^2). Large infestations of *C. taxifolia* have been shown to negatively impact the biodiversity of many species of algae, benthic invertebrates and fishes.

In June 2000 divers detected the Mediterranean strain of *C. taxifolia* in the Agua Hedionda Lagoon located in Carlsbad, California. The publicity generated led to the discovery of a second population of *C. taxifolia* 75 miles north of Carlsbad, in Huntington Harbor. The introduced *C. taxifolia* was able to survive, and to spread over large areas, primarily in eelgrass (*Zostera marina*) beds.

The Southern California *Caulerpa* Action Team (SCCAT), a collaborative team of scientists, regulators and stakeholders, was formed in June 2000 to respond to the *C. taxifolia* introduction. The infestation sites were surveyed and SCCAT decided to attempt an ongoing eradication of the introduced alga. At Aqua Hedionda no new colonies have been found since fall of 2002. At Huntington Harbor no new colonies have been found since winter 2002.

In 2002 the Aquatic Nuisance Species Taskforce recommended that a *Caulerpa* Working Group be formed to provide input on the development of a National Management Plan (NMP) that addresses potentially invasive species in the genus *Caulerpa*. The intent of the NMP is to prioritize a variety of control strategies that federal, state, and local agencies, and the private sector can use, to prevent additional introductions, limit the spread of *Caulerpa spp*., eradicate *Caulerpa spp*., where feasible, and reduce the impacts of the existing populations.

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IMPLEMENTING A NATIONAL MANAGEMENT PLAN FOR THE GENUS ERIOCHEIR (MITTEN CRABS)

Recent studies have demonstrated that the mitten crab (*Eriocheir spp.*) populations in the San Francisco Bay-Delta system pose several threats to the ecological health and economic vitality of California.

- Mitten crabs are omnivorous throughout their lifecycle and can feed on and directly impact resident flora and fauna.
- Bait stealing by mitten crabs can interfere with recreational and commercial fishing in the Bay-Delta.
- Fish salvage operations are can be impacted by the downstream migration of large numbers of mitten crabs.
- Burrowing by mitten crabs may contribute to bank erosion, which can threaten levee stability or alter the course of streams.
- Mitten crabs can be secondary hosts for the Asian lung fluke (*Paragonimus westermani*), which can cause disease in humans or animals that become infected with the parasite.

The Aquatic Nuisance Species Task Force (ANSTF) is an intergovernmental body established by the Nonindigenous Aquatic Nuisance Prevention and Control Act (NANPCA) of 1990. At the request of the ANSTF, U.S. Fish and Wildlife Service supported a literature review, a public meeting and workshop, and the development of a 1999 report to the ANSTF entitled "The Chinese Mitten Crab Invasion of California: A Draft Management Plan for the Genus *Eriocheir*". In 2001 the ANSTF developed a Mitten Crab Control Committee charged with the task of reviewing and editing that draft plan. The broad and representative membership of the committee has worked cooperatively to complete a management plan that will best meet the needs of this evolving issue. The final plan was approved in November, 2003 by the ANSTF.

The goals of this National Management Plan for the Genus *Eriocheir* are to prevent or delay the spread of *Eriocheir* species to new areas and to reduce the negative impacts of existing *Eriocheir* populations in U.S. waters.

To date significant progress has been made on addressing the goals and objectives of this management plan. Scientific studies have advanced understanding of many aspects of mitten crab ecology in the Bay-Delta System. Control methods have been tested at fish salvage facilities in California's Central Valley. Educational outreach to law enforcement officials, resource managers and the public is ongoing.

While progress has been made, there are many essential tasks of mitten crab management that still must be addressed.

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BOATER ASSESSMENT IN CALIFORNIA: UNDERSTANDING A POTENTIAL PATHWAY FOR ZEBRA MUSSELS (DREISSENA POLYMORPHA) AND OTHER NON-NATIVE SPECIES

The zebra mussel (*Dreissena polymorpha*) would likely cause significant environmental and economic impacts if introduced to the San Francisco Estuary. This freshwater bivalve can proliferate rapidly and clings to virtually all hard surfaces. In areas where zebra mussels have been introduced they have caused significant damage to aquatic infrastructure and aquatic ecosystems.

Understanding the potential vector (s) for anthropogenic introduction and dispersal of non-native invasive species is critical in developing prevention, control, and management strategies. This study uses zebra mussels (*Dreissena polymorpha*) as the non-native invasive species, but this type of approach could be used for other similar species. The current survey provides an understanding of the potential movement of zebra mussels west of the 100th Meridian via boat trailers entering into the Sacramento-San Joaquin Rivers Delta.

Boat activity was assessed through interviews (i.e., angler and recreational boater) to determine the origin and general husbandry practices of the boats (e.g., state with zebra mussels present, no prevention taken between launch sites). Rest areas along the borders of California, Nevada, and Oregon were also used to gather data as well as boat launch sites in the Delta. Our data provide an understanding of this potential pathway and assist with initiating discussions related to targeting prevention and control strategies for zebra mussels and other similar non-native species west of the 100th meridian.

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TIDAL WETLAND RESTORATION AT THE HAMILTON ARMY AIRFIELD SITE ON SAN PABLO BAY: A MASS BALANCE APPROACH TO MERCURY

The formerly used defense site, Hamilton Army Airfield (HAAF), has been transferred to the State of California. Over 90% of the wetlands in San Francisco Bay have been lost since the industrial revolution. The U.S. Army Corps of Engineers (USACE) is working with the California State Coastal Conservancy and the San Francisco Bay Conservation and Development Commission to reconstruct wetlands at HAAF and restore 203 hectares of tidal habitat to endangered species such as the Clapper Rail and the Saltmarsh Harvest Mouse.

HAAF has subsided approximately 6-9 feet below mean sea level and will require 10 million cubic yards of fill material to elevate the site to the point where *Spartina foliosa* can colonize and the natural sediment trapping, marsh building physical dynamic can proceed. USACE will provide dredged material from the bay to the HAAF site. This beneficial use of the dredged material will save a significant part of the cost of transport to the Deep ocean Disposal site. However, although production of methylmercury (MeHg) and its incorporation in the aquatic food web is a concern for many wetlands reconstruction efforts, it may be particularly problematic in the Bay.

Wetlands are believed to be sources of MeHg production and export, and HAAF represents only 203 hectares of the additional 23,300 hectares of wetlands to be established around the Bay by 2055. Means to mitigate MeHg magnification in bay aquatic food webs are needed but currently unknown.

We have prepared annual mass balances based on data collected by us and on values derived from the literature. Our estimates indicate that non-vegetated wetlands created from dredged material initially import mercury, and may start exporting mercury when fully vegetated. However, the uncertainty around our current predictions is high. Our ongoing research focuses on reducing the uncertainty around critical values we have identified. Although export is believed to be low, the uncertainty around these potential adverse environmental impacts of wetland restoration should decrease when more results of preemptive environmental research become available.

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SPACE USE OF FORAGING FORSTER'S TERNS (STERNA FORSTERI) IN SOUTH SAN FRANCISCO BAY, CALIFORNIA

Forster's tern (*Sterna forsteri*) is a medium-sized tern found breeding colonially in saltwater and freshwater habitats in North America. In California, Forster's tern is a Species of Special Concern and, in the San Francisco Bay, nests primarily on island or levee habitats provided by artificial salt evaporation ponds. In 2005, we captured and radio-marked 31 pre-breeding Forster's terns on 4 colony sites within the Alviso salt pond complex of Don Edwards San Francisco Bay National Wildlife Refuge (DESFBNWR) in the South San Francisco Bay, California. Foraging Forster's terns were tracked aerially and using truck-mounted telemetry systems throughout the San Francisco Bay region. For terns with 20 or greater foraging locations, we estimated home-range and core-area sizes, defined as the areas encompassing 95% and 50% of the probability distribution, respectively. Foraging terns averaged a home-range size of 3,874 ha and a core-area size of 892 ha. All core-areas encompassed artificial salt evaporation ponds within DESFBNWR, indicating the importance of salt pond habitat for foraging terns. Forster's terns are potentially faced with vast habitat alterations as restoration efforts in the South San Francisco Bay aim to convert artificial salt pond habitat to tidal marsh. Effective management of Forster's terns in the South San Francisco Bay will need to not only conserve or create colony sites but also take into account the foraging movements of terns within the bay and salt pond systems.

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MITOCHONDRIAL COI ANALYSIS OF AN INVASIVE COPEPOD

The first recorded occurrence of the copepod *Tortanus dextrilobatus* in San Francisco Bay was in 1993 and within a year the population had become abundant. It is thought that the copepod was introduced via the ballast water of cargo ships from South China and in this study we investigate whether there is genetic evidence for this hypothesis.

As a pilot project, we sampled *T. dextrilobatus* in San Pablo Bay and amplified the mitochondrial cytochrome oxidase subunit I gene (COI) using primers developed by Folmer et al. (1994). An approximately 680 bp portion of COI was sequenced from each of nine individuals.

We used BioEdit to align and edit the sequences to 641 bp. MEGA was then used to calculate pairwise distances and nucleotide diversity (π). The results of this analysis show 38 segregating sites (S) along the 641 bp sequence and an average number of segregating sites per site (pS) of 0.059282. There were nine unique haplotypes among the nine individuals sequenced. Nucleotide diversity (π) is 0.016121.

These results show several haplotypes in San Francisco Bay, but pairwise distance calculations suggest these haplotypes are closely related to one another. The low sequence divergence suggests recent divergence and supports a recent invasion. These preliminary results cannot be fully interpreted until they are compared to samples from Chinese populations of *T. dextrilobatus*, work which is currently in progress.

The effect of this predatory, invasive species on ecology on SF Bay is unknown.

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STAKEHOLDER-DRIVEN WETLANDS RESTORATION PLANNING: THE SEARS POINT RESTORATION PROJECT

Large-scale wetlands restoration projects affect individuals and organizations in addition to providing natural resource benefits. Thus, it is critical that those affected are part of the restoration planning process. The Sonoma Land Trust (SLT) has embarked on an ambitious planning effort to restore tidal and seasonal wetlands and enhance and manage native upland communities across 2,327 acres in southern Sonoma County. The Sears Point Restoration Project presents the Bay Area's sole opportunity to restore transitions from 400' above sea level to tidal marsh and will directly benefit a broad range of special status species of birds, mammals, amphibians, invertebrates, and plants by completing a 3,700-acre mosaic of restored habitats in the Sonoma Baylands region.

Historically, tidal marshes fringed San Pablo Bay. Over 82% of the North Bay's historic tidal wetlands have been lost, primarily to agricultural reclamation during the 1890s. Several planning efforts, including the landmark *Baylands Ecosystem Habitat Goals Report*, are being utilized as roadmaps for restoration and as support in undertaking recent North Bay wetland restoration projects. In addition to the scientific consensus which supports the Sears Point Restoration Project, SLT is relying on a comprehensive data collection effort to complement a broad Stakeholder Group involvement process as it develops the site's Preliminary Restoration Plan.

The Sears Point Project Team completed the Conceptual Restoration Plan between December 2004 and April 2005. The Plan outlines restoration scenarios for between 1,000 and 1,400 acres of tidal marsh restoration, over 400 acres of seasonal wetland restoration and enhancement, and management elements for restoration of native grasses, wildflowers and vernal pools on the uplands portion of the property. The team presented the Conceptual Plan at a meeting of the project Stakeholder Group on May 5. More than 50 people attended, including agency staff, farmers, cattle ranchers, and our neighbors. The Stakeholder Group provided approximately 100 discrete comments that are significantly guiding the plan's development.

SLT's Stakeholder involvement process highlights the need to include diverse partners and respond to disagreements as early as possible, while the project is yet in a conceptual phase. These lessons provide resource managers with an understanding of the importance of early involvement, proactive public outreach, and negotiation on project elements.

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WHICH WEED TO WHACK? INVASIVE PLANTS OF GREATEST ECOLOGICAL CONCERN IN CALIFORNIA

San Francisco Bay has been called the "most invaded estuary" in the world. While that title referred to invertebrate animals, invasive plants are also numerous, whether in lands surrounding the estuary (broom spp.), along the edge of the shore (*Lepidium*), or on the bay's mudflats (*Spartina*). Land managers, often faced with an overwhelming number of invasive species, need to know where to focus their control efforts. The California Invasive Plant Council (Cal-IPC)'s inventory of Invasive Plants of Greatest Ecological Concern in California (commonly called the "weed list") addresses this need in several ways. It provides a tool to help land managers choose priority species for control, alerts restoration workers to new problem species, identifies research gaps, and aids in commenting on environmental documents. It also serves as a resource for working with the horticultural community to identify problem plants still on the market.

The 2005 list updates and expands the 1999 version, which was based primarily on the knowledge and judgment of an expert panel. The 2005 list uses a new criteria system and includes detailed documentation on approximately 300 non-native species that invade wildlands in California. It is the most comprehensive summary available on these plants. Each species was categorized using a Plant Assessment Form (PAF) with 13 criteria divided into three sections: ecological impacts, potential invasiveness, and habitats invaded. Scores from each section were combined into a total rating of High, Medium, Low, or Considered But Not Listed. Ratings represent the level of statewide ecological concern for that plant. Species with high scores on impacts, but limited current distribution, were designated "Alert" plants, indicating their high potential for spread. Plant Assessment Forms and the full criteria are available on the Cal-IPC website (www.cal-ipc.org).

In late 2005, the full list of ratings will be published in a summary that will include habitats of concern and geographic regions invaded (based on the Jepson Manual). Future plans include developing an on-line system where land managers can submit and view data on new invasions.

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TRANSPORT IN THE DELTA

The Sacramento-San Joaquin Delta historically has been thought of as a riverine system dominated by outflows of fresh water from the Sacramento and San Joaquin River systems. Recent research indicates that Delta hydrodynamics are much more complex, with tides playing a much bigger role in moving salt, sediment – and anything else in the main channel -- than previously thought. The findings have implications for project operations, ecosystem restoration, water quality and fish protection.

Utilizing video and computer graphics derived from real-time measurements of water and fish movements, the short video captures how the Delta works on a tidal timescale. It gives policy-makers and stakeholders better tools to develop and evaluate options for managing competing uses of California's largest and most important estuary.

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PHOTO-DEGRADATION OF METHYL MERCURY IN THE SACRAMENTO-SAN JOAQUIN DELTA

Methyl mercury is photo-degraded to less toxic forms of mercury. Photo-degradation is thought to be a removal mechanism for methyl mercury in the surface waters of the Delta as water flows from the Sacramento River to the export pumps. The results of this study indicate that photo-degradation does decrease methyl mercury concentrations in the surface water of Steamboat Slough and the Mokelumne River. Methyl mercury degradation rates (11% to 22% per day – preliminary data) were calculated from bottle incubation experiments that were performed at various times of the year. Degradation rates were also shown to decrease with depth below the river surface. Measurements of dissolved organic carbon, total suspended solids, UV-A and UV-B, and photosynthetically active radiation were also collected. Preliminary findings suggest that photo-degradation is an important removal mechanism for methyl mercury and has important implications for the understanding of mercury cycling in the Sacramento- San Joaquin Delta.

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SEDIMENT DYNAMICS IN SAN FRANCISCO BAY SALT MARSHES

Sediment accretion rates and changes in relative elevation were measured in San Francisco Bay at two natural salt marshes (Greco Island and the mouth of the Coyote Creek) and one restored marsh (Crissy Field). Rates are being measured using feldspar marker horizons and sedimentation-erosion tables (SETs). At each location, three replicate transects were established in summer and fall 2000, with stations in low-, mid-, and high-marsh areas; monitoring continues on an annual basis.

Rates of sediment accretion at most sampling stations ranged from 2-5 mm/yr at both natural marshes, except at low-marsh sites along Coyote Creek, where accretion was up to 20 mm/yr in the first year of sampling. Natural salt marshes in other locales typically accumulate 2-10 mm/yr with slightly higher rates in areas with high rates of subsidence. Whereas most locations at Greco Island were stable, shallow compaction substantially affected relative elevation of the marsh at Coyote Creek, with most sampling locations showing a reduction in relative elevation over the first few years of sampling. At Crissy Field, both accretion rates and changes in relative elevation were highly variable, with no consistent trends across the marsh. Although sedimentation in subtidal areas within Crissy Field have been reported to be high, accretion rates on the marsh surface were relatively low, averaging less than 10 mm per year.

Wetland sediment dynamics will be a critical issue for the large-scale restoration of salt ponds in south San Francisco Bay. These results give some indication of likely sedimentation and compactions rates in mature San Francisco Bay salt marshes; however, more data are needed to evaluate long-term trends, spatial variability, and accumulation rates in recently restored marshes.

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INVESTIGATION AND CONTROL OF CONTAMINATED GROUNDWATER DISCHARGES TO SURFACE WATER IN THE SAN FRANCISCO BAY REGION

The San Francisco Bay Estuary serves as the outlet to the Pacific Ocean for waters draining an area of approximately 59,000 square miles. The Bay is encircled by over 200,000 acres of tidal marshes, mudflats and other intertidal and shallow subtidal habitats. These habitats provide spawning, resting and feeding areas for a multitude of aquatic and terrestrial organisms, such as the Chinook Salmon, California Sea Lion, California Clapper Rail and Salt Marsh Harvest Mouse. Freshwater tributaries to the Bay also provide important habitat. Although the volume of groundwater discharging into the Estuary and tributaries comprises only a fraction of the total water input, these discharges potentially affect all of the tidal, near-shore, and riparian habitats and are an important component of the ecosystem.

The land adjacent to the Estuary and tributaries is also intensely urbanized, with a population exceeding five million people. Over 5,000 contaminated sites have been identified around the Bay, including landfills, refineries, chemical manufacturers, gasoline stations, dry cleaners and various other industries. Petroleum and chlorinated solvents are the most common chemicals of concern. Recently, perchlorate has come to the forefront as a chemical of concern. The majority of the contaminated sites include impacts to shallow groundwater (<20 m). The ages and lengths of chlorinated solvent plumes along with other hydrogeologic data can be used to estimate the migration rates (e.g., 20 to 75+ m/yr) and volumes of groundwater discharging into the Estuary or tributaries in a particular area (e.g., tens to hundreds of m3/yr per linear meter of shoreline). Understanding these relationships aids in predicting the timing, extent and magnitude of potential impacts to the Estuary and tributaries.

Impacts to the Estuary and tributaries are mitigated through the identification, investigation and remediation of contaminated sites within striking distance of important habitats. This includes screening of groundwater data with respect to surface water protection goals. Groundwater "buffer zones", where concentrations of contaminants are not allowed to exceed specified goals, are established at the downgradient edge of a plume. Remedial actions are site-specific but can include slurry walls, reactive barriers, groundwater pump-and-treat systems, in-situ treatment of impacted aquifers and monitored attenuation. These actions all play an important role in continued efforts to restore and enhance the ecosystems of the San Francisco Bay region.

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GROUNDWATER-SURFACE WATER INTERACTION: AN EMERGING ISSUE IN REGULATORY DECISION-MAKING AND RESOURCE MANAGEMENT

The highly urbanized San Francisco Bay Area is affected by impacts from commercial, industrial, and residential development, including wastewater and industrial discharges, historic loss of wetlands, stream modification for flood control and urban development, and surface water and groundwater pollution by a myriad of chemicals. Expansion of residential development in the past twenty years has led to the covering of natural recharge areas, greater storm water runoff, and alteration of stream channels and riparian zones. At the same time, water quality in rural areas is threatened by over-grazing, excess agricultural fertilizer and pesticides use, confined animal facilities, and expansion of sewage and septic systems.

Historically, regulatory and resource agencies have dealt with these issues through separate groundwater and surface water programs. This compartmentalized approach often lacks communication and coordination, which can lead to management of one resource at the expense of the other. Increased awareness of groundwater and surface water interactions will lead to improved water quality in the Bay Region. Integration of both programs is especially important as solutions are sought for better storm water management and attainment of total maximum daily loads (TMDLs).

The Water Board's Groundwater Committee formed the Groundwater-Surface Water Interaction Workgroup to facilitate better integration of groundwater and surface water programs. The Workgroup's mission is to preserve, enhance, and restore water quality through a comprehensive understanding of the hydrologic cycle, focusing mainly on collaborative engagement between surface water and groundwater staff, facilitating an increased knowledge of surface water and groundwater interaction.

The Workgroup's goals include (1) evaluate existing scientific knowledge,and identify and fill gaps in our agency's understanding of groundwater/surface water interaction, in order to develop eventual guidance; (2) develop a long-term, integrated management approach, based on systematic, scientific assessment; and (3) create blueprints for action (fact sheets). We expect some of our recommendations to be evaluated for integration into the Water Board's planning document (Basin Plan) and fact sheets to become part of our educational outreach.

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POPULATION STATUS OF THREATENED DELTA SMELT IN THE SACRAMENTO-SAN JOAQUIN ESTUARY

Delta smelt (*Hypomesus transpacificus*) is a short-lived pelagic fish (1-2 years) endemic to the upper Sacramento-San Joaquin Estuary, California, with spawning habitats in the freshwater Delta and planktonic larvae gradually moving downstream to juvenile and adult brackish water habitats. A significant population decline of delta smelt, detected since the late 1970s, resulted in federal and state listings as a threatened species in 1993. The population varied considerably, yet still remained low throughout the 1990's.

Beginning in 2004, the abundance of delta smelt seems to have reached the lowest levels ever reported as indicated by the two most recent long-term abundance indices for adults (2004 fall midwater trawl, FMWT) and juveniles (2005 summer townet, STN). The timing of these two recent record low abundance indices tends to coincide with: 1) similar recent declines of other pelagic fish species in the Delta (native: longfin smelt, splittail; non-native: striped bass, threadfin shad) and 2) steady low relative abundance of post-larval and juvenile delta smelt detected since 2002 (summed relative abundance of the first eight 20-mm surveys) and 3) declining abundance of zooplankton in 2004, including copepods, a major prey item of delta smelt.

Reported long-term declines of delta smelt abundance and reductions in mean fish length since the early 1990s may be affecting other important life-history traits such as longevity and population fecundity. Thus, previously reported long-term impacts may be cumulatively acting, along with potential recent impacts, to further reduce the population size of delta smelt and the quality and/or quality of its remaining habitat in the Upper San Francisco Estuary.

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ESTIMATION OF PASSAGE FLOWS FOR ANADROMOUS FISH THROUGH CRITICAL RIFFLES IN STEVENS AND COYOTE CREEKS, SANTA CLARA COUNTY, CALIFORNIA

Regulated streams are ubiquitous throughout the western United States and play key roles in providing drinking water, flood protection and power generation for residents of the region's major urban centers. However, streamflow regulation also impacts anadromous fish by fundamentally changing the hydrology and sediment transport regimes of the affected watersheds and by introducing artificial migration barriers. These problems have long been recognized by the private and public sectors and, as a result, many local, state and federal agencies are actively engaged in managing reservoir releases for the benefit of anadromous fisheries.

Balance geomorphologists and engineers, working with local fisheries experts, evaluated passage conditions along Stevens and Coyote Creeks, two regulated streams in Santa Clara County. This study was part of a larger effort headed by the Santa Clara Valley Water District to measure the condition of habitat for chinook salmon, steelhead trout and other native fish species in several streams in the region. Field work and analyses focused on riffles in the middle reaches of each stream, which were identified as especially problematic for passage due to constrained geometric characteristics. Adequate passage conditions were based on meeting a modified version of the criteria developed by Thompson (1972) which stipulates 0.8 feet of depth over 25% of the total stream cross-sectional width or over a continuous 10% of the width. Balance provided a likely range of passage flows for each critical riffle based on three different methods: (1) manual measurements of streamflow during winter storms, (2) hydraulic modeling with HEC-RAS, and (3) iterative passage flow calculations utilizing Manning's and appropriate continuity equations.

Critical passage flows were identified for each stream and are compared to similar work at other locations, particularly results from Mosley (1982) in New Zealand. Results from this project have been used by the Santa Clara Valley Water District to make decisions regarding the magnitude of water releases from upstream reservoirs during periods of up-migration. The iterative flow calculation methodology shows promise as a useful tool for resource managers who may not have the budget or requisite technical resources needed to run HEC-RAS or establish gaging stations.

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WATER AND PESTICIDES INFORMATION CENTER: TOOLS FOR EXPLORING RELATIONSHIPS BETWEEN PESTICIDE USE AND WATER QUALITY IMPAIRMENTS

Pesticides are a major pollutant responsible for impairing waters in the San Francisco Bay Estuary. Access to monitoring data, pesticide use reporting (PUR) data, physical properties, aquatic toxicity studies and water quality criteria is essential for evaluating the relationships between pesticide use and water quality. The applicable data sets are produced and maintained by a number of different organizations, a fact that has historically made such analyses difficult and time-consuming.

The purpose of our work is to develop a new web site—the Water and Pesticides Information Center (WaterPIC)—that will provide fast, easy, and free access to a centralized repository for all of these data sets and tools for working with the data. In one website, Pesticide Action Network North America (PANNA) has integrated: surface water sampling results from the California Department of Pesticide Regulation (DPR), California's Regional Water Quality Control Boards, and the United States Geological Survey; pesticide application records from DPR; pesticide chemical properties assembled by PANNA; and environmental toxicity from the United States Environmental Protection Agency. Anyone with an internet connection can study pesticides in the San Francisco Bay Estuary and surrounding, up-stream watersheds for time periods between 1990 and 2003. The WaterPIC provides unbiased, scientifically defensible information on pesticide use and its effects on the San Francisco Bay Estuary.

This presentation will provide an overview of the web site, its capabilities, and a description of methods used for data processing and database construction. Additionally, the presentation will provide several examples of how scientists, regulatory agencies, and community groups can use the WaterPIC's dynamic data tables and graphing tools to quickly and easily study correlations between pesticide use and surface water monitoring concentrations over time in the San Francisco Bay Estuary.

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MATE LIMITATION AS A BARRIER FOR INVASIONS OF ZOOPLANKTON TO THE SAN FRANCISCO ESTUARY

Invasions of zooplankton mediated by ships ballast water pose a significant threat to the ecosystem of the San Francisco Estuary (SFE). Oceanic exchange of ballast water is the only management measure currently being applied routinely to reduce the influx of potential invaders. Nevertheless, pessimistic view on its effectiveness has prevailed primarily in part because considerable numbers of viable zooplankton and their resting eggs have been found in post-exchanged waters.

Whether or not the post-exchanged zooplankton will invade depend on the growth and range expansion in receiving ecosystems, for which continuous mating and reproduction are required. In a diluted environment such as following a discharge of ballast water, however, mating may be impaired because of the difficulty in locating mates, which may lead to failed invasion even with suitable habit conditions. Of particular importance with respect to bioinvasions is therefore how mate limitation can influence population dynamics of invasive zooplankton.

Few attempts have been made to quantitatively examine their invasion risk. Here we present mating results of a common estuarine copepod that mate limitation is a major barrier for invasions of zooplankton. Mating success of this copepod shows that oceanic exchange fails to prevent their mating during the voyage. A population model incorporating the mating success further confirms that the copepod is likely to establish its population in most ports. The approach presented in this study can be applied to most zooplankton in assessing their invasion risk to the SFE.

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A FISH LADDER FOR ADULT WHITE STURGEON? PRELIMINARY RESULTS (A): PASSAGE EFFICIENCY

Conventional fish ladder designs are inefficient regarding sturgeon passage. To assist in the design of "sturgeon-friendly" passage structures we undertook an ambitious sturgeon study. The swimming performance of 117 wild-caught adult white sturgeon (*Acipenser transmontanus*) were tested in a large flume (2.1 m wide by 1.5 m deep by 24.4 m long) at the University of California, Davis' J. Amorocho Hydraulics Lab over the 2002-2005 period. Several types of fish ladder structures were tested for fish passage performance including: vertical and horizontal barriers of various heights, widths, and slopes (0, 4, and 8%), a submerged 60-cm-diameter orifice, and a set of slotted triangular baffles of various designs for higher energy dissipation at a 4% slope.

The 2003 data showed that faster velocities 0.76 – 1.07 m/s (2.49-3.51 ft/s) cued fish to swim upstream. Sturgeon were also able to pass adjacent to horizontal barriers where water velocities reached 2.52 m/s (8.27 ft/s) by swimming in bursts, followed by a resting and recovery period in slower-moving water. In 2004, the medium velocity treatment (1.02 m/s; 3.35 ft/s) on a 4% slope yielded the highest sturgeon passage percentage (71%). The 8% slope also had the highest percentage of successful sturgeon passage (29%) at a medium velocity (1.23 m/s; 4.03 ft/s). All successful passage of sturgeon through the orifice barrier occurred at the slow velocity (1.2 m/s; 4.08 ft/s). No sturgeon passed the medium 2.47 m/s (8.11 ft/s) or high 2.56 m/s (8.70 ft/s) velocities. Preliminary critical swimming velocity experiments showed that sturgeon could hold position, at 1.06 m/s (3.5 ft/s), using pectoral fins for "anchoring" to the flume bottom. However, we were not able to fatigue the fish in the test channel with the available equipment. In 2005 fish passage through a 5-baffle fish ladder at a 4% slope was achieved at both 31 and 35 cfs water discharges. At 31 cfs, 63 % of fish passed the high-tail-water (deeper) scenario where only 24% passed the low-tail-water scenario. At 35 cfs, 40% of fish passed within a modified slot design. Successful white sturgeon passage structures may use high velocity sections ranging over 0.84 – 2.52 m/s (2.76-8.27 ft/s) and slower water sections of 0.51 – 0.68 m/s (1.67-2.23 ft/s) for rest and recovery.

We set out to determine if sturgeon passage is possible with a Through Delta Facility, (through-put: 4,000 cfs). Decisions concerning the design and construction of a "sturgeon-friendly" passage facility will be needed to facilitate the migration of these magnificent fish through the San Francisco Delta Estuary. Research was under the guidance of the Interagency North Delta Fish Facilities Technical Team and funded by the Department of Water Resources and CALFED.

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A FISH LADDER FOR ADULT WHITE STURGEON? PRELIMINARY RESULTS (B): STRESS DURING PASSAGE

Many conventional fish ladder designs are inefficient regarding sturgeon passage. To assist in the design of "sturgeon-friendly" passage structures, we designed, built, and tested a laboratory fish ladder with 5 energy-dissipation baffles, having vertical slots and horizontal weirs. We measured blood hematocrit, and plasma pH, cortisol, lactate, and glucose concentrations to assess physiological stress responses during passage. Changes in plasma cortisol levels provide direct assessments of the severity and duration of the primary stress response; while changes in hematocrit, plasma pH, glucose, and lactate (secondary stress responses) characterize the severity of stress, the time needed for recovery, and possible metabolic or respiratory acid-base imbalances. Hematocrit and plasma glucose measurements define within-fish or fish-environment fluid shifts (e.g. osmoregulatory dysfunction). Blood samples were collected from 5 white sturgeon (mean FL: 156 cm) via in-dwelling cannulae, implanted 24 h prior to the experimental run. Samples (3 ml) were taken at four time periods: holding tank resting, post-acclimation, 15 min post-experiment, and 24 h post-experiment.

Our preliminary results showed a mild stress response to the pre-test handling and a more severe one after exercise of the fish. For example, cortisol increased after handling and then increased further at 15-min post exercise. After 24 h, cortisol levels had returned to holding tank resting levels. Lactate levels were positively correlated to cortisol levels over the same time periods. Thus, fish were using white muscle and anaerobic metabolism in response to handling and transport from the holding tank to the flume, and for burst swimming needed to attempt the crossing of the baffles upstream. Plasma pH showed a decreasing trend, post-exercise, most likely reflecting the metabolic acidosis. With larger sample sizes, more exact values, as opposed to general trends, will become useful for assessing stress levels associated with sturgeon passage through ladders.

Overall the physiological responses showed significant stress associated with passage. From a bioenergetics point of view, transient stress responses are adaptive but a prolonged stress response can decrease energy allocations to reproduction, and immunoregulation. Minimizing stress during ladder passage should be a concern for managers when constructing and operating fish-friendly ladder systems. These preliminary results also illustrate the need for further research into the effects of ladder structures on the stress levels of fish and the resulting metabolic and fitness costs associated with white sturgeon migration through San Francisco-Delta Estuary.
Research funded by CALFED and DWR, with guidance from the North Delta Fish Facilities Technological Team.

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MAPPING SOUTH SAN FRANCISCO BAY SEABED DIVERSITY

Acoustic seabed classification is the organization of the sea floor into discrete units based on the characteristics of its acoustic response. The acoustic response can be captured as an echo time series using a single beam echosounder with stand-alone or integrated digital acquisition hardware. Alternatively, an image from a multibeam echosounder or sidescan sonar can be used for classification. A map of sea floor acoustic diversity can be generated using unsupervised classification techniques applied to time series or image data. Acoustic diversity is considered a proxy for geoacoustical parameters including acoustic impedance contrast, scatter and volume reverberation which all vary with sediment type. In addition biological and anthropogenic features can influence the acoustic response.

Data for acoustic seabed classification were collected as part of a California Coastal Conservancy funded bathymetric survey of South San Francisco Bay in early 2005. These data were collected to improve the understanding of the distribution of seabed sediment types and their erodibility. This information is critical for planning the restoration of South San Francisco Bay salt ponds. A QTC VIEW seabed classification system recorded echoes from a single beam 50 kHz echosounder. Approximately 450,000 seabed classification records were generated from an area of about 30 sq. miles. Ten distinct acoustic classes were identified. The ten classes represented the spatial distribution of estuary sediments broadly segmented into tidal flat, nearshore, shelf, channel, and dredged sediments. The classification scheme will be further refined using sediment data from 150 grab and core samples and benthic community composition data from 10 bottom samples collected in the study area.

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ESTIMATE OF MERCURY EMISSION FROM GASOLINE AND DIESEL FUEL CONSUMPTION, SAN FRANCISCO BAY AREA, CALIFORNIA

Gasoline samples (*n = 20*) collected from San Francisco Bay area refineries and service stations had mercury concentrations ranging from 0.08–1.4 ng g^{-1}; diesel samples (*n = 19*) had concentrations of 0.05–0.34 ng g^{-1}. These relatively low levels show little evidence for mercury enrichment or contamination into these fuels from the refining process. Combustion of these fuels in the San Francisco Bay area contributes 0.7–13 kg Hg yr^{-1} to the environment, with an average of 5 kg Hg yr^{-1}. Assuming the fate of this emission is to the atmosphere, the total flux from the combustion of these fuels represents less than 10% of the total atmospheric emissions in the San Francisco Bay area.

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AN INTRODUCTION TO THE SAN FRANCISCO BAY NATIONAL ESTUARINE RESEARCH RESERVE

The San Francisco Bay National Estuarine Research Reserve (SF Bay NERR) is the newest component in a nationwide program of reserves run by the National Oceanic and Atmospheric Administration (NOAA) and coastal states. The NERR system protects more than one million acres of estuarine land in 26 reserves. This national network of reserves was established for long-term research, education and stewardship of the nation's estuaries. The SF Bay NERR is a partnership among NOAA, San Francisco State University, California State Parks, the Solano Land Trust and the Bay Conservation and Development Commission. Our site includes two of the largest, most pristine tidal wetlands in the San Francisco Estuary: China Camp State Park in Marin County and the Rush Ranch Open Space Preserve in Solano County.

China Camp State Park and Rush Ranch Open Space Preserve were chosen to be part of the NERR system in part because scientists frequently use the relatively pristine tidal marshes and surrounding uplands as reference research sites. We encourage, coordinate, and assist existing and new research projects at both sites. Additionally, with the implementation of System Wide Monitoring Program (SWMP), we will provide high quality environmental and biological data for use by scientists, managers, and educators. SWMP was developed by the NERR system to explore how natural events and human activities affect the health of coastal ecosystems throughout the nation. As part of this program, two data-loggers will be permanently deployed at both China Camp and Rush Ranch. The loggers measure and record a number of water-quality variables (e.g., water level, temperature, salinity, and pH) every fifteen minutes. A sophisticated weather station will also be established at Rush Ranch. Additionally, monitoring of various biological parameters are being implemented in the coming months. Data from these programs are available from NOAA's Central Data Management Office at http://cdmo.baruch.sc.edu/.

In addition to facilitating research at the sites, SF Bay NERR is developing active education programs for the public, educators, and coastal decision makers throughout the Bay Area. In August, we offered the first in a series of Tidal Wetland Workshops in partnership with Elkhorn Slough National Estuarine Research Reserve's Coastal Training Program. The workshop entitled, "Introduction to Ecology and Regulation of Tidal Wetlands in Central California and the San Francisco Bay" was designed to provide municipal planners, environmental consultants, and land managers with basic scientific background necessary to make more informed decisions regarding tidal wetlands. Topics for future workshops in the series will be determined based on an assessment of the needs of the management community and the availability of expert speakers.

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MONITORING LEGACY AND EMERGING POLLUTANTS AT THE TOP OF THE SAN FRANCISCO BAY FOOD WEB

The Regional Monitoring Program for San Francisco Bay is measuring legacy and emerging pollutants in eggs of the double-crested cormorant as an indicator of long-term trends and regional spatial variation. Sampling began in 2002 and is being conducted every other year. At each location, 2 composites of 10 randomly selected eggs were collected. One of the three sampling locations was also sampled in 1999-2001 under a different study but using the same methods, providing a longer record of temporal variation.

PCB concentrations (sum of congeners) ranged from 1200 to 4500 ng/g fresh wet weight (fww) over the six year period, with considerable interannual variation and significant differences among the different sampling locations. Concentrations of p,p'-DDE ranged from 1400 to 7200 ng/g fww, with less interannual variation than the PCBs and no distinct spatial pattern. Dieldrin concentrations ranged from 1 to 77 ng/g fww, were quite variable among years with no significant difference among locations. Mercury concentrations ranged from 0.17 to 1.17 ug/g fww, and were relatively consistent over time but indicate significantly higher accumulation in the lower South Bay. PBDE concentrations showed some variability over time and space, with the highest concentrations (up to 960 ng/g fww) in the North Bay. Other analytes analyzed and detected in the eggs included selenium, dioxins, bis(2-ethylhexyl)phthalate, butylbenzylphthalate, di-n-butylphthalate, synthetic musks (tonalide and galaxolide), and p-nonylphenol.

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SPACE USE OF AMERICAN AVOCETS IN SOUTH SAN FRANCISCO BAY

Wetland conservation of endemic waterbirds may be improved with greater knowledge of their space use patterns. Life-history patterns often are neglected in the analysis of home range, core use areas, and spatial movements. From March through July 2005, we radio-marked 50 American Avocets (*Recurvirostra americana*) in the South San Francisco Bay and monitored 5 individuals from pre-breeding through post-breeding. Our results indicated that American Avocet space use did vary with life-history stage. Pre-breeding habitat use was primarily non-tidal salt ponds and some surrounding tidal areas, while avocets used only non-tidal salt ponds for nesting habitat. Pre-breeding home ranges (894 ha) and core use areas (130 ha) were greater than during the incubation stage (258 and 53 ha, respectively). Post-breeding home ranges (4,940 ha) and core use areas (872 ha) were, in turn, greater than during pre-breeding and incubation stages. Pre-breeding and incubation stage core use areas often overlapped, indicating that avocets were prospecting in potential nesting locations prior to egg-laying. As expected, core use areas during the incubation stage centered on nest locations. Stable water levels, consistent food resources, and lack of ground predators may play a role in nest site selection. Large post-breeding home ranges suggested that American Avocets used a wider range of foraging areas when not restricted by reproductive activities. During each stage, American Avocets used a wide variety of habitats, including non-tidal and tidal salt ponds, tidal sloughs, mud flats, and water treatment ponds. This species could benefit from management practices that include large foraging and nesting areas composed of a variety of wetland types.

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PEYTON SLOUGH REMEDIATION REMOVES IT FROM THE BAY AREA LIST OF TOXIC HOT SPOTS

Mountain Copper Company operated a copper smelter at the edge of Carquinez Strait in Martinez from the early 20th century to 1966. Large piles of cinders and slag, smelting by products, subsided and were later covered with fill. Groundwater passing through these materials contaminated Peyton Slough and its associated wetlands, currently owned by Rhodia, Inc. and the State Lands Commission. The Regional Water Quality Control Board Bay Protection Toxic Cleanup Program identified the Slough as a toxic hot spot within the San Francisco Bay Area and issued a Cleanup Order requiring that Rhodia Inc. adopt cleanup requirements for contaminated sediment in and adjacent to the Slough.

A multi-agency task force provided design input as well as exerted regulatory authority over the project. After extensive soil and groundwater monitoring and remediation planning, the project secured permits or agreements from the San Francisco Bay Conservation and Development Commission, the California Department of Fish and Game, the U.S. Army Corps of Engineers, the State Lands Commission, the Regional Water Quality Control Board and the City of Martinez.

Construction began in 2004 on an innovative slough remediation project. The design incorporates placement of an engineered cap on a one-mile long reach of the slough between the Strait and Waterfront Road. Most of this reach will be restored to tidal wetland. A new slough was dredged parallel to and east of Peyton Slough, enlarging and extending an existing slough. Design of the slough re-alignment increases the flow capacity by 20%, increases water management options for McNabney Marsh (located upstream), maintains tidal influence in the surrounding marshes and was accomplished with no net fill to the Bay. Sinuosity was added to the new channel, in contrast with the former straightened, engineered alignment and a tide gate structure with 2 Nekton and 3 flap gates was constructed.

Construction management has included engineering and biological problem solving. A rotary ditcher was used effectively to cut small tributary channels in the dry but was too heavy to function on the tidal marsh plain and mats were necessary to facilitate equipment access. Special status species monitoring identified California black rail, Suisun song sparrow and salt marsh common yellowthroat nesting locations to be avoided. During work in active channels, fill was placed at lower low water, whenever possible. In addition, fish exclusion zones were installed and fish removal was conducted prior to placement of fill.

Construction is continuing during 2005, however, areas restored to one-half foot below existing marsh plain grade in fall 2004 already have nearly 100% cover with wetland plants.

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AN INVESTIGATION OF LOW DISSOLVED OXYGEN CONDITIONS IN THE SAN JOAQUIN RIVER USING STABLE ISOTOPIC TECHNIQUES

Low dissolved oxygen (DO) conditions in the deep water shipping channel (DWSC) of the San Joaquin River (SJR) at Stockton, CA inhibit the upstream migration of salmon and other anadromous fish during periods of low flow. There is considerable controversy regarding the relative roles of two biogeochemical mechanisms that can contribute to DO depletion: 1) decomposition of algae from upstream locations and 2) nitrification of ammonium from a nearby waste water treatment facility. To better understand the timing and relative importance of the mechanisms responsible for oxygen depletion across diurnal cycles, samples were collected for isotopic and chemical analysis during two separate 48 hour sampling campaigns in August 2004. Water samples from the DWSC were taken from a stationary houseboat at the locus of lowest DO in the channel, and from upstream and downstream locations along the channel. All samples were analyzed for $\delta^{18}O$ of DO, $\delta^{15}N$ and $\delta^{13}C$ of seston, $\delta^{15}N$ and $\delta^{18}O$ of nitrate, $\delta^{13}C$ of dissolved inorganic carbon (DIC), $\delta^{18}O$ of water, and concentrations of DO, ammonium, and nitrate.

Of all the measured parameters, ammonium, DO, and $\delta^{18}O$ of DO showed the strongest diurnal fluctuations and variability with depth at the stationary houseboat location. The diurnal variation in DO and $\delta^{18}O$ of DO is primarily caused by photosynthesis occurring in the upper water column during daylight hours, while DO remains relatively low and constant at depth during the day. Physico-chemical parameters indicated diurnal stratification and overturn of the channel related to tidal action. Vertical mixing of the water column occurred on the highest tide during both weeks, dropping DO in the entire water column to concentrations observed at depth during the day (<3.0 mg/L), and yielding the highest $\delta^{18}O$ of DO values. Increases in $\delta^{18}O$ of DO coincided with decreases in DO, suggesting O_2 consumption through respiration of organic matter and/or by nitrification of ammonium.

Loss of ammonium in the DWSC was also evident on a diurnal cycle, strongest in the late evening hours. Lower NH_4 concentration could be due to nitrification by bacteria, uptake by phytoplankton, and/or tidal mixing effects. The $\delta^{15}N$ of seston observed longitudinally along the DWSC was consistently higher than the $\delta^{15}N$ of NO_3, indicating that actively growing phytoplankton utilized a nitrogen source other than local nitrate. This nutrient source is possibly ammonium released from the waste water treatment plant upstream of the DWSC. Future work will focus on the transition between normal DO conditions and periods of DO depletion.

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FATE AND TRANSPORT OF MERCURY IN THE SAN JOSE/SANTA CLARA WATER POLLUTION CONTROL PLANT

This is an interim report on a multi-year study of the fate and transport of mercury within the San Jose/Santa Clara Water Pollution Control Plant (Plant), required by NPDES permit CA0037842 provision E.4.a. Since freshwater inputs to the Lower South San Francisco Bay are dominated by WPCP effluent for part of the year, and small amounts of dissolved and methylmercury may impact fish and wildlife, processes of removal, dissolution, and methylation in wastewater treatment are of particular interest.

In Phase I of the study, weekly representative samples were taken from various process steps from October through June to determine the forms of mercury present and to understand any transformations that might be resulting from treatment. Influent total mercury concentrations range from about 100-500 ng/l. Effluent concentrations range from about 2-5 ng/l, with the greatest reductions at steps where solids are removed. Total mercury is reduced by more than 98%. Dissolved mercury is reduced by approximately 50%, and methylmercury by about 97%. Total Hg is removed at each step where solids are removed, and the greatest reduction in dissolved and methylmercury occurs at the secondary process step. This suggests that the biological processes may be demethylating mercury and/or converting dissolved forms to solids as bacterial biomass grows.

Total and methylmercury concentrations in sludge are consistent with patterns seen in aqueous phases, further confirming that total and methylmercury are being captured in biosolids. Phase 2 of the study will concentrate on longer term (seasonal) patterns in mercury processes, and may include small scale focused study of individual pathways.

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SEASONAL TRENDS OF COPPER IN THE LOWER SOUTH SAN FRANCISCO BAY

In conjunction with the effort to establish Site-Specific Objectives for copper in Lower South San Francisco Bay (LSSFB) and as part of its subsequent waste discharge permit, the City of San Jose (City) monitored total and dissolved levels of copper in the South Bay from 1997 to 2005. This monitoring was used to compare copper concentrations to Lower South San Francisco Bay Copper Action Plan trigger levels. The City monitored copper monthly during wet and dry seasons at 10 LSSFB stations. One station each in Coyote Creek and the Guadalupe River were added in 1997 to characterize tributary inputs to the LSSFB.

Since 1997, ambient dissolved copper concentrations in LSSFB have shown a remarkably regular sinusoidal trend with concentrations higher in the dry season and lower in the wet season. Mean ambient Bay copper concentrations in the dry season tend to be 12 to 46% greater than wet season averages and have been 26% higher than the wet season concentrations across an 8-year average. The eight year mean dry season dissolved copper concentration of 3.20 ppb (SD = 0.63; n = 554) was significantly higher than the wet season mean concentration of 2.53 ppb (SD = 0.60; n = 548; $p << 0.0001$). This suggests a copper cycling mechanism affecting dissolved copper concentrations seasonally in the LSSFB as a result of seasonal factors such as creek and treatment plant flows, TSS, or organic ligands.

Dissolved copper concentrations from two Lower South Bay tributary stations did not show significant seasonal differences between wet and dry seasons ($p=0.19$). There were significant spatial differences for dissolved copper concentration from tributary stations when compared to concentrations observed in LSSFB during wet and dry seasons. Tributary station concentrations were always significantly lower than LSSFB concentrations ($p<<0.0001$ for both seasons). Total copper seasonal and spatial trends were not similar to those observed in dissolved copper.

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DETERMINANTS OF SEASONAL ABUNDANCE IN KEY ZOOPLANKTON OF THE SAN FRANCISCO ESTUARY

Our investigation examines how two co-occurring species of copepods, *Eurytemora affinis* and *Pseudodiaptomus forbesi*, partition habitat and whether their populations are structured by predation from the invasive Asian clam, *Potamocorbula amurensis*. We sampled across the Low Salinity Zone in Suisun Bay and the Sacramento-San Joaquin Delta throughout the course of a year, and then performed a stage-based life history analysis of both populations. Laboratory tests determined the time-to-development for each of the naupliar and juvenile stages. Our initial results show distinct spatial and temporal habitat use that corresponds to both physiographic and biotic parameters. While intense predation helps structure both populations, subsidies from the Delta allow the introduced P. forbesi to persist even as the population of the naturalized *E. affinis* declines during seasonal periods of high clam abundance.

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MERCURY IN BIRDS OF THE SAN FRANCISCO BAY-DELTA: TROPHIC PATHWAYS, BIOACCUMULATION AND ECOTOXICOLOGICAL RISK TO AVIAN REPRODUCTION

Mercury (Hg) contamination of the San Francisco Estuary, from historic mining activities, is a major obstacle for restoration ecologists and managers working to conserve and restore ecosystem services and protect native species. In a collaborative multi-institution research project, we are using avian reproduction to examine effects of Hg within the Bay-Delta ecosystem. Here, we present our study's approach to understanding methylmercury (MeHg) bioaccumulation and effects on avian reproduction. An integrated field and laboratory approach is being used to quantify MeHg bioaccumulation and evaluate exposure risks to birds. A comprehensive field assessment of MeHg exposure and response in three feeding guilds within the estuary is being combined with a laboratory assessment of the variation in embryo MeHg sensitivity. These guilds include (1) littoral feeding recurvirostrids (American Avocet and Black-necked Stilt), (2) diving benthivores (Surf Scoter), and (3) obligate piscivores (Caspian Tern, and Forster's tern). Each of these guilds represents a unique component of the Estuary's foodweb, and this largely determines Hg exposure and accumulation.

We are characterizing the pre-breeding foraging areas of each species using radio-telemetry. Next, we are sampling each species' prey base within these areas to determine ambient MeHg concentrations in their potential diet, and quantifying MeHg trophic transfer using stable isotope analysis and Hg concentrations from pre-breeding birds. During the breeding season, egg Hg concentrations are being compared to nest success and maternal Hg concentrations to examine reproductive impairment and maternal transfer. Chick growth and survival in relation to Hg concentrations in feathers is also being examined. We are carrying-out these numerous studies throughout the San Francisco Bay during 2005-2007. The scientific and management implications of these findings will support state-wide efforts to restore the San Francisco Bay-Delta region.

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CALIFORNIA AQUATIC NON-NATIVE ORGANISM DATABASE (CANOD)

The Ballast Water Program is an effort to control the introduction of non-native species into our coastal waters from the ballast of ships. The initial phase involved both field collections and a literature review which resulted in creation of a database that includes information on all known non-indigenous aquatic species in the marine and estuarine waters of the state. The current 5-year phase will include a re-survey of the ports and estuaries surveyed in 2000, as well as a more intensive survey in the San Francisco Estuary and, for the first time, a comprehensive survey of California's outer coast. Data sources for the California Aquatic Non-native Organism Database (CANOD) and a project timeline are presented.

Species were characterized as non-native, cryptogenic (not enough information to unambiguously determine if they are introduced or native), or NativeX (native with possible range extension).

The survey found a total of 747 organisms (or taxa) that were categorized as introduced or were considered most likely to have been introduced. All areas of the California coast studied as part of this survey have experienced some level of invasion by species not native to the state or not native to the area of the coast where they were recently discovered. Species totals are greatest in the two major commercial ports, San Francisco and L.A./Long Beach. However, the smaller commercial ports and the many small harbors and bays along the coast also have a significant number of non-native species.

Annelids (aquatic worms), primarily polychaete worms, were the dominant taxon comprising 32.9 % of the species identified. Arthropods (crabs, shrimp, etc) were the second most abundant taxon identified, comprising 21.7% of the species. Other common taxa identified included molluscs (10.3%), fish (9.7%), and cnidarians (5.1%).

The most common potential pathways of introduction were ballast water (20.6%), hull/ ship fouling (17.9%), and aquaculture (13.7%), but there were also a significant number classified as ‘unknown’ (28%). The majority of the species introduced to California appear to have come from the northwest Atlantic, the northwest Pacific and the northeast Atlantic.

The database and a report submitted to the Legislature in December 2002, titled *A SURVEY OF NON-INDIGENOUS AQUATIC SPECIES IN THE COASTAL AND ESTUARINE WATER OF CALIFORNIA* can be found on the Web at http://www.dfg.ca.gov/ospr/index2.htm.

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LONG-TERM TRENDS IN SEDIMENT DEPOSITION AND EROSION IN SOUTH SAN FRANCISCO BAY

In the midst of a large-scale tidal wetland restoration of up to 15,100 acres of South San Francisco Bay (South Bay) salt ponds, it is now more important than ever to improve our knowledge of the complicated sediment dynamics of this estuary. Understanding the changing morphology of the bay as well as long-term spatial and temporal variations in sedimentation processes will aid in the development of restoration strategies to create new intertidal habitat while minimizing erosion of the existing marsh or tidal flats.

We have analyzed historical hydrographic surveys collected by the National Ocean Service (NOS, formerly the U.S. Coast and Geodetic Survey) as early as 1858 to determine long-term changes in sedimentation patterns and volumes throughout South Bay (Foxgrover *et al.*, 2004). This analysis revealed a net loss of sediment from 1858 to 1983; however, within this time frame there were periods of both deposition and erosion. In addition, trends in net sedimentation varied spatially within the bay, with the region south of the Dumbarton Bridge being the only area that experienced a net deposition throughout all time periods.

Unfortunately, the last hydrographic survey collected by NOS was in 1983. This creates a critical data gap and the essential question of how sedimentation and erosion within South Bay have changed from 1983 to the present. For this reason, the U.S. Geological Survey coordinated, and the California State Coastal Conservancy funded, the collection of a bathymetric survey of South Bay in January of 2005.

We present maps of bathymetry and sediment deposition and erosion calculated from the five surveys collected by NOS from 1858 to 1983 as well as the recently generated 2005 survey collected by Sea Surveyor Inc. In addition, we will provide a quantitative analysis of sedimentation rates and volumes throughout the past 150 years. This information will be used to model processes and formulate approaches that will improve the success of restoration.

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THE ROLE OF THE U.S. ARMY CORPS OF ENGINEERS IN ESTUARINE RESTORATION: A SAN FRANCISCO BAY PERSPECTIVE

The San Francisco District of the U.S. Army Corps of Engineers (Corps) is one of many agencies working together to reverse the trend of wetland loss in the Bay Estuary by restoring large areas of former tidal salt marsh. All Corps projects have been proposed and are supported by a local sponsor agency.

The Corps utilizes a four-phase approach for implementation of projects:

- *Planning Phase*: involves a Reconnaissance and Feasibility Phase. The Reconnaissance Phase identifies problems and determines Federal Interest. The Feasibility Phase fully defines problems and opportunities and, based on the evaluation of economic and environmental alternatives, recommends a plan.
- *Pre-construction Engineering and Design Phase (PED)* conducts technical and design studies.
- *Construction Phase* commences following congressional authorization and receipt of Construction General funds.
- *Operation and Maintenance Monitoring Phase* involves routine operation and maintenance of the project by its local sponsor.

The Corps' process is illustrated by looking at various ongoing projects in the San Francisco Bay through advancing stages of completion. The two-phased Planning Process is exhibited in the South San Francisco Bay Shoreline Study, in which the Corps is working with a number of state and local agencies to plan the restoration of the salt ponds to marsh. The Corps will begin to prepare design plans and specifications for each construction stage in the Design Phase of the Napa River Salt Marsh. In the Construction Phase of the Hamilton Army Airfield, the Corps is currently testing the existing levees before actual construction can proceed and is responsible for scoping the work, contracting it to private contractors, and overseeing its execution in accordance with quality assurance standards. At the Sonoma Baylands Wetland which is currently in the Operation, Maintenance, and Monitoring Phase, the Corps is monitoring various physical and biological aspects of the site to ensure healthy estuary development. Together, these projects could restore nearly 30,000 acres of vital wetlands that ring the estuary.

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BANK RESTORATION OF A FLOOD CONTROL CHANNEL IN A MUTED TIDAL MARSH

Traditional engineering structures used for bank stabilization exist along the shore and in the sloughs of the San Francisco Bay. Replacement of such structures with native vegetation would provide salt marsh habitat functions and values where none may currently exist.

Alameda County Flood Control and Water Conservation District (District) proposed to replace an existing tidegate structure at the mouth of a flood control channel designated Zone 4 Line A adjacent to the Hayward Regional Shoreline in the City of Hayward, California. Mitigation was required for the impacts associated with this project from the Army Corps of Engineers. The mitigation site is located on the north bank of an unnamed, muted tidal channel adjacent to the location of the tidegate structure.

Mitigation was created by removing approximately 800 cubic yards of concrete rubble riprap covering approximately 8,400 square feet of bank adjacent to an existing salt marsh. The riprap had been placed in 1971. The removal of the riprap provided elevation and substrate conditions suitable for the establishment of approximately 11,200 square feet of salt marsh. Once the riprap was removed the bank was planted to restore the functions and values of the marsh as well as to provide bank stabilization.

A total of 1,400 plants were planted in April 1996. Species planted included pickleweed, alkali heath and saltgrass. Eight hundred supercell-grown individuals of pickleweed were planted at staggered intervals on 1-foot centers in the lower slat marsh area. Three hundred supercell-grown individuals each of alkali heath and saltgrass were planted on 2.5 to 3-foot centers above the high water mark in the upper marsh areas and near the road in the upper salt marsh area. In addition, during the winter of 1997, a seed mix containing the following species was spread at the site: saltgrass, gumplant (*Grindelia hisrutula* var. hirsutula), spearscale (*Atriplex triangularis*) and marsh rosemary (*Limonium californicum*).

The site was monitored annually by the use of 20 half meter square quadrats placed in each of the upper and lower marsh areas. Percent cover was recorded for each species in each quadrat. During the first year of monitoring the number of quadrats sampled in the lower marsh was reduced to 10, after consultation with the U.S. Army Corps of Engineers, due to the size of the study area.

Final monitoring for this site was conducted in the fall of 2001. The intent of the mitigation was to establish native salt marsh vegetation with greater than 50% cover in both the upper and lower marsh areas at the end of the five year monitoring period. The primary indicator of hydrology was the extent of pickleweed establishment. The lower marsh area achieved a 78.5% rate of cover consisting primarily of pickleweed and Fleshy jaumea. The upper marsh area achieved an 80.75% rate of cover consisting primarily of pickleweed and saltgrass. Success criteria was met and exceeded at this site. Nine years after the installation of the marsh vegetation this site is continuing coverage of pickleweed and saltgrass. The success of this restoration project shows, in certain instances, that substitution of traditional bank stabilization (e.g. riprap) with vegetation along sloughs can be a viable replacement alternative as well as a means of re-establishing muted tidal marsh functions and values.

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NAPA-SONOMA MARSHES WILDLIFE AREA: NAPA RIVER UNIT RESTORATION PHASE 1 - LOWER PONDS 1,1A, 2, 3, 4, AND 5

In 1994, the State of California purchased nearly 10,000 acres of commercial salt ponds along the Napa River to be included as part of the Department of Fish and Game's Napa-Sonoma Marshes Wildlife Area. Identified as the Napa River Unit, the objective for this property is conversion of the salt ponds into a mosaic of naturally, self-sustaining and managed habitats that will provide resources to support populations of plants, fish, and wildlife, including endangered species, migratory waterfowl, shorebirds, and anadromous and resident fish. Other important benefits desired from the project include improved water quality and enhanced public use with wildlife-compatible recreation opportunities. To achieve these goals, project proponents undertook an eight-year planning and permitting process to determine the most feasible restoration approach.

The planning process was completed in 2004, and the restoration of the Napa River Unit is scheduled to begin in fall 2005 as Phase 1 with construction activities being undertaken in Ponds 1, 1A, 2, 3, 4, and 5. Construction will include such activities as breaching and lowering levees, replacement or removal of water control structures, armoring of necessary levees, and excavation of historic tidal channels. The restoration techniques utilized as part of this project are not new, however the overall size of the project is unique. Considered one of the largest habitat restoration projects in the United States, the Phase 1 construction activities of the Napa River Unit Restoration will improve approximately 5,300 acres within the Wildlife Area.

In addition to the construction activities, the Napa River Unit Restoration Project will include physical and biological monitoring to assist the Department of Fish and Game with adaptive management decisions, and to benefit planning for similar restoration efforts. Estimated to take more than 50 years before tidal marsh vegetation is colonized in some of the deeper ponds, the benefits to the inhabitants of the San Francisco Bay Estuary are expected to occur immediately after construction begins.

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LEPTOSPIROSIS IN STRANDED CALIFORNIA SEA LIONS: WHAT IS THE SOURCE OF INFECTION?

Leptospirosis is a zoonotic disease affecting humans, wildlife and domestic animals. It is caused by a spirochete bacteria of the genus *Leptospira*. Outbreaks in humans are usually seasonal and associated with occupational or recreational activities that increase exposure to contaminated water. The first leptospirosis epidemic documented in California sea lions was in 1970, and *Leptospira interrogans* serovar *pomona* was isolated from animals with kidney failure.

The epidemiology of the disease in sea lions is unclear. Whether epidemics of leptospirosis in sea lions result from repeated introduction of the pathogen into the population, or are a result of changes in herd immunity amongst sea lions allowing an epidemic to spread rapidly is unknown. *L. pomona* does not survive in sea water. Introduction of the pathogen, therefore would have to be from a freshwater source, possibly through swimming in rivers or estuaries or via an anadromous prey species.

We examined the medical records from California sea lions stranded along the central and northern California coast from 1981 to 2004. Leptospirosis outbreaks were documented in 1984, 1988, 1991, 1995, 2000 and 2004. During outbreak years, over 60% of sea lions admitted to TMMC stranded because of leptospirosis and 70% of those cases were subadult males. Strandings occurred primarily in the fall months (August-October). Animals that stranded from Santa Cruz north to the Oregon border were more likely to have leptospirosis than those that stranded from Santa Cruz south to San Luis Obispo.

California sea lions that breed in July on the Channel Islands migrate north along the California coast to Oregon, Washington and British Columbia in the fall. Males migrate further north than females who return regularly to the Channel Islands to nurse their pups. Timing of their migration through the San Francisco bay area coincides with leptospirosis epidemics. From 1995-2002, numbers of sea lions at Pier 39 in San Francisco peaked during the months of August, September, and October when there were an average of 400 sea lions/day on the pier.

Because leptospirosis outbreaks correlate temporally with sea lion presence in San Francisco bay, we suspect that if leptospirosis is re-introduced to the population to trigger these outbreaks, the source of the pathogen could be somewhere in the San Francisco Bay-Delta Estuary drainage.

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AN INTEGRATED WETLANDS ASSESSMENT PROGRAM FOR THE SAN FRANCISCO BAY AREA AND CALIFORNIA

In conjunction with several partners, including EPA, USFWS, State and Regional Water Boards, and the California Coastal Commission, the San Francisco Estuary Institute (SFEI) is developing an integrated wetlands assessment program for the Bay Area that focuses on providing answers to the fundamental questions that are commonly raised by wetland managers. The approach consists of three basic tiers or levels of activity: (1) wetland inventories; (2) assessments of wetland condition; and (3) intensive monitoring and research of selected wetland sites. The specific activities within each level are described below, and the information generated by the approach is designed to be accessible on the Wetland Tracker web site. Visit www.wrmp.org for the Wetland Tracker and other components described here.

Level I. *Inventories* are the most basic component of a comprehensive wetlands assessment program, and they are essential for identifying the spatial distribution and abundance of wetland and riparian resources. While there are a number of efforts to map wetlands on the regional, county, and local levels, in the Bay Area SFEI is updating the National Wetlands Inventory to provide more specific information on wetland habitat types and small wetland patches. This update comprises the Bay Area component of the California State Wetland Inventory, which (when completed) will include regional and statewide reports on the status and trends in the distribution and abundance of each kind of wetland. The State Inventory will act as a sample frame in probabilistic surveys of ambient wetland condition, of which CRAM (see Level II) may be a component.

Level II. *Assessment methods* use observations and measurements to evaluate a management endpoint such as wetland function, condition, or beneficial use. The California Rapid Assessment Method (CRAM) is being developed by SFEI with partners in the southern (SCCWRP) and central (CCC) parts of the state and is currently in the calibration stage. CRAM, as a rapid assessment method, uses visible conditions to indicate levels of key functions or beneficial uses that vary predictably along gradients of environmental stress. The stressors, such as habitat conversion, biological invasion, hydro-modification, and pollution are anthropogenic causes of changes in wetland function. Once validated, CRAM can be used where intensive data are lacking. Rapid assessment can thus lessen the amount and kinds of data needed to monitor wetlands across a region or over time.

Level III. *Intensive monitoring and research* components of a comprehensive monitoring program are needed to develop indicators, techniques of data collection and analysis, and methods to manage data and information. Empirical research should yield predictive models of the relationships between stressors, functions, and conditions, as needed to calibrate and validate the inventories and rapid assessments. SFEI has developed several standard protocols for Level III monitoring, including for sedimentation, tidal marsh vegetation, and several wildlife species.

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SIMULATING SALT INTRUSION INTO SUISUN BAY AND THE WESTERN DELTA

Salinity intrusion into the western Sacramento-San Joaquin Delta impacts both fish abundance and Delta water quality. The current salinity standard for the San Francisco estuary is based on the location of 2 ppt bottom salinity (X2) along the estuary. The position of X2 historically varied from 40 to 100 km from the Golden Gate, and is strongly dependent on freshwater flow. Seasonal variations in X2 result from winter runoff, and the highest salinity intrusion typically occurs during late summer conditions.

The purpose of this modeling effort is to investigate the potential mechanisms underlying the relationships of fish abundance to flow ("fish-X2"). As a first step toward this goal, the three-dimensional TRIM model has been calibrated and validated under a large range of tidal, freshwater inflow and wind conditions. Comparisons to continuous observations and detailed salinity transects, collected as part of the entrapment zone study in 1994, indicate that the model accurately predicts tidal variability in salinity and stratification during both spring tides and neap tides.

This poster focuses the intrusion of salt into Suisun Bay and the western Delta that occurs during spring and summer, when X2 is correlated to abundance of several estuarine organisms. Following high Delta outflow periods, salt intrusion depends largely on gravitational circulation and stratification. In many regions tidal trapping and other tidal dispersion processes are also known to be important. The three-dimensional model represents these processes and is shown to accurately predict salt intrusion during spring and summer of two years with dramatically different Delta outflow. The use of detailed modeling to simulate these processes can lead to a better understanding of the relationships between flow and habitat and serve as a valuable management tool for protecting water quality in the Delta.

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BAYLANDS AND CREEKS OF SOUTH SAN FRANCISCO BAY: A PUBLICLY ACCESSIBLE MAP REVEALS THE LANDSCAPE AND CULTURAL CONTEXT FOR RESTORATION

The restoration of South San Francisco Bay involves re-establishing a diverse range of wetland habitats to create a resilient, functional South Bay Landscape. Yet many of the individual habitats of interest have not been seen within the region in significant size for generations. As result, information about landscape-level patterns -- such as habitat mosaics, subregional variation, and the relationship between Baylands and watersheds -- has been limited.

As part of the Oakland Museum of California's *Creek and Watershed Map Series*, we produced a foldout, poster-size, double-sided map synthesizing geographic, ecological, and historical information about the South Bay past and present. One side presents new wetlands mapping of the South Bay below Dumbarton Point conducted by SFEI as part of the National Wetlands Inventory. The map also includes recent mapping of creeks, storm drains, and watersheds by William Lettis and Associates, and extensive place name annotation.

The reverse side of the map, titled “South Bay Landscape through Time,” presents the South Bay circa 1850 and explores the changing human relationship to the South Bay Baylands since European contact. The map provides a view of the complex patterns of tidal channel networks and marsh pannes that emerge within large tidal marshlands. These data were compiled from precise historical maps by the United States Coast Survey. The map also illustrates tribal regions, Ohlone shellmounds, 19th-century commercial landings, historical place names, and adjacent creeks and willow groves.

Since successful restoration of the South Bay will also involve restoring cultural connections to this largely unfamiliar landscape, the map explores the ways that people in the South Bay have intimately interacted with this broad transitional environment between dry land and open bay. We illustrate how particular tidal channels became corridors for commerce, the remarkable shellmounds of the Bay shore, waterfowl hunting in the “sloughs”, and the expansion of salt harvest from a small-scale traditional activity to an industrial operation. The map is available at local environmental education centers and through the Oakland Museum at www.museumca.org/creeks.

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FACILITATING THE EXCHANGE AND REPORTING OF MONITORING DATA

The San Francisco Estuary Institute's Regional Monitoring Program for Trace Substances (RMP) is the primary source for long-term contaminant monitoring data for the San Francisco Estuary and provides high quality, scientific information for formulating technically sound policies regarding the Estuary. To facilitate this exchange and use of monitoring data, the RMP's data management and information system incorporates standardized data storage procedures that are comparable to the SWAMP statewide effort, a web-based tool for accessing results, and a variety of graphical methods and reports for presenting synthesized results to different targeted audiences.

Water, sediment, and bioaccumulation data collected by the Status and Trends Monitoring Program are used by the San Francisco Bay Regional Water Quality Control Board for regulatory purposes, such as evaluating the Estuary for 303(d) listing of water bodies, calculating National Pollutant Discharge Elimination System (NPDES) permit conditions, and modeling for estimating Total Maximum Daily Loads (TMDL). In addition, long-term monitoring data are used to evaluate whether management actions are successful in reducing contaminant loads or mitigating impacts to the Estuary.

Due to this need to provide high quality monitoring data, the integrity of the RMP data is evaluated by a rigorous QA/QC verification and validation process before being made available to water quality managers, decision-makers, scientists, and the public through a web-based data tool for retrieving subsets of the data. These results are also compiled and synthesized in annual reports (*The Pulse of the Estuary* and *Annual Monitoring Results Report*), technical reports, and peer-reviewed journal articles. By maintaining an integrated data management and information system, the RMP is able to provide the scientific data needed for addressing important management questions.

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SAN JOAQUIN RIVER BASIN-WIDE WATER TEMPERATURE MONITORING/MODELING PROJECT, AND USE OF THE HEC-5Q WATER TEMPERATURE MODEL AS A MANAGEMENT TOOL ON THE LOWER SAN JOAQUIN RIVER AND ITS TRIBUTARIES.

The San Joaquin River Basin-Wide Water Temperature Monitoring/Modeling Project is a multi-agency project funded by CALFED. The project team includes CDFG, USFWS, USBR, NOAA, Tri-Dam, as well as all of the involved Irrigation Districts. This project started in 1999 on the Stanislaus River. In 2005, the project was expanded to include the San Joaquin River from the Stevinson Bridge downstream to the Mossdale Bridge and three of the tributaries on the San Joaquin River; the Stanislaus, Tuolumne, and Merced Rivers below the major reservoirs.

HEC-5Q is the water quality simulation model used in the original Stanislaus River Temperature Modeling/Monitoring Project designed to simulate the thermal regime of mainstem reservoirs and river reaches. HEC-5Q can be used to evaluate options for coordinating reservoir releases among projects to examine the effects on flow and water quality at specified locations in the system. It can also be used to model the effects of any structural or operational modifications to the system. To calibrate the model, a collaborative effort of historical data collection was needed. The cooperation between team members produced several years of water temperature, flow, meteorological, and reservoir data.

The model is being used in the San Joaquin River Basin to analyze different water regimes that can improve water temperatures on river reaches that have been identified as fishery habitat for fall-run Chinook salmon (*Oncorhynchus tshawytscha*) and steelhead Rainbow trout (*Oncorhynchus mykiss*). Identification of the thermal regime in response to upstream water management operations throughout these river reaches is critical to anadromous fish restoration in the San Joaquin River Basin. Decreasing the water temperatures can improve spawning and rearing fishery habitat, and help decrease fish mortality.

Current monitoring efforts by CDFG include: monthly manual downloads of 76 water temperature recording stations throughout the San Joaquin Basin, monthly reservoir profiles that record water temperature and depth at different locations on the major reservoirs, and the collection of meteorological data from five weather stations in the basin that are maintained by the CDFG. The data from several water temperature monitoring stations on the Stanislaus River are sent to California Data Exchange Center (CDEC) and is available online. We hope to increase our number of monitoring sites available at CDEC because the project expansion has greatly increased our number of monitoring stations.

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CONSIDERATIONS REGARDING NON-NATIVE FISHES AND ADAPTIVE MANAGEMENT ACTIVITIES IN THE SACRAMENTO AND SAN JOAQUIN DELTA

Successful pioneering and establishment activities of non-native fishes are directly related to the ecological characteristics of the invading species as well as abiotic and biotic characteristics of the receiving system. Risk of invasion and establishment can be attributed to such factors as species ecological attributes, biological integrity of the receiving system, and individual fish condition. Fish data collected by the Delta Juvenile Fish Monitoring Program in the Stockton Fish and Wildlife Office was used to begin discussions regarding non-native fishes. Ecological attributes of non-native fish species were inferred based on trophic level, reproductive guild, and environmental tolerances (e.g., flows, temperature, and D.O.) in the published literature. These attributes were then used to examine the usefulness of non-native fishes as indicators of compromised ecosystem health. This approach could provide an additional tool to gauge habitat restoration success or failure. We provide demographical data for the delta, draw inferences about fish distribution, and recommend adaptive management strategies for integration of non-native fish metrics into planning and management strategies and activities.

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INTRODUCTION OF THE SIBERIAN PRAWN, EXOPALAEMON MODESTUS, TO THE SAN FRANCISCO ESTUARY

The Siberian prawn, *Exopalaemon modestus* (Heller 1862), was recently introduced into the San Francisco Estuary. The purpose of this poster is to summarize the current information available about *E. modestus* in the estuary, including taxonomy, distribution, abundance, and life history. Specimens and data were collected from 2000-2004 by several long-term monitoring projects and special studies. Since the initial collection in 2000, distribution of *E. modestus* expanded rapidly throughout the brackish and freshwater portions of the estuary, including areas upstream of the delta. As of late 2004, it ranged from Knights Landing (Yolo County) on the Sacramento River in the north, down to Mud Slough (Merced County), a tributary of the San Joaquin River, in the south. It was also found throughout Suisun, Grizzly and Honker bays to Carquinez Strait, and infrequently in San Pablo Bay

The abundance of *E. modestus* also increased rapidly since 2000, and by 2002 it was the most common caridean shrimp in Suisun Marsh and the lower Sacramento and San Joaquin Rivers. However, abundance declined in some areas as of either 2003 or 2004. *E. modestus* is unique, as it is the only caridean shrimp present in the upper estuary that can complete its life cycle in freshwater. Although the effects of this introduced species are largely unknown, *E. modestus* is likely to continue its expansion within the estuary and its watershed and become established in other freshwater areas of California.

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CONTROLLING THE SPREAD OF NEW ZEALAND MUD SNAILS ON WADING GEAR

The New Zealand mud snail is an invasive species new to California. First discovered in the Owens River, east of the Sierra Nevada Mountains in late 1999, it has now been identified from the Mokelumne, Calaveras and Napa rivers as well as Putah Creek on the west side of the Sierra Nevadas. All of these waterways ultimately drain into the San Francisco Bay and Estuary. Mud snails have been found in concentrations in excess of 100,000 snails/m^2 in infested waterways. This invasive species will likely have impacts on native species, fisheries, and aquatic ecosystems of the Sacramento-San Joaquin watershed. Unintentional transport on fishing gear and equipment, notably wading gear, is likely one of the primary vectors spreading mud snails among water bodies. In this study, a phased approach identified several chemicals and cleaning methods that could easily be used in the field, and were efficacious in removing snails from wading gear with minimal corrosiveness to the gear.

New Zealand mud snails were exposed in laboratory tests to solutions of benzethonium chloride, chlorine bleach, Formula 409® Disinfectant, Pine-Sol®, ammonia, grapefruit seed extract, isopropyl alcohol, potassium permanganate, and copper sulfate. With the exception of grapefruit seed extract, potassium permanganate and isopropyl alcohol, these materials all killed mud snails within five minutes. Wading gear was repeatedly exposed to bleach, copper sulfate, Pine-Sol®, benzethonium chloride, and Formula 409® Disinfectant for prolonged periods. Bleach and Pine-Sol®, at concentrations efficacious in killing snails, did structural damage to the wading gear. Solutions of copper sulfate (252 mg/L Cu), 1,940 mg/L benzethonium chloride, and 50% Formula 409® Disinfectant killed New Zealand mud snails within five minutes and had minimal effects on wading gear integrity. Wading gear was completely submersed or put in a dry-sack with the cleaning solutions and shaken in field trials. The results of these trials indicate that copper sulfate (252 mg/L Cu), benzethonium chloride (1,940 mg/L) and Formula 409® Disinfectant (50% dilution) solutions under field conditions can prevent the spread of New Zealand mud snails on wading gear. Copper sulfate solution (252 mg/L Cu), and 50% Formula 409® Disinfectant were also sprayed on wading gear in separate trials. The copper sulfate solution was successful at controlling 100% of the snails, however the Formula 409® Disinfectant (50% dilution) solution was not, exhibiting a significant rate of survival for NZMS.

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ESTUARINE FOOD WEB LINKAGES OF RESTORED TIDAL WETLANDS IN THE SAN FRANCISCO ESTUARY

Historically, food webs in large estuaries, such as San Francisco Bay and Delta (SFBD), were primarily based on autochthonous detrital material, but included augmentation of organic matter from the watershed and ocean. However, the current size of the SFBD's adjoining wetlands reflects a diminutive 15% of its historical extent. Because the SFBD has marginal wetlands remaining, current scientific literature suggests that the overall estuary relies heavily upon the SFBD's phytoplankton production, rather than marsh primary production, to drive the estuarine food web (Canuel *et al.* 1995).

As a component of the CALFED-sponsored Integrated Regional Wetland Monitoring program, we are comparing the food webs of tidal marshes in northern San Francisco Bay. Currently, a variety of restoring marshes between 10 and 80 years since the reintroduction of tidal exchange now exist alongside remnant natural marshes. We hypothesize that food webs in SFBD's newly restored wetlands are based primarily upon allochthonous bay phytoplankton, but that in more mature marshes, primary production from autochthonous sources plays a larger role. Using multiple stable isotope analysis, including $\delta^{13}C$, $\delta^{15}N$, and $\delta^{34}S$ in a space-for-time substitution, we track food web linkages in restored and natural marshes to explain how food webs change over time and across space. Our targent fish species represent both marsh residents and transient species. Invertebrate species include bivalves, crustaceans, and neuston. Source organisms include C_3 and C_4 emergent marsh plants, submerged aquatic vegetation, benthic algae, and phytoplankton. Using these indicator organisms, we gauge the potential contribution of restored marshes to the greater SFBD food web.

Preliminary results indicate that phytoplankton does not play as large of a role in our study marshes as previously anticipated. In general, phytoplankton makes up no more than 8- 10% of the base diet of any individual fish or invertebrate examined to date, regardless of the organism's feeding guild or residential status. We found no strong phytoplankton consumption pattern along the marsh age gradient. This finding is perhaps due to the stronger influence of site geomorphology, which dictates detrital retention. Additionally, even the youngest marsh examined exhibited substantial vegetation cover, and therefore strong autochthonous detrital inputs.

In further contrast to the current paradigm, we find that emergent marsh plants contribute significant amounts to the base diets of fish and invertebrates. Contributions fluctuate monthly, with the most pronounced differences seen during the winter. The largest player, however, is benthic microalgae collected from unvegetated surfaces. In some cases, benthic algae makes up over 80% of the base diets of inland Silversides, and 60% of the base diets of the clam, *Macoma balthica*. Younger restoring marshes tend to have higher benthic algae contributions than ancient and centennial marshes. These preliminary results indicate that benthic algae food web contributions, as opposed to phytoplankton, may be a useful indicator of marsh restoration status and contribution to SFBD food webs.

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PCBs, HG, DDTs AND PBDEs IN SAN FRANCISCO BAY SPORT FISH, 2003

The Regional Monitoring Program for San Francisco Bay has found legacy contaminants such as PCBs, Hg, and DDT in sport fish at concentrations exceeding human health screening values (SV). Leopard shark, striped bass, white sturgeon, California halibut, and brown smoothhound shark had the highest number of SV exceedances for mercury with maximum concentrations in leopard shark exceeding 1.0 ppm ww. Shiner surfperch, striped bass, white croaker, white sturgeon, and jacksmelt had the highest number of SV exceedances for PCBs with maximum concentrations in shiner surfperch, white croaker, and white sturgeon approaching 500-600 ppb ww. One anchovy composite from the South Bay had the highest PCB concentration (607 ppb ww) of any species sampled and was also high in DDTs and PBDEs. There is a decreasing Bay-wide trend in DDT concentrations (lipid normalized) in shiner surfperch over the period 1994-2003. In addition to legacy contaminants, PBDEs were also measured in 2003. The highest PBDE concentrations (maximum of 96 ppb ww in white sturgeon from the South Bay) were found in shiner surfperch, striped bass, white croaker, and white sturgeon.

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MONITORING OF PRIORITY TOXIC POLLUTANTS IN HIGHWAY STORMWATER RUNOFF

During dry period, contaminants from various sources are deposited on surfaces and accumulate until precipitation occurs. When it rains, stormwater scours contaminants mainly from impervious paved surfaces and then transports them into the receiving waterbodies such as rivers, lakes, and estuaries. The U.S. EPA now considers that contaminants in stormwater runoff are one of the most important sources of water quality degradation. This study monitored contaminants (127 individual chemicals, PCBs, and toxaphene) listed in California Toxics Rule (CTR). This project provides insight into the types and concentrations of hazardous chemicals in highway runoff so cost-effective stormwater runoff control strategies can be developed. In order to assess toxic potentials of highway stormwater runoff, concentrations of contaminants are compared to California water quality standards. Heavy metals closely related to vehicle operation are likely to exceed California water quality standards. Nickel exhibited higher concentrations than water quality standards in about 30% of samples. Copper and zinc exceed ambient water quality standards more frequently. Among organic contaminants, 4,4-DDE, chlordane, and 1,1-dichloroethylene are likely to exceed CTR standards frequently. These contaminants are not related to vehicle operation and highway maintenance. So atmospheric wet deposition and/or dry deposition of particles driven by wind from agricultural fields may be suspected as a source of 4,4-DDE and chlordane. Atmospheric wash-off may be the source of 1,1-dichloroethylene. PAHs such as chrysene that comes mainly from vehicle emission were also above the CTR standards at some events. Generally, concentrations of most chemicals were higher in the early phase of precipitation season (November) compared to the late phase of precipitation season (February and March). This temporal trend is related to the unique weather pattern of California having almost no precipitation generally between May and the late October. Monitoring data revealed that highway stormwater runoff may be harmful for aquatic organisms. So contaminants in highway stormwater runoff need to be reduced to meet the water quality standards. It can be accomplished by adopting appropriate BMPs, source control and/or post-attenuation (treatment control).

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HISTORICAL TRENDS OF ORGANIC CONTAMINANTS AND TRACE METALS IN SALT MARSH, SAN FRANCISCO BAY, CALIFORNIA

Many regulatory actions have reduced input of contaminants from point-sources and consequently environmental quality has been enhanced significantly. However, continuous growth in population especially in urban areas may induce increased input of contaminants from non-point sources, resulting in slowed progress toward the clean environment. Historical trends of regional water quality can be revealed by chemical analyses of contaminants in sediment core. Hydrophobic organic chemicals and metals in the water column generally tend to be adsorbed onto particulate materials and then find their way in the sediment as a sink. As a result, sedimentary levels of contaminants can represent overall water quality. Sediment cores were collected from Stege Marsh, San Francisco Bay, California, to investigate the historical input of organic contaminants (PAHs, PCBs, and organochlorine pesticides) and trace metals. Depth profiles indicated that the degradation of water quality had been started since the 1940s and 1950s and continued until the 1970s when the use of PCBs, DDT, and leaded gasoline was peaked. PCB congener patterns revealed that PCB 1248 was a predominant source. PAH distribution patterns and some PAH ratios indicate PAHs from gasoline and diesel combustion were the major sources. Iron normalized lead concentrations are decreasing continuously after leaded gasoline was phased out. Iron normalized zinc concentrations were the highest at the deepest section (55 ~ 60 cm) and exhibited continuous decreasing pattern towards the surface. Though nickel concentrations were higher than sediment quality guidelines, iron normalized enrichment factor confirms that Bay area terrestrial soils contain elevated levels of naturally originated nickel. Sedimentary levels of contaminants provide evidences that water quality has been enhanced after the use of these contaminants was banned and restricted. Effects range-median quotients in surface sediments are 5 times lower compared to sediments deposited in the 1970s. Concentrations of contaminants in surface sediments, however, are still higher than sediment quality guidelines.

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INTEGRATED LIDAR AND BATHYMETRIC SURVEYS OF THE SOUTH SAN FRANCISCO BAY REGION: NEW DATA FOR SALT POND RESTORATION PLANNING

Marsh elevations and pond and bay depths are fundamental information for successful planning of restoration of salt ponds. From 2003 to 2005, detailed surveys were conducted to collect these data to support salt pond restoration in South San Francisco Bay. In 2003 and 2004, bathymetric surveys of 35 salt ponds were completed. From May 5 to 21, 2004 an airborne topographic LIDAR survey was made of the dry ponds, intertidal mudflats (flown at tides below mean lower low water- MLLW), marshes, and the 100-year floodplain. The survey area was more than 325 km^2, extending north from the Alviso ponds to Oakland airport on the east shore and to San Francisco airport on the west shore. Approximately 250 million data points were collected resulting in a data density greater than one point per square meter. Georeferenced digital video was also collected during this survey. From January 10 to April 5, 2005 a comprehensive bathymetric survey was made of the South Bay, Coyote Creek, and selected tidal sloughs. The survey area was approximately 250 km^2, extending from tidal sloughs and Coyote Creek in the south to approximately San Leandro Marina on the east shore and to Coyote Point on the west shore. Sounding data was collected every 0.3 m along track lines. Track line spacing was 100 m in the Bay and less in Coyote Creek and the sloughs. NOAA played a key role in the bathymetric survey by selecting tide gauge type, loaning accurate acoustic tide gauges, determining optimum locations for tide gauges, aiding in installation of tide gauges, and developing tidal zoning to correct soundings to the 1983-2001 tidal epoch MLLW tidal datum. Referencing soundings to MLLW for the 1983-2001 tidal epoch allows comparison to earlier surveys to determine geomorphic change and whether the bay and mudflats are sinks or sources of sediment—a key question in restoration. NOAA also developed the conversion from MLLW datum to NAVD88, the LIDAR datum. This conversion makes it possible to merge the bathymetry and LIDAR survey to create continuous coverage of elevation and depth. Scientists and managers will use the integrated topographic and bathymetric data as baseline conditions, to document historical change of the bay-mudflat-slough-marsh-pond system, and to evaluate the system response to different restoration strategies.

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RAPID GROWTH OF JUVENILE CHINOOK SALMON (ONCORHYNCHUS TSHAWYTSCHA) ON CENTRAL VALLEY FLOODPLAINS WITH PROLONGED INUNDATION

Recent research has revealed that juvenile Chinook salmon have greater growth and survival rates on Central Valley floodplains than in river channels, largely due to greater productivity of floodplains. In this study, we reared juvenile Chinook in cages during two flood seasons to experimentally compare growth rates between river and floodplain habitats of the Cosumnes River, California. The cages were deployed during the period when wild Chinook are migrating downstream and potentially rearing in floodplain habitats. Fish rearing on the floodplain had significantly higher growth rates than those rearing in the river; juvenile Chinook rearing within seasonally inundated floodplain habitats with terrestrial vegetation had the highest overall growth rates. Growth of fish in the river site upstream of the floodplain varied with river flows. When flows were high, juvenile Chinook experienced slow growth and high mortality, but when the flows were low and clear, the fish grew rapidly. Fish in the river site below the floodplain in inter-tidal water had very poor growth rates (e.g. fish on the floodplain grew 2.5 times faster than fish rearing in this site). These findings show that juvenile Chinook can have higher growth rates within ephemeral habitats on a restored floodplain than within perennial ponds and river locations. Seasonally inundated floodplains that experience prolonged flooding were historically extensive in the Central Valley and may have provided vast high-quality rearing habitat for juvenile salmon. Restoration and management of floodplain habitats to maximize seasonal flooding may provide population-scale benefits to Central Valley Chinook salmon.

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DISTRIBUTION OF MERCURY IN SALICORNIA AND SPARTINA ACROSS A CONTAMINATED SALT MARSH

The movement of mercury (Hg) in the food web is one of the greatest challenges facing the Estuary. We have studied Hg in the dominant plants of Stege Marsh in Richmond. Although not known to have specific past contamination, Hg occurs at elevated levels in the sediments there, ranging from 1 to 10 ug/g over root-zone depths. (A nominal value for the earth's crustal rocks is 0.1 ug/g; for Central San Francisco Bay sediments it is 0.2ug/g.) Formed by deposition of fine sediment during the 20th century, this elevated Hg presumably arose from a combination of particle sources such as local industrial/urban run-off (which includes atmospheric deposition), Coast Range mine drainage and Sierra Nevada placer wastes.

What counts is the Hg moving out of the sediments: how, to what extent, and where.

A detailed spatial map of Hg, as detected in the salt exuded from the surface of *Spartina* shoots, indicates variation of more than 2 orders of magnitude; certain areas of the marsh have 100-fold higher relative Hg mobilization than others. (The same is true, with different patterns and degrees of variation, for other heavy metals.) *Salicornia* accumulates metal salts in its shoots and levels higher than 0.1 ug/g (dry weight) have been found. These would be approaching consumption advisory levels for fish high on the food chain.

Our next step will be to distinguish methyl Hg from inorganic Hg in order to best characterize the hazard posed to herbivores or detritivores, or by tidal export of detritus.

We will also look at seasonal changes through the growth, flowering and die-back cycles of these dominant salt marsh plants.

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EVALUATION OF ENDOCRINE DISRUPTION ON SPLITTAIL (POGONICHTHYS MACROLEPIDOTUS) IN SACRAMENTO – SAN JOAQUIN ESTUARY

This investigation evaluates the potential endocrine disruption in the Sacramento splittail (*Pogonichthys macrolepidotus),* a native fish of the Sacramento/San Joaquin River estuary. The objective of the study is to determine the presence of the endocrine disruption biomarker vitellogenin and determine contaminant profile by deploying semi-permeable membrane devices (SPMD) and Polar Organic Chemical Integrative Samplers (POCIS).

In recent years, there has been increasing concern regarding the role of environmental contaminants as endocrine disruptors. It is widely recognized that there are numerous chemicals in the aquatic environment that will affect hormonal regulation in aquatic vertebrates. At least 45 chemicals have been identified as potential endocrine-disrupting contaminants, including industrial, municipal, agricultural contaminants (such as dioxins and polychlorinated biphenyls [PCB's]), insecticides (such as DDT and carbaryl), alkylphenoxy compounds (such as nonylphenol), and herbicides (such as dichlorophenoxy acetic acid [2,4D] and atrazine). Many of the chemicals released into the aquatic environment have had only minimal toxicological testing.

The principal habitat of splittail is the Sacramento-San Joaquin estuary. Sampling of fish took place at Suisun Slough and its tributaries. Blood is collected from the caudal vein and immediately centrifuged to separate blood plasma from red blood cells. The blood plasma is flash frozen and kept frozen until vitellogenin analysis. Water sampling is done via SPMD and POCIS. SPMDs and POCIS are passive sampling devices used to monitor trace levels of organic contaminants. Concentrations of endocrine disrupting chemicals in rivers can change daily or even hourly. SPMDs and POCIS allow us to get true picture of contaminant present in the water that the splittail reside and spawn in.

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SWIMMING PERFORMANCE IN EXERCISE-CONDITIONED, CULTURED DELTA SMELT

Information on the comparative swimming performance of wild and cultured fish of the same species and body size is often lacking. Such information can be of use when considering cultured fish as performance surrogates for wild fish that might be difficult to obtain or that represent a population of either steeply declining or dramatically low numbers (e.g., endangered). Because cultured fish are not subjected to the same selective forces as those in wild populations and because exercise conditioning (swim endurance training during rearing) has been shown to improve swimming performance in several cultured, as well as wild, fishes, exercise conditioning is worth consideration as a culture technique to improve swimming performance in cultured fishes. However, questions remain concerning how closely the swimming performance of cultured (including exercised conditioned) fish match those of wild fish of interest. Because of the interest in the (threatened) delta smelt in the Sacramento – San Joaquin Delta, our objective was to compare the swimming performance (measured as critical swimming velocity, U_{crit}) of un-exercised and exercise-conditioned delta smelt. These results could then be compared to a previous study of wild delta smelt swimming performance. After pilot studies over the 2003 – 2004 period established an acceptable exercise conditioning regime, fish were exercise conditioned for 45 d and U_{crit} was measured in a Brett-type, recirculating swim chamber. Research was supported by a grant from the California Department of Water Resources.

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HORIZONTAL, VERTICAL AND TEMPORAL VARIABILITY OF PHYTOPLANKTON IN A SHALLOW SYSTEM, FRANKS TRACT, SAN FRANCISCO BAY

The nutrient-rich, shallow waters of San Francisco Bay support high rates of primary production, limited not by nutrients but by light availability and benthic grazing. Although the extent of reduction in phytoplankton biomass by benthic bivalves is dependent on the spatial and temporal variability of physical and biological factors, the relative importance of these factors is unknown.

A comprehensive field study was carried in Franks Tract from 27th April - 10th May 2004 to study the effects of different hydrodynamic conditions on the grazing rates of *Corbicula fluminea*. Detailed measurements of the physical environment with concurrent measurements of phytoplankton concentrations were made during two 30-hour experiments. Integrated water samples were collected at eight vertical heights at the four corners of a 10 m x 20 m rectangle. The evolution in time of the horizontal variation in chlorophyll *a* across the channel, was captured by autonomous underwater vehicle transects.

Results from the study illustrate the complexity of chlorophyll *a* concentrations due to dynamic hydrodynamic conditions. The data demonstrate the temporal and horizontal spatial patchiness of phytoplankton that grazers, such as *Corbicula fluminea*, must adapt to if they are to thrive in this low productivity system.

Vertical profiles of chlorophyll *a* are affected by grazing, settling, vertical mixing and horizontal advection. Using the detailed physical measurements made during this study we hope to devolve the processes responsible for the complicated time series of chlorophyll *a* concentration profiles collected. Some early findings, such as the large vertical gradients in chlorophyll *a* concentration that persisted for hours when the water column was stratified, were surprising given the shallow depth of the water. The hydrodynamic and chlorophyll *a* concentrations were used to calculate grazing rates of the clams as a function of the hydrodynamic conditions via a control volume method.

Since phytoplankton blooms are the most important food source for upper trophic levels in this system, understanding phytoplankton dynamics is essential to predicting the success of threatened fauna, such as fish, in San Francisco Bay. The results from the Franks Tract study can be generalised to the other shallow water regions of San Francisco Bay, thereby allowing our conceptual and numerical models of the ecosystem to be improved.

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THE INFLUENCE OF WIND DRIVEN WAVES ON VERTICAL TRANSPORT, GRIZZLY BAY, SAN FRANCISCO BAY

Understanding the hydrodynamics of shallow water systems is essential to understanding phytoplankton dynamics. Tide-driven pressure gradients and surface wind stresses provide the dominant forcing of the shallow waters of San Francisco Bay. These forces determine both the bottom friction and the vertical mixing, which in turn dictate the vertical and ultimately, the horizontal distribution of phytoplankton.

A series of numerical studies have evaluated the relative importance of different processes affecting phytoplankton distribution in shallow water including: tidal shallowing and deepening, stratification and wind-wave resuspension of sediment. However, the effects of wind waves on vertical mixing have not been included in these models. We know from studies of the surface of the ocean and deep lakes that wave breaking and rotational waves lead to increased levels of turbulence in the upper portion of the water column. In the shallow water, where the bottom boundary layer may overlap with the wind-wave surface layer the situation is likely to be more complicated. For example, wind waves may increase the frequency with which phytoplankton is mixed out of the surface layer into the deeper, light limited portion of the water column where the grazing rate due to benthic organisms is greater.

Measurements were made in Grizzly Bay, 1st May-2nd June 2005 in order to parameterize vertical mixing under wind-wave conditions. An array of four acoustic Doppler velocimeters (ADVs) recorded velocities, pressure and acoustic backscatter (a proxy for sediment concentration) synchronously, at four heights in the 2.5 m water column. A vertical array of thermistors and conductivity sensors were used to capture stratification events. A record of “sea state" was gained via a high resolution camera which recorded 5 images every hour, allowing the presence of wave breaking and Langmuir cells to be identified. A wind station recorded wind velocities every 10 minutes for the duration of the experiment.

Parameters such as, Reynolds stresses and the dissipation of turbulent kinetic energy, were calculated from the ADV data set and the preliminary results indicate that increases in turbulent kinetic energy can extend almost half the depth of the water column under large wave conditions. This data will be used to help us understand the relative importance of different physical forces in mixing suspended and resuspended sediment particles and phytoplankton in and out of the euphotic zone. Such an understanding will allow us to more accurately predict phytoplankton growth conditions in shallow water systems via numerical models which will be a necessary component in our planning for ecosystem restoration.

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INTEGRATED REGIONAL WETLANDS MONITORING (IRWM) PROJECT: LANDSCAPE USE BY HERONS AND EGRETS IN THE SAN FRANCISCO ESTUARY

We measured the colony size, productivity of successful nests, and nest survivorship at 45 known heronries within 10 km of historic tidal-marsh of San Pablo Bay and Suisun Bay. The data were used to evaluate landscape associations of heronries and the potential use of six IRWM study marshes by herons and egrets. This work is part of a larger, ongoing project that began in 1990 to monitor all known heronries in the northern San Francisco Bay region.

We analyzed landscape associations based on the areal extents of NOAA land cover types (from Landsat images, 2000-2002) and several wetland-patch (FRAGSTATS) metrics within 1, 3, 5, 7, and 10 km of heronries. First, we compared land cover and wetland patch metrics at all distance scales with those of randomly selected, unoccupied sites. These comparisons revealed selection of nesting areas with more estuarine emergent wetland and more open water within 1 km of heronries than expected. However, herons or egrets did not nest within 1 km of IRWM sites. Fourteen-year patterns of productivity (pre-fledging brood size) of successful nests were significantly related to landscape conditions at relatively large spatial scales. Great Blue Heron brood size increased with the extent of estuarine emergent and open-water wetlands within 10 km; Great Egret brood size increased with the extent of estuarine emergent wetlands within 10 km and greater wetland edge complexity within 5 km. The long-term productivity of successful Great Blue Heron and Great Egret nests within 10 km of IRWM sites was greater for sites near Suisun Marsh than for sites in San Pablo Bay marshes

We used aircraft to track foraging flights of Great Egrets departing from heronries in Suisun Marsh. Using these data, we modeled foraging dispersion according to (1) distance from heronries and (2) cumulative extent of estuarine/palustrine habitat. Most Great Egrets foraged within 3 km of heronries or within distances that encompassed less than 15 km^2 of estuarine/palustrine emergent wetland. These models predicted greater foraging densities at Sherman Lake and Brown's Island than at IRWM sites in San Pablo Bay marshes.

Our results contribute to the development of techniques to measure the effects of landscape conditions on local ecological processes and, specifically, on the use of marshes by an important group of predators. Future investigation will focus on incorporating measurements of foraging habitat quality and validating models with surveys of heron and egret use of particular foraging sites.

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AQUATIC RESTORATION PLANNING IN THE YOLO BYPASS FLOODPLAIN

Over the last three years, the Aquatic Restoration Planning and Implementation section of DWR has been working collaboratively toward aquatic restoration in Yolo Bypass. Our original assignment was to implement a floodplain-scale adaptive management experiment to learn how native fish populations respond to changes in seasonal floodplain inundation, and compare success of native biota in a mosaic of habitat types. Because the adaptive management experiment would entail ecosystem restoration, it was anticipated that the experiment would increase habitat diversity, terrestrial material input, primary production, and invertebrate production.

Many constraints were identified from the start, but three: existing land use, flood control regulations, and ESA regulations have been the most imposing thus far. We are working to resolve these constraints by providing incentives for participation, demonstrating the limits of flood inundation impacts, and by working with stakeholders, other flood management agencies, and environmental enhancement proponents. We are also seeking to improve the biological function of Yolo Bypass by providing fish passage past Fremont Weir, and to reduce uncertainty by monitoring for associated biological effects. We plan to make the project operable, and in fact, fully reversible, by fitting any hydraulic structure designed with gates. If, after project implementation, water quality, introduced species, or any other issues were found to be adversely impacted by project implementation, the project could be reversed, returning to the current inundation operations.

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TEMPORAL AND SPATIAL VARIABILITY OF CHLOROPHYLL-a VERSUS PARTICULATE CARBON AND NITROGEN RELATIONSHIPS IN SAN FRANCISCO BAY: IMPORTANCE FOR ESTIMATING BIOMASS AND ECOSYSTEM MODELING

In making accurate estimates of the amount of phytoplankton biomass, both chlorophyll-*a* and carbon measurements are critical. Since chlorophyll is required for photosynthetic fixation of carbon dioxide into particulate carbon (POC) it follows then that a consistent relationship between the ratio of phytoplankton carbon and chlorophyll-*a* should exist.

Data collected from central San Francisco Bay provides a seasonal picture of the relationship between POC and chlorophyll-*a*. Samples were collected daily during a one month time series for summer (June 16 – July 16, 2004), fall (September 1 – October 1, 2004), winter (February 2 – March 1, 2005), and spring (March 17 – April 8, 2005). Water was collected from the seawall at the Romberg Tiburon Center (RTC). Samples for chlorophyll-*a* were filtered onto GF/F filters and analyzed for fluorescence using a Turner Designs fluorometer with phaeophytin correction. Samples for POC and particulate nitrogen were collected onto precombusted GF/F filters and analyzed using a PDZ Europa 20/20 GC-MS system

POC concentrations ranged from 32 to 380 μmol L^{-1} during the study period while chlorophyll-*a* concentrations range from 1.4 to 9.3 μg L^{-1}. Visual observation indicated that during times with chlorophyll blooms, fall and spring, POC: chl *a* relationships were the closest. Linear regressions of POC : chl *a* were constructed for each season . The y-intercept provides an indicator of the amount of detrital C and varied between 70-165 μmol L^{-1}. A better fit regression (higher r^2 value) occurred when the amount of detrital C was low, as occurred in fall ($r^2 = 0.76$). Spatial variability was also considered using samples collected from San Pablo Bay and Suisun Bay. These data indicate that the POC: chl *a* ratio is best matched in the San Pablo Bay, followed by the central SF Bay and that ratios for Suisun Bay do not indicate a good relationship. The very high detrital load in Suisun Bay may contribute to this weak relationship.

These data show there is considerable seasonal and spatial variations in the POC: Chl *a* ratio. This variability should be considered when making accurate estimates of phytoplankton biomass in estuarine environments and when applying such ratios in estuarine ecosystem models. This scientific study highlights that managers and agencies should be careful when predicting particulate carbon and nitrogen content from chlorophyll concentrations or visa versa.

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ENHANCING ECOSYSTEM FUNCTION BY IMPROVING LEVEE STABILITY: SUISUN MARSH-DELTA PROJECT SUMMARY

The 1400 miles of levees in Suisun Marsh and the Delta are key features of the region's ecology and infrastructure. Age, outmoded design, subsidence, floods, earthquakes and inadequate maintenance are increasing risks of levee failure. The Delta Risk Management Strategy is assessing the threat to the Delta's function as a drinking water source, a place to live, farm, and work, and a fish and wildlife habitat that these levee stability hazards pose.

Many projects to improve levee stability and reduce the damage from unintended levee failure are underway or being planned. These include projects at Van Sickle Island, Meins Landing, Dutch Slough, Decker Island, Twitchell Island, Beaver Slough, Staten Island, Grizzly Slough, and McCormack-Williamson Tract. Together, these projects affect about 21,800 acres, roughly .5 percent of the region's area, and about 25 miles of levees. Project features include (1) wildlife-friendly and setback levees that protect critical areas, including managed wetlands, from flooding (2) waterside berms that support shaded riverine habitat, (3) levee breaches to restore marshes and floodplains, (4) subsidence reversal experiments, (5) flood protection corridors used for wildlife-friendly agriculture, (6) borrow sites where the excavation of levee maintenance materials is creating new habitat areas, and (7) mitigation areas that offset levee projects' environmental impacts. In addition to reducing risks of unintended levee failure, these projects are resulting in:

- Better habitat for at-risk species including splittail and salmonids;
- Rehabilitated ecosystem functions;
- Enhanced opportunities for harvestable species including waterfowl and striped bass;
- Restored channels, marshes, and floodplains;
- Water quality improvements; and
- New approaches to the control of invasive species.

These individual projects are contributing to cumulatively significant ecosystem and levee stability improvements. They are also pointing to new ways to reduce risks of unintended levee failure while protecting Suisun Marsh and the Delta. In the future, even more may be accomplished by larger projects, such as projects at Franks Tract, Big Break, or Sherman Lake, that integrate levee improvements with ecosystem restoration and environmental protection.

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ANNUAL AND SEASONAL VARIATION IN SPECIES ASSEMBLAGES IN CREATED AND RESTORED HABITAT, NAPA RIVER, CALIFORNIA

The objective of the Napa River Fisheries Monitoring Program is to document fish species composition, life stage, seasonality, and environmental correlations associated with the fishes' use of habitat created by the ACOE Napa River/Napa Creek Flood Protection Project. By lowering and breaching levees along the Napa River, the Corps has created several riverside marsh terraces, and has restored over 250 acres of tidal wetlands and floodplains (known as the South Wetland Opportunity Area). Restoration of the area is providing habitat for a variety of native and non-native fish species. Sampling efforts over four years (March 2001 to July 2002, January to July 2003, and March to July 2004) in created, restored, and main water habitats have captured over 59,000 larval fish and 12,000 juvenile and adult fish. Species assemblages varied annually and seasonally. In 2001, inland silversides dominated the catch in the recently created and restored areas. In April 2002, over 3,000 young-of-the-year Pacific herring were captured in created and restored habitats. In July 2003, a seasonal increase of striped bass and threadfin shad dominated the catch in all habitats. In June and July 2004, Sacramento splittail were the most abundant native fish captured in the created and restored habitats. Results to date indicate that: 1) juvenile Sacramento splittail abundance is positively correlated with salinity in created and restored habitat; 2) juvenile Sacramento splittail were more abundant in created and restored shallow habitat than surrounding deep non-restored habitat; and 3) striped bass appear to have a seasonal distribution (dominating the species composition in July) and striped bass abundance is positively correlated with salinity. Variability in species assemblages reflects changes in environmental conditions and possibly successional changes in created flood and marsh plain habitat. Results of the monitoring program have identified species that benefit from newly restored and created habitat, documented seasonal trends in habitat use, and revealed correlations between environmental conditions and fish distribution and abundance. The results of this project will be useful in developing approaches to restore fish habitat within the Bay/Delta.

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FIELD METHODOLOGY AND SUMMARY OF SOUTH SAN FRANCISCO BAY WINTER-SPRING 2004 MONITORING DATA

The goal of the South Bay Salt Ponds Restoration Project is to restore and enhance a mosaic of wetlands, while maintaining many of the ponds as managed ponds. The potential restoration area includes the recently acquired salt ponds which consist of about 7,500 acres of existing ponds in the southern part of the South Bay, 4,800 acres of ponds along the East Bay shoreline, and about 1,500 acres along the West Bay shoreline.

Capturing a winter runoff period is particularly important in terms of determining the impacts of large rainfall-runoff on salinity in sloughs and the South San Francisco Bay. In addition, high flow periods are important in terms of observing water surface elevations during coinciding high flows and high tides for flood management purposes.

Between January and April 2004, eleven automated sensors and data loggers were deployed throughout the South San Francisco Bay to characterize important physical and chemical processes during a period associated with runoff. Combinations of water level, conductivity and temperature were monitored and surveyed into a geodetic datum.

We present various representative data and discuss the mobilization efforts and hardships within an extremely difficult environment. In addition, we emphasize the procedures used to ensure accurate sensor and subsequent time series elevations and calibrations as well as associated quality assurance and control protocols; This project is a case study in how to properly collect field and survey data in this environment.

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SPATIAL DISTRIBUTION OF WEEDS ON CROPLAND ASSOCIATED WITH LARGE-SCALE RESTORATION ON THE UPPER SACRAMENTO RIVER

The movement of pests from restored riparian forest tracts into nearby agricultural lands is a major focus of concern for farmers in the Sacramento River region. For example, restored or remnant riparian habitat may contain seed propagules of weed species of concern for farmers. In a survey of farmers within the Sacramento River Conservation area, weeds from riparian areas were considered a negative issue by over 70% of farmers surveyed. Although there is extensive research on the movement of invasive species from agriculture to restored habitat, there has been little research investigating movements of weeds from natural habitat to agricultural areas.

In this poster, we present the results of field research conducted in 2004 to determine the effects of restoration of riparian forest on the spatial distribution of weeds in nearby cropland within the Sacramento River Conservation Area. On 28 different farms we determined above-ground species diversity and abundance. Further, because the seedbank is often a better determinant of plant diversity and abundance in such highly managed systems, we collected soil samples and conducted seed bank surveys. We identified over 75 species from seed bank samples, 30% more species than observed in the above-ground surveys, probably due to intensive above-ground management. We present a spatial analysis of the species diversity and abundance of weeds in relation to their dispersal mechanisms, distance to forest, and management.

Restoration of terrestrial riparian ecosystems is a crucial goal for improving water quality, fisheries habitat, and terrestrial wildlife habitat. In particular, restoration of the Sacramento River terrestrial riparian habitat is essential for improving water quality and restoring species and ecosystem services in the Bay-Delta region. However, views on agricultural use of the Sacramento River are highly polarized, with, on the one hand, concern about the potentially harmful impacts from pesticides and fertilizers used in conventional agriculture, and, on the other hand, the exceptionally high agricultural value of the region's fertile land and abundant water. These concerns call into question the optimal extent and pattern of riparian restoration projects and impact the chances of restoration success. For example, along the Sacramento River, the area designated for restoration was decreased in 2002 due to landowner concerns. More specific accounting of the costs and benefits of riparian restoration for neighboring agriculture, such as the effect of restoration on weed abundance, may significantly reduce conflict and alter the patterns and extent of restoration efforts.

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PESTS AND PEST-CONTROL AT THE INTERFACE BETWEEN RESTORED RIPARIAN HABITAT AND ORCHARD CROPS IN THE SACRAMENTO RIVER CONSERVATION AREA

Restoration of terrestrial riparian ecosystems is a crucial goal for improving water quality, fisheries habitat, and terrestrial wildlife habitat. In particular, restoration of the Sacramento River terrestrial riparian habitat is essential for improving water quality and restoring species and ecosystem services in the Bay-Delta region. At the same time, management of the Sacramento River ecosystem is also highly contested because of its economic potential for urban, agricultural and recreational uses. I will present an overview of my research which focuses on this contested interface between agricultural and riparian habitat in the Sacramento River watershed, particularly on the effects of riparian habitat on pests and pest control in nearby agricultural systems. The movement of pests from restored riparian forest tracts into nearby agricultural lands is a major focus of concern for farmers in the Sacramento River region. At the same time the movements of pest predators from restored habitat could benefit agricultural production and reduce pesticide requirements**.**

My objective is to use extensive fieldwork and existing data to answer the following questions concerning the interactions between riparian restoration areas and adjacent farmlands:

1) What are the quantities and distribution patterns of serious agricultural pests, including weeds, insects and mammals, from riparian forest into farmlands?
2) Does crop production benefit from elevated densities of pest enemies, including both arthropod and avian predators, that move from riparian forest areas into nearby farmlands? If so, how far does this beneficial effect of riparian forest sites extend into farmlands?

I will focus my work on what is arguably the most important crop grown within riparian areas– walnuts – and to a suite of its most important pests and predators. I have research sites at 27 walnut farms that range from adjacent up to eight kilometers from restored riparian habitat, and up to three kilometers from remnant riparian forests. My goal is to share my findings with the agricultural and restoration communities, fostering better understanding of the impacts of restoration and focusing management priorities. Without support from stakeholders and the community for terrestrial riparian habitat, many of the CALFED Ecosystem Restoration Program goals are not possible. In particular, it is critical to have community support for upstream terrestrial restoration in order to achieve recovery of species, native and harvestable, to rehabilitate natural processes in the Bay-Delta and its watershed, to restore and protect functional habitats, and to improve and maintain water and sediment quality. My research will use strong science and a strategic modeling approach to determine how to adapt riparian habitat management for stakeholder support and ecosystem restoration success.

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SOUTH BAY SALT POND RESTORATION PROJECT INTERACTIVE MAP

The South Bay Salt Pond Restoration Project is restoring 25 square miles of salt ponds from Hayward, South to San Jose and East to San Mateo. The Project is opening ponds to tidal action with the intent of restoring lost tidal habitats. Increasing the tidal landscape will create more aesthetic areas, more habitat for wildlife, and more open space for public use and enjoyment.

Much data collection and analysis has gone into the planning stages of this project. The San Francisco Estuary Institute acts as the clearinghouse of the collected GIS data and all ancillary data. A website (www.southbayrestoration.org) was created to provide access to documents, photos, maps, scheduled events, and press releases about the Project. To enhance the public's knowledge of the Project, SFEI has created an interactive map where interested parties can view information without the need for expensive software. This Interactive Map allows the public to view the current and historical conditions around the project areas.

The Interactive Map is viewed using a web browser and allows the user to explore data pertaining to the South San Francisco Bay and the restoration project. Data are arranged into 'themes' and include Water Quality, Infrastructure, Wildlife, Historical Baylands, Jurisdictional Boundaries and Recreation. Visitors can view the spatial data in relation to the Project area. For example, users can see where endangered wildlife has been sited in relation to landscape type or what the project area landscapes were in 1800. The interactive map's zoom and pan tools allows users to focus in on a particular restoration complex, pan around the project area or zoom out for a regional view. Other map features include the SF Bay's high and low tide lines, regional shaded relief, highways and IKONOS aerial imagery with a 1 meter pixel resolution.

Since its launch in early May, 2005, the South Bay Salt Pond Interactive Map has received over 1,000 hits and much positive feedback.

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MEASURING SEDIMENT IN JACK LONDON'S STREAMS: HISTORICAL LAND USES, TODAY'S ROADS, AND THE SONOMA CREEK TMDL

Content: In 2002, with 600 acres added to the existing 800-acre Jack London State Historic Park (JLSHP) from the adjacent Sonoma Developmental Center, the California Department of Parks and Recreation also inherited a complex network of old and new forest and ranch roads. The JLSHP roads potentially cause sedimentation to salmonid-bearing headwaters of Sonoma Creek, an important tributary to San Pablo Bay, due to wet-season runoff from roads with poor alignment, infrequent maintenance, undersized culverts, and uncontrolled drainage. Many of the roads must be retained, because they are also important culturally: they were constructed as a support network for Jack London's Beauty Ranch; they are required for the current park water system and emergency access; and they are of interest to the public as a year-round multi-use trail system.

The Sonoma Ecology Center (SEC) is a nonprofit group working toward a condition of sustainable ecological health in the Sonoma Valley. SEC is monitoring turbidity and suspended sediment exposures for aquatic organisms in streams draining portions of JLSHP with (1) old, untreated roads and trails and (2) newly rehabilitated roads and trails. The majority of JLSHP land is drained by Asbury, Mill, and Graham Creeks, all tributaries to perennial Sonoma Creek. During winter storms, heavy runoff carries sediment to these streams, increasing suspended sediment levels and turbidity. Highly turbid waters have been observed to reduce growth rates and impair the ability of aquatic species, including endangered steelhead trout, to feed.

Four years of continuous and grab sampling of suspended sediment and turbidity in major tributaries, as well as assessment of mainstem loading, have yielded preliminary results that indicate (1) suspended sediment concentrations (SSC) pose a moderate impact to over-wintering fish during wet storms and (2) the magnitude and duration of SSC are severe enough to cause major physiological stress, but not direct mortality, during monitored events. SEC's water-quality monitoring is being supplemented by methods of sediment production analysis, such as modeling using the Revised Universal Soil Loss Equation, to inform the development of a sediment budget for Sonoma Valley in support of the Sonoma Creek Sediment TMDL. The TMDL will result in an amendment to the Water Quality Control Plan for the San Francisco Bay Basin.

Featured projects: Recontouring, Revegetating, and Narrowing Roads and Trails in Jack London State Historic Park (319[h], 2004), Reducing Sediment Pollution in Sonoma Creek Watershed (Proposition 13, 2003), Jack London State Historic Park Watershed Assessment and Planning (DFG, 2003 and PSMFC, 2003), Effects of Management Practices on Peak Flows and Sediment Loading (319[h], 2001), Sonoma Creek Watershed Conservancy (CALFED, 2001).

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LONG-TERM CHANGES IN VEGETATION RELATED TO NATURAL AND ANTHROPOGENIC ENVIRONMENTAL FACTORS IN AN INTERMITTENTLY TIDAL BRACKISH MARSH OF THE SUISUN BAY WATERSHED

Over an eleven-year period, data were collected on vegetation, water quality and microtopography in an intermittently tidal brackish marsh located near Pacheco Creek, on the south shore of Suisun Bay in the northern portion of the San Francisco Bay Estuary. The study location was subject to natural and anthropogenic disturbances. Water quality parameters, particularly salinity, exhibited substantial variation with season, revealing that site characteristics range from fresh to hypersaline. Salinity variation results from complex temporal relationships between precipitation, desiccation, and intermittent tidal flow events. Seasonal occurrences of macroinvertebrates and fish were consistent with water column salinity fluctuations. A high-resolution microtopographic survey (+/- 0.5 cm elevations on 10 x 10 cm centers) was performed to relate vegetation changes to elevation. Major plant elements included *Atriplex, Cotula, Distichlis, Scirpus, Polypogon, Ruppia, Salicornia,* and *Typha* as well as the invasive *Lepidium latifolium*. Vegetation data collection included numerous fixed-point photographic records (1994-2005) and percentage cover values for over 70 fixed 1-meter square quadrats (2000-2005). Vegetation data trends were evaluated to determine the effects of several environmental factors and processes: vegetation mechanical disturbance and subsequent succession, long-term vegetation changes, effects of invasive species, seasonality and growth phases, desiccation, and microtopography. The responses of vegetation to these factors will be presented graphically in the poster.

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BEAUTY AND THE BEAST: THE NEW CYANOBACTERIAL BLOOM OF MICROCYSTIS AERUGINOSA IN THE SAN FRANCISCO ESTUARY

A bloom of the toxic cyanobacteria (bluegreen algae) *Microcystis aeruginosa* now occurs in the upper San Francisco estuary during the summer and fall. The establishment and long-term development of this organism is potentially important for the estuarine management and restoration because it may impact both ecosystem function and drinking water quality. The first field surveys conducted in 2003 and 2004 indicated this bloom was widespread throughout the upper estuary between July and November. The bloom was toxic and contained cancer causing toxins called microcystins, including the highly toxic microcystin-LR. The bloom biomass peaked in the central Delta during late August and early September, but bloom biomass and toxicity did not always coincide. The highest toxicity occurred in the Sacramento River during early September. The impact of the bloom on estuarine function and the recent decline in pelagic fish production in the Delta is unknown and under study. However, microcystins were found in all food web organisms sampled that are eaten by pelagic fish from the small planktonic rotifers to jellyfish.

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CALIFORNIA CLAPPER RAIL POPULATION TRENDS IN THE SAN FRANCISCO BAY ESTUARY

Over the past 200 years, human impacts to tidal salt marshes of the San Francisco Bay estuary have drastically reduced and degraded this integral part of the overall bay ecosystem. Many bird species live within tidal marsh habitat, including the federally endangered California Clapper Rail (*Rallus longirostris obsoletus*). This species is highly susceptible to human impacts, particularly habitat alteration and loss, and depredation by introduced predators.

The last comprehensive survey of Clapper Rails in San Francisco Bay took place in 1992-93. Over the ensuing years, tidal marsh habitat in San Francisco Bay has increased significantly through wetland acquisition and restoration. A new call-count survey was initiated in 2005 at 36 marshes to estimate numbers of rails within the tidal marsh complex and to assess the how these changes in tidal marsh habitat may have affected Clapper Rail populations. Half of these marshes had been surveyed in 1992-93.

This poster examines changes in subpopulations at individual marshes between the 1992/93 and the 2005 surveys, and evaluates the population at a regional level. Patterns in population trends of Clapper Rails throughout the estuary are presented, as well as various broad-scale landscape associations, including Clapper Rail numbers and channel morphology, vegetation community, and proximity to urban environments.

The 2005 Clapper Rail survey was an important gauge of estuary-wide management efforts over the last 12 years. California Clapper Rails are a sensitive species that is endemic to the estuary, and an indicator species for restored tidal marsh habitats.

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WETLAND DESIGN AND MANAGEMENT OPTIONS FOR CONTROL OF MERCURY IN SAN FRANCISCO BAY

Based in part on high levels of mercury in fish tissue resulting in fish consumption advisories, San Francisco Bay (Bay) has been listed as a water body impaired by mercury. Methyl mercury is listed by the State of California as a cancer-causing substance under the provisions of Proposition 65 and is also a potent neurotoxin. Bay Area residents, especially low-income and certain ethnic groups, catch and consume fish from the Bay despite fish advisories. Studies by the U.S. Fish and Wildlife Service indicate that levels of mercury may accumulate in Bay Area bird populations at concentrations high enough to imperil the survival or recovery of threatened and endangered species resident in the Bay. The San Francisco Bay Regional Water Quality Control Board ("the Board"; "Region 2") has adopted a Total Maximum Daily Load (TMDL) for mercury in the Bay and has designated this TMDL as one of the highest water-quality priorities for the region. Methyl mercury, the form that is most toxic and most readily available for uptake by organisms, is the primary form of mercury in fish. Therefore, efforts to reduce production of methyl mercury are important components of the Board's mercury control strategy.

The purpose of this project is to identify specific, practical measures to substantially reduce methylation of mercury in the Bay and to produce a Wetland Implementation Plan that can be incorporated as an element for wetlands as the Board adaptively implements the mercury TMDL. Control measures developed in this project for Bay wetlands also may be applicable to wetlands elsewhere in California and may be suitable for incorporation into other mercury TMDL implementation plans.

This poster will describe the cooperating organizations, technical objectives, key project elements and processes to be implemented over the course of this 3-year project that was begun in July 2005.

This project has been funded by a grant from the Coastal Nonpoint Source (Northern) bond funds established under California's Proposition 13 (Costa-Machado Water Act of 2000).

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USING A SPATIALLY BALANCED, RANDOM SAMPLING DESIGN TO ASSIST INFORMED MANAGEMENT DECISIONS

The San Francisco Estuary Regional Monitoring Program for Trace Substances (RMP) is the primary source for long-term contaminant monitoring information for the Estuary. The RMP was initiated in 1993, and is an innovative and collaborative effort between the scientific community, the San Francisco Bay Regional Water Quality Control Board (Water Board), and the regulated discharger community. The RMP includes a Status and Trends component for evaluating spatial and long-term temporal contaminant trends throughout the Estuary. Additional special studies address specific scientific questions relating to water quality and beneficial uses.

The RMP Status and Trends sampling plan was redesigned in 2002 employing the Generalized Random Tessellation Stratified design (GRTS) utilized by the U.S. Environmental Protection Agency's Environmental Monitoring and Assessment Program (EMAP) for monitoring the condition of the nation's coasts and large estuaries. Each year, the Status and Trends program sequentially samples randomly selected water and sediment stations for trace contaminants and other water quality indicators providing increased spatial coverage of the Estuary over time. This design will provide environmental managers and regulators with statistically defensible information about the spatial and temporal distribution of regulated and emerging contaminants in the Estuary.

The new Status and Trends monitoring design is well suited to address some of the new, more focused, RMP management questions developed jointly, in 2005, by Bay Area scientists, environmental regulators, and the regulated community. Some of the management questions the new random sampling design will address include:

- What are the spatial and temporal patterns of contamination in the Estuary and it's sub-regions?
- How does contamination in the various Estuary regions compare to each other, and to specific water and sediment effects thresholds?
- What is the spatial and temporal extent of sediment toxicity in the Estuary?
- What are possible pathways of contamination to the Estuary?
- Is contamination in the shallow reaches of the Estuary different from the deeper channels?

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CONTRASTING BIOGEOCHEMISTRY OF SIX TRACE METALS DURING A SPRING PHYTOPLANKTON BLOOM IN SAN FRANCISCO BAY

We studied the interaction between a nutrient enriched phytoplankton bloom and metal cycling in South San Francisco Bay by measuring Co, Cu, Mn, Ni, Pb, and Zn during the 2003 spring bloom. We used vertical profiles and trace metal clean sampling techniques to collect samples and characterize water chemistry, including dissolved oxygen, total suspended solids, salinity, chlorophyll-a, and phaeophytin. We then used a novel statistical technique to reduce the water chemistry to 3 diagnostic factors that characterized the rise of the bloom, amount of adsorbent, and the decay of the bloom. That approach allowed us to determine that dissolved Mn, Ni, and Pb significantly ($p<0.05$) decreased as the bloom grew. That decrease corresponded with the complete depletion of dissolved inorganic nitrogen and dissolved silicate by the time the bloom peaked at >150 µg/L of chlorophyll-a on March 4. About 220 x 10^3 mol of Ni were assimilated by the phytoplankton during the bloom, which was about 2.5 times more than the annual Ni loading to the bay from wastewater treatment plant discharge. In contrast, Cu concentrations did not vary during the bloom, which was consistent with previous research showing that Cu was sufficiently complexed by organic ligands to prevent phytoplankton uptake. Our statistical approach also allowed us to make the first measurements showing that dissolved Co, Zn, and Pb significantly ($p<0.05$) increased during bloom decay. We also found a significant ($p<0.05$) increase in dissolved Mn during bloom decay, which agreed previous research showing that Mn could be remobilized from sediments following blooms. Remineralization of phytoplankton could also have accounted for some of rise in dissolved metal concentrations during bloom decay. The different responses of the metals during the bloom were consistent with past studies on their speciation and biogeochemistry in the estuary and demonstrated that nutrient enriched blooms affect metal cycling.

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CHARACTERIZATION OF FISH ASSEMBLAGES WITHIN SAN FRANCISCO BAY: IMPLICATIONS FOR BIOLOGICAL MONITORING STRATEGIES AND DESIGN OF HABITAT RESTORATION PROJECTS.

The U.S. Fish and Wildlife Service (USFWS) juvenile fish monitoring program (JFMP) has intermittently collected data during an ongoing study in the San Francisco Bay area over the past 24 years as part of a combined effort to monitor juvenile fish abundance in the Sacramento-San Joaquin Delta and estuary. For the last six years, the JFMP has regularly collected data on fish species richness and abundance, salinity, and temperature from eight sample sites within San Francisco Bay. Here we provide an analysis of five fish assemblage metrics (species richness, diversity, similarity, stability, and persistence) that were assessed for the Bay Region as a whole, within each site over time, and among sites within years from 1999 through 2004. We also propose a framework to illustrate the utility and define limitations of incorporating JFMP fish monitoring data as a foundation for ongoing and future restoration projects by other agencies.

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A SURVEY OF CURRENT RESTORATION AND WATER MANAGEMENT PROJECTS IN THE NAPA RIVER WATERSHED

This poster presentation will include a review and discussion of several current habitat restoration, watershed management, and water resources management activities occurring in the Napa River watershed. Either in planning, design, or implementation phases, these concurrent projects include: the Napa River flood control project in St. Helena; Napa River restoration along Rutherford Reach; Napa River flood control and restoration projects in City of Napa; Napa River total Maximum Daily Load studies for sediment and pathogens; Napa County Baseline Data Report; and the lower Napa River and Salt Marsh restoration.

This poster presentation has 3 primary goals. The first goal is to present summaries of the objectives and key findings for the stated projects occurring in the Napa River watershed. The second goal is to suggest and describe what the cumulative benefit of such multiple projects may be when viewed collectively from the whole watershed perspective. This leads to the third goal, which is to consider from the cumulative watershed perspective, what contributions such individual projects make to the habitat of the bay system downstream. Within this third goal, the authors will be available to discuss how considering the integration of such multiple projects may be an appropriate template for further development of the Bay Area's Integrated Regional Water Management Plan (IRWMP).

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WATERSHED STEWARDSHIP: GPS CREEK AND BIOASSESSMENT SURVEYS

In Contra Costa County volunteers are working with local agencies, resource managers and regulators to monitor and improve the health of local creeks and watersheds that drain to the San Francisco Bay and Delta regions. The Contra Costa Watershed Forum's Citizen Watershed Monitoring and Assessment program mobilizes existing volunteer organizations to implement a coordinated countywide citizen-based watershed monitoring program. Volunteers are trained to collect physical habitat data with global positioning systems (GPS) and bioassessment data using the California Stream Bioassessment Procedure. Volunteers and other stakeholders utilize this data to identify and prioritize future water quality improvement projects.

GPS Creek Surveys document vegetation (type, invasive species), human disturbances (outfalls, bridges, dams), and channel conditions (substrate, canopy cover, bank composition). The data can be presented graphically on a map as well as analyzed to quantify habitat conditions.

Bioassessment Surveys utilize benthic macroinvertebrates (bugs) to screen for water quality problems. Monitoring the diversity and abundance of aquatic bugs helps determine the biological integrity and overall health of watersheds. Bioassessment surveys provide volunteers and regulators a cost-effective method to monitor water quality, identify possible pollutant sources, and target restoration and pollution prevention actions.

The volunteer collection efforts augment the on-going work by agencies to characterize and monitor watersheds. The baseline data, as well as annual monitoring by Citizen Watershed Monitoring and Assessment program provides resource managers and regulators data needed to address habitat restoration and pollution reduction strategies in Contra Costa County. This program empowers citizens to be effective watershed stewards by providing skills, resources, and facilitating relationships with agency staff to cooperatively monitor and address water quality issues. Watershed stewards turn education into action with tangible, scientific data to make well-informed decisions to improve water quality at the watershed scale.

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SEDIMENT SOURCE STUDY FOR NOVATO CREEK MARSH IN THE SAN FRANCISCO ESTUARY

Trace and minor elements, Sr isotope ratios and stable C and N isotopes can be used in combination to determine the sediment source history for sensitive tidal marshes around the San Francisco estuary. Four sediment cores were collected from tidal marshes in a transect along Novato Creek, a tributary to San Pablo bay in the northern reach of the San Francisco Estuary. The cores were subsampled at 1 to 2 cm intervals and sediments were analyzed for changes in organic content, trace elemental concentrations, C and N isotopes and $^{87}Sr/^{86}Sr$ isotopic ratios. The goal of this work is to determine changes in the relative sources of sediments to a tidal marsh along this large estuary. Determining the sources of sediments is of interest because current mitigation and restoration projects around the Bay must consider whether the sediment supply will be sufficient for projects, or if opening diked wetlands to tidal flow will result in salt water intrusion further up-estuary, into the Sacramento-San Joaquin Delta (the Delta).

Sediment end member sources supplying the tidal marshes along Novato creek include: autochthonous organic detritus; fine sediments carried through the Delta from the Sacramento or the San Joaquin river drainages; sediments resuspended from within the Bay; sediments carried down-stream from the Novato creek drainage. Changes in the organic content (LOI) of the sediment cores indicate changing marsh conditions from productive marshlands to less productive, perhaps subtidal conditions. The C and N isotopes provide further details about the vegetation: high C isotope values are typical of either the salt tolerant, low marsh *Spartina foliosa*, or the salt tolerant, high marsh plant, *Distichlis spicata*. Fresher conditions typically have plants with low C isotopic ratios.

Principal component analysis (using CANOCO) of modern mineral sediments collected from end member sources allows differentiation between the potential sources for the local marshes. Results have been used to produce a model that calculates the relative inputs from each of the specified end members for different depth samples within each marsh sediment core. The marsh sediments reveal both spatial (reflecting distance from the bay) and temporal (depth, reflecting changes over time) differences.

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CALFED NON-NATIVE INVASIVE SPECIES PROGRAM AND REFERENCE COLLECTION

Introductions of non-native invasive species (NIS) are a significant global threat to freshwater and marine ecosystems. These introductions are considered to be the second most important threat to biodiversity in North America because of their social, economic, and ecological effects. Over the past hundred years, hundreds of non-native species have been introduced to the San Francisco Bay-Delta. Within the last few decades, the frequency of international transfer has been greatly accelerated by various human activities. To help aid in the identification of these non-native species, the United States Fish and Wildlife Service Non-Native Invasive Species Program is compiling a NIS reference collection. The NIS reference collection is intended to be a resource for members within the Interagency Ecological Program (IEP) but is available to all organizations and interested professionals. This program has been charged with developing and coordinating this collection through funding from CALFED and the support of the academic community.

The intent of this collection will be to catalog aquatic NIS found in the freshwater portion of the Delta and San Francisco estuary. The current collection, which has recently been updated, is also part of the California Department of Fish and Game Bay-Delta teaching and reference collection. Along with non-native fish and invertebrates, we also anticipate adding non-native plants to the collection in the future. The collection will include two types of specimens: historical documentation specimens (i.e., voucher specimens) and teaching or reference specimens. The historical documentation specimens will be kept to verify the occurrence of a species outside of its natural range and to provide evidence that can be scrutinized by the scientific community. Access to these specimens will be restricted. Teaching or reference specimens will be used to aid or confirm the identification of a species. These specimens can be handled and used for instructional purposes. For example, when area professionals need to verify the specimen identification from field sampling, they could access teaching specimens on site.

In conjunction with the specimen collection, we are developing a NIS database. The primary purpose of this database is for users to have web-based access to query information regarding specimens in the NIS reference collection. Information such as common name, scientific name, family, life stage, size, quantity, condition, where the specimen was collected including GPS coordinates, and who, or what agency, identified the specimen is available.

We are currently asking for specimen donations for several non-native species which are in poor condition or are missing from the current collection.

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SEASONAL PHYTOPLANKTON EXCHANGE BETWEEN THE COASTAL PACIFIC AND CENTRAL SAN FRANCISCO BAY

From 2002-2003 we measured scalar fluxes at the mouth of San Francisco Bay just inland of the Golden Gate Bridge. Data were collected during each of three seasons: winter/spring runoff, summer upwelling, and fall relaxation. For each experiment, 12 minute transects across the channel were repeated continuously for 25 hours for two days, one during spring tide and one during neap tide. Measurements included cross-sections of currents, temperature, salinity, chlorophyll-a fluorescence and optical backscatter. Results from these experiments indicate a net flux of chlorophyll-a into San Francisco Bay during coastal upwelling and a net flux out of the estuary during other seasons. The net flux is comprised of an advective (river) and dispersive component (tidal); the direction of advection is always out of the estuary (seaward) while the dispersive direction changes seasonally. Dispersive flux direction is inland during summer and seaward during fall and spring. Using dimensional analysis to compare these exchange rates and estimates of local effective growth we found that dispersion dominates the chlorophyll balance of Central San Francisco Bay. These results imply phytoplankton found in Central Bay did not originate there but were transported from a region where the effective growth rates were large relative to transport. Synthesis of our experimental results and historical records suggest that during spring phytoplankton found in Central Bay originate in South San Francisco Bay and during summer originate in the coastal ocean. Depending on limiting conditions and specific species, shifts in San Francisco Bay phytoplankton community composition may be engendered by changes in oceanic populations and communicated via dispersion rather than alterations to the local dynamics.

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LANDSCAPE-SCALE GEOMORPHIC EFFECTS OF WETLAND RESTORATION ASSOCIATED WITH THE SOUTH BAY SALT POND RESTORATION PROJECT

South San Francisco Bay (South Bay) hydrodynamics, morphology, and habitats have changed substantially over the past 150 years under the influence of natural and anthropogenic processes. The largest perturbation was the conversion of 90% of the tidal marsh areas to salt ponds, agriculture, and urban development, accompanied by a 40% decline in intertidal mudflats. Although it is nearly impossible to separate out the impact to the system attributable to the original conversion of marsh to salt ponds, it is reasonable to assume that an action of comparable magnitude, such as the restoration of 15,100 acres of salt ponds to tidal marsh in the South Bay Salt Pond (SBSP) Restoration Project, could produce a system-wide response as dramatic as that observed over the past century. Therefore, it is important to consider the potential long-term system response during restoration planning.

A landscape-scale geomorphic assessment was performed to assess the rate at which the restored salt ponds will evolve from tidal mudflat to marsh, and how this restoration may affect South Bay sediment dynamics, morphology, and ultimately the extent of tidal mudflat and shallow-water habitats. The first step in understanding the morphology of this complex system relies on an examination of historical change. The second step relies on calibrating a sediment budget model to past geomorphic change in order to create a predictive tool for assessing potential future changes, both in response to restoration alternatives and in response to a "no project" scenario. This predictive model is used to track the change over time in the various areas of interest, namely the deep subtidal channel, the shallow subtidal regions, the intertidal mudflats, and the salt ponds restored to tidal action. A second suite of tools is then used to evaluate the projected change within each area, such as examining the evolution of tidal habitat within the restored salt ponds. Information from this analysis is then used to revise the bathymetry within the South Bay and the restored ponds.

Preliminary results suggest that sufficient sediment is available for tidal restoration and that even the most subsided ponds are likely to support marsh vegetation within the 50-year planning horizon. This study is supported by funds provided by the California State Coastal Conservancy, and the Packard, Hewlett and Moore Foundations

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WWW.WETLANDTRACKER.ORG — THE WETLAND PROJECT TRACKER

The Wetland Project Tracker (Tracker) provides public access to a wide variety of information about wetland restoration, mitigation, creation, and enhancement projects in the San Francisco Bay Area, including location, size, habitats, sponsors, and status.

Planned and completed projects are displayed on an interactive regional map. Summary information is displayed alongside this map, and project information pages provide additional information on each project. A number of new tools assist the user in obtaining desired information.

Project information can include any electronic file, such as reports, data, photos, scanned maps, or web links. Anyone can submit files with their browser and make them available for others to download. In this way the Tracker becomes a permanent online library for each project.

To keep the Tracker up-to-date, a routine method of obtaining project information from permit-granting agencies has been developed.

The Tracker is designed to track wetland projects in the context of all regional wetlands. An updated inventory of regional wetlands is being developed through a modified version of the National Wetlands Inventory, using a locally-vetted set of habitat definitions and terminology. The South Bay inventory is complete and other regions are underway.

Presently focused on tidal and formerly-tidal wetlands, the Tracker has received funding to track projects in a pilot watershed. The Tracker is also expanding to tally wetland impacts associated with mitigation projects. The end goal is to track net change in all wetlands of the region.

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YOLO BYPASS WATER QUALITY MANAGEMENT PLAN

The Yolo Bypass ("Bypass") is a leveed, 59,000-acre floodplain, approximately 41 miles long and 1-3 miles wide, parallel to and on the west side of the lower Sacramento River in California's Yolo and Solano Counties (see map at right).

The Bypass is a vital flood control feature that protects low-lying areas in the Sacramento area. In addition, it receives water from local drains and creeks, and urban stormwater and wastewater. Water is used beneficially within the Bypass in several ways, most notably agriculture and wildlife habitat. Discharges to the San Francisco Bay-Delta also contribute to regional drinking water supplies.

The objective of this project was to develop a comprehensive water quality management plan for the Bypass. The general steps followed to develop the plan were to:

- Identify through review of existing information and stakeholder input current pollutants of concern (POCs) for the Bypass;
- Conduct surface water quality monitoring to help quantify POCs and their major sources;
- Identify and evaluate effective, implementable control measures for reducing POC concentrations and loads;
- Investigate, if necessary, the applicability of current water quality criteria for the POCs and the feasibility of developing site-specific objectives;
- Involve stakeholders regarding POCs and potential control measures;
- Produce a Water Quality Management Plan containing a recommended implementation program to address POCs that are degrading surface water quality.

The plan sets forth a series of actions to achieve water quality objectives appropriate for the Yolo Bypass. The most stringent, potentially applicable water quality objectives found in the Basin Plan, local NPDES permits, and proposed Basin Plan amendments are the basis of the objectives compared with monitoring data. Options considered for addressing the POCs to meet those objectives are as follows, generally in order of most preferable first:

- Implement control measures. Implement feasible and cost-effective control measures such as described previously in this report.
- Undertake research and special studies. Conduct focused studies that improve the conceptual model for certain POCs or that aid in quantifying effectiveness of control measures.
- Monitor water quality. Monitor water quality to improve our ability to detect changes in water quality and to quantify linkages in the conceptual models for various POCs.
- Conduct site-specific objective or beneficial use studies. Address POCs coming from predominately natural and uncontrollable sources.
- Participate in future stakeholder activities. Participate in related stakeholder forums and in the development of plans and policies that directly impact water quality in the Bypass.

The resulting plan provides an adaptive management framework in which some recommended actions aim to reduce POC loads while others would provide for additional information for improving our ability to effectively manage water quality in the Bypass. Actions described under these options address all high and medium priority POCs. Future stakeholder activities are also recommended to foster collaboration and participation as information improves the ability to manage water quality.

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SHORELINE SPACES: PUBLIC ACCESS DESIGN GUIDELINES FOR THE SAN FRANCISCO BAY

The San Francisco Bay is a dominant feature of the nine-county Bay Area and provides an environment for many forms of public enjoyment. The San Francisco Bay Conservation and Development Commission (BCDC) adopted the *Public Access Design Guidelines* in 1985 to provide the San Francisco Bay region with a design resource for development projects along the shoreline. However, since 1985, new information on ways to improve the design and usability of public access areas has emerged. Perhaps the most important recent advance has been the increased understanding of the potential conflicts between public access and wildlife.

Shoreline Spaces: Public Access Design Guidelines for the San Francisco Bay (2005 edition) takes a new, comprehensive approach to informing development teams about enhancing public access along the shoreline of the Bay. The revised document provides recommendations for designing enjoyable public shoreline spaces and also reflects the current knowledge on the interaction of public access and wildlife. Through the use of vivid photographs, the guidelines inform developers how to create shoreline spaces that allow the public to discover, experience and appreciate the Bay's natural resources. In areas where wildlife is present, the guidelines offer a number of strategies to minimize or avoid effects on wildlife, such as the use of boardwalks, fencing, viewing overlooks and moats.

The design principles that are included in the *Public Access Design Guidelines* apply to all development proposals along the shoreline of the Bay and, in doing so, help foster public support for Bay resource protection and promote stewardship of the San Francisco Bay.

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NATIVE OYSTER RESTORATION IN SAN FRANCISCO BAY: ECOSYSTEM ENHANCEMENT AND CONSERVATION OF NATIVE SPECIES

The native oyster *Ostrea conchaphila* was historically abundant in the San Francisco Bay-Delta Estuary where it supported harvesting by Native Americans and early European settlers as well as early mariculture operations. A combination of factors such as over harvesting, burial by mining sediment, predation by non-native species, and pollution from unregulated urban growth severely impacted oyster populations in the bay.

Renewed interest in local native oysters was stimulated by successful restoration of oysters in Cheseapeake Bay and elsewhere promoted by the NOAA Community Based Restoration Program. A resurgence of oyster populations would provide habitat for many associated species and food for several native species of fishes and birds. Moreover, oysters filter large volumes of water during feeding and respiration offering potential benefits to water quality and invasive species deterrence. Anecdotal evidence for their presence led to informal surveys of their distribution and an initial effort to determine if planktonic larval oysters would recruit onto appropriate habitat (oyster shells). Results showed that oysters were widely distributed, although sparse, in intertidal and subtidal habitats. Planktonic larvae were widespread and readily recruited onto strings of oyster shells suspended in the water and monitored by volunteers. This supported the hypothesis that native oyster populations could be enhanced and restored by providing additional shell substrate for settlement. Once a critical mass was developed it was thought that the oysters would be able to persist and expand their own oyster shell reefs.

A combination of habitat enhancement in the Richardson Bay Audubon Sanctuary and quantitative ecological surveys to investigate limiting factors other than shell habitat has advanced our understanding of the native oyster in the bay. Pallets of oyster shells placed in the deep intertidal and shallow subtidal by Tiburon Audubon Society volunteers successfully demonstrated that in this area, shell substrate was limiting and quickly settled on by oyster larvae that subsequently survived and grew at high rates. The ecological investigations revealed that the native oyster populations were most abundant in the estuarine portion of the bay, not the far south bay. They were more abundant on rocky substrate than where fine silt predominated, and they were inversely related to abundance of non-native oyster drill predators. Oysters were very abundant in areas where larvae would be retained by water circulation such as in marinas and residential lagoons.

The success of early efforts to provide shell habitat for oyster recruitment has stimulated similar experiments by volunteer groups at several locations. The Tiburon Audubon Center is expanding its studies to the effects on oyster populations of larval retention areas and to possible synergism with eelgrass. The ecosystem benefits of expanding oyster populations are being documented by monitoring fish, birds, and water quality near the new oyster reefs.

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CHARACTERIZATION OF MERCURY CONCENTRATIONS IN SUSPENDED SEDIMENT LOADS IN GUADALUPE RIVER AND COYOTE CREEK, SAN JOSE, CALIFORNIA: CAN TMDL TARGETS BE MET?

San Francisco Bay is listed on the Clean Water Act 303(d) list as a water body impaired by mercury. Studies provide evidence that mercury from the consumption of contaminated fish can cause neurological disorders in humans. Fishing advisories for San Francisco Bay were first issued in 1994 and then updated in 1999 and recommend that people that catch and consume fish caught from the Bay limit their consumption. In addition, there is growing evidence that mercury is the cause of hatching failures in some native rare and endangered species that live and feed in habitats within the tidal Bay margin.

In response to the impairment listing, a mercury TMDL for San Francisco Bay was developed by the Region 2 Regional Water Quality Control Board (RWQCB). The Bay TMDL contains specific recommendations for the Guadalupe River (the watershed that contains the historic New Almaden Mining District – the largest mercury production area in North America) including the following: "Quantitatively demonstrate that the mercury concentration of suspended sediment that best represents sediment discharged from the watershed to San Francisco Bay is below the suspended sediment target".

The question is: Can this target (0.2 mg/kg) be reasonably met given atmospheric and other sources of mercury still being supplied to the watershed? Presently the Guadalupe River suspended sediment load has a mercury concentration that is approximately 10 times greater than the target during low to moderate rainfall years and possibly exceeds the target even more during very wet years.

To help answer this question, SFEI carried out a small pilot study on Coyote Creek at the USGS gage at Hwy 237. During Water Year 2005 (lower than average discharge), a total of seven water samples were collected during floods and analyzed for total mercury. If we make the reasonable assumption that most of the total mercury is particulate, the sediment concentrations for Coyote Creek averaged approximately 0.2 mg/kg. We don't know if the data collected during water year 2005 are representative of all water years, but the data appear to suggest that Coyote Creek can meet the Bay TMDL sediment mercury target. The data also support a hypothesis that other Bay Area watersheds dominated by urban and atmospheric sources can be managed to meet the target. It is presently difficult to predict if watersheds contaminated by mining wastes such as the Guadalupe River can be remediated and managed to meet the target but this should be a focus of future efforts.

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ECOLOGICAL SURVEYS OF NON-NATIVE AQUATIC SPECIES IN THE SACRAMENTO-SAN JOAQUIN DELTA

The ongoing invasion of the Sacramento-San Joaquin Delta (Delta) by non-native aquatic species (NAS) continues to threaten species protected under federal and state Endangered Species acts as well as the overall diversity and integrity of this ecosystem. The Delta is susceptible to ongoing and increasing introductions of non-native aquatic species from many pathways including ballast water releases from ships traveling to area ports. The Nonindigenous Aquatic Nuisance Prevention and Control Act of 1990, and its reauthorization in 1996 (renamed the National Invasive Species Act; NISA), provides for conducting ecological surveys in waters that are considered highly susceptible to invasion by aquatic nuisance species resulting from ballast water operations or other operations of vessels.

Specific areas of interest identified in NISA include San Francisco Bay, Chesapeake Bay, Honolulu Harbor, and the Columbia River system. As part of this effort, the U.S. Fish and Wildlife Service (FWS) Aquatic Nuisance Species (ANS) program has also funded a two-phased ecological survey for the Delta. Phase I was completed in May 2005, and included a literature review of NAS in the Delta, a database format to store, organize and present this information, and analysis of the sources, vectors, and time-sequence of introductions of both estuarine and freshwater NAS currently found in the Delta. Phase II involves field verification of the literature review and surveys of under-sampled habitats identified during Phase I. The ANS program, through the FWS Stockton office, has also funded similar ecological survey work in San Diego Harbor. All of these efforts compliment ongoing NAS survey work by California Department of Fish and Game Oil Spill Prevention and Response program (OSPR; see OSPR poster at this conference), and other marine work conducted by the San Francisco Estuary Institute.

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PHOSPHATE OXYGEN ISOTOPE RATIOS AS A TRACER FOR SOURCES AND CYCLING OF PHOSPHATE IN NORTH SAN FRANCISCO BAY

A seasonal analysis assessing variations in the oxygen isotopic composition of dissolved inorganic phosphate (DIP) was conducted in the San Francisco Bay estuarine system, California. Isotopic fractionation of oxygen in DIP (exchange of oxygen between phosphate and water) at surface water temperatures occurs only as a result of enzyme-mediated, biological reactions. Accordingly, if phosphate demand is low relative to input and phosphate is not heavily cycled through the biomass, the oxygen isotopic composition of DIP will reflect the isotopic composition of the source of phosphate to the system. Such is the case for the North San Francisco Bay, which has been anthropogenically impacted and possesses high surface water phosphate concentrations. Variability in the oxygen isotopic composition of phosphate ($\delta^{18}O_p$) in the bay is primarily controlled by mixing of water masses with different $\delta^{18}O_p$ isotopic signatures. $\delta^{18}O_p$ values range from 11.4 ‰ at the Sacramento River to 20.1 ‰ at the Golden Gate. Deviations from the two-component mixing model for the North Bay reflect additional, local sources of phosphate to the estuary that vary seasonally. Most notably, large deviations from the mixing model are present at the confluence of the North Bay with the Napa River when river discharge was greatest. Furthermore, wastewater treatment plant effluent also appears to cause deviations from two end-member mixing, particularly during the dry season.

Because nutrient enrichment can have devastating consequences for estuarine ecosystems, identifying and understanding nutrient inputs and their impact on estuarine systems is of critical importance for management and restoration of these ecosystems. These data suggest that $\delta^{18}O_p$ can be an effective tool for identifying phosphate point sources and understanding phosphate dynamics in the San Francisco Bay.

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FISH SPECIES ASSEMBLAGES IN SELECTED SALT PONDS AND SLOUGHS IN SOUTH SAN FRANCISCO BAY

Although intended mostly to benefit aquatic birds, salt pond restoration activities are also likely to influence resident and migratory fishes. This study was conducted to gain a better understanding of fishery resources inhabiting salt ponds and sloughs in portions of South San Francisco Bay that are currently undergoing restoration. Specific objectives were as follows: (i) to characterize fish species assemblages in the Alviso and Eden Landing salt pond systems, and (ii) if two or more species assemblages are present, to determine if they are associated with water quality or other environmental variables. Fish were sampled with gill nets, bag seines (salt ponds only), and minnow traps at roughly three-month intervals from March 2004 to June 2005. Altogether, we captured 12,392 fish representing 16 families and 20 species. Seining accounted for the highest numbers of fish (69%) even though this sampling technique was restricted to salt ponds (sloughs were too muddy for seining). By comparison, fewer fish were caught with gill nets (26%) and minnow traps (5%). Gill nets captured mostly topsmelt, northern anchovy, and leopard shark, whereas seines and minnow traps captured mostly rainwater killifish and longjaw mudsucker. Preliminary data analysis suggests that the species assemblage of salt ponds consists mostly of topsmelt, rainwater killifish, longjaw mudsucker, and yellowfin goby, whereas the species assemblage of sloughs consists mostly of topsmelt, northern anchovy, leopard shark, and striped bass. The abundance of longjaw mudsucker was directly correlated with pH and salinity, whereas the abundances of American shad, striped bass and northern anchovy were inversely correlated with these two variables. On the other hand, the abundance of striped bass was directly correlated with water depth. Results from this study will be used to better manage water quality for fish and wildlife resources in existing salt ponds and improve the design of new salt ponds as part of future restoration activities.

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BENEFITS OF MULTIPLE CONSERVATIVE WATER QUALITY CONSTITUENTS IN HISTORICAL AND FORECAST SIMULATIONS

In August 2004, in order to investigate possible causes of taste and odor complaints from South Bay Aqueduct water users, the Delta Simulation Model 2 (DSM2) was used to investigate the sources of water at the SWP's Clifton Court Forebay. At the time it was believed that a significant amount of the water reaching the South Bay Aqueduct was organic-rich water coming from the Jones Tract pump-off operations. DSM2 volumetric fingerprinting results were useful in aiding water quality experts access the possible sources of the South Bay Aqueduct taste and odor issues. Based on the usefulness of the model in identifying the sources of water reaching the SWP, DSM2 volumetric fingerprints were again used by water stakeholders to explain possible causes of abnormally high organic carbon concentrations in January and February 2005. By February 2005, DSM2 volumetric fingerprints, similar to those used in August 2004 and January and February 2005 were being incorporated into the MWQI weekly water quality reports as a semi-regular feature. In March 2005, two additional fingerprints, (1) source of EC at Clifton Court Forebay and (2) source of DOC at Clifton Court Forebay, were added to the weekly water quality reports in order to provide better insight into the relationship between source water and water quality at the SWP. This poster focuses on discussing the benefits of using comparisons fingerprinting and sources of water and mass in interpreting and understanding the modeling results of conservative water quality constituents and general circulation patterns in the Sacramento-San Joaquin Delta.

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A RAPID TRASH ASSESSMENT METHOD APPLIED TO WATERS OF THE SAN FRANCISCO BAY REGION: REGION-WIDE RESULTS OF SYSTEMATIC MEASUREMENT OF TRASH IN STREAMS

The Regional Water Quality Control Board, San Francisco Bay Region has recently developed and tested a methodology to systematically assess trash levels in water bodies and on adjacent stream banks. The regional Basin Plan prohibits discharge of rubbish and debris to waters of the state so that beneficial uses are not adversely affected by trash. When the Water Board received requests in 2002 to formally list certain water bodies as impaired by trash, no data were available to defensibly distinguish impaired sites from unimpaired sites. In response, the Surface Water Ambient Monitoring Program (SWAMP) of the San Francisco Bay Region has developed and piloted a rapid trash assessment methodology, refining the method through field experience and by conferring with representatives from local government and nonprofit groups. At selected sites trash is removed, counted, and categorized along a land-marked 100-foot section of stream. The site is scored according to three qualitative and four quantitative criteria: aesthetics, threat to aquatic life, threat to human health, number of trash pieces, and the source of trash—upstream, direct litter, or dumping. Categories include plastics, glass, paper, metal, fabric/cloth, construction debris, toxic, biodegradable, biohazard, and miscellaneous. Twenty-four regional sites were visited at least three times between Spring 2003 and Summer 2005. Each site was assessed and scored during dry and wet weather conditions, providing a quantitative estimate of trash return rates at different times of the year. Quantitative measurement of trash pieces, overall site scores, and field notes are useful methods to track trash characteristics and provide insight into the potential sources of trash. This method also helps to evaluate the effectiveness of trash cleanup and current management approaches at a specific site. We have learned that the number of pieces rather than pounds better represents the effects of trash on beneficial uses of waters. The rapid trash assessment methodology is an effective method of documenting trash in waters in various demographic and geographic locations in the San Francisco Bay Region, and may assist in setting priorities to reducing trash to the Estuary.

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SOURCES OF PYRETHROIDS IN URBAN RUNOFF

Pyrethroid insecticides are causing widespread toxicity to sediment-dwelling organisms (*Hyalella azteca*) in urban creeks draining to the San Francisco Estuary. These insecticides have many urban uses, including surface applications to control insects around buildings, on lawns, and in gardens, and underground injection to control termites. Rainfall and non-rain urban runoff washes a small portion of the pyrethroids applied to outdoor surfaces into urban creeks. (Urban runoff is the only urban discharge to San Francisco Bay Area creeks, as municipal and industrial wastewater treatment plants do not discharge to local creeks.)

An evaluation of urban pyrethroid products identified the following pyrethroids as priorities for water quality: bifenthrin, cyfluthrin and beta-cyfluthrin, cypermethrin, deltamethrin, esfenvalerate, lambda-cyhalothrin, permethrin, and tralomethrin. These pyrethroids differ significantly in their toxicity to *Hyalella azteca*—for example, bifenthrin is 21 times as toxic to *Hyalella* as is permethrin. Since their toxicity is cumulative (apparently additive), the use analysis looks at "permethrin equivalents" rather than total quantities. Using California Department of Pesticide Regulation pesticide use reporting, sales, and product label databases, pesticide user surveys conducted by the University of California Integrated Pest Management Program, other government reports, and scientific literature, the urban use of pyrethroids in the San Francisco Bay Area was estimated and evaluated to identify the major sources of pyrethroids in urban runoff.

Most Bay Area urban pyrethroid use is by professional applicators (this is true on the basis of total quantity as well as total toxicity-based permethrin equivalents). Most urban professional applications of pyrethroids are for structural pest control. Some professional structural pest control applications involve underground injection; however, these are not separately identified in California pesticide use reporting data. Product label information can be used to identify the minimum quantities of each pyrethroid applied to urban surfaces. Professional and consumer structural pest control applications are of particular interest, as these applications are the ones most likely to involve treatment of impervious surfaces (e.g., pavement and building surfaces), which have much higher pesticide washoff fractions than pervious surfaces (e.g., lawns and gardens).

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ASSESSING IMPACTS OF ANTHROPOGENIC CONTAMINANTS ON SEDIMENTARY MICROBIAL COMMUNITIES AND ORGANIC MATTER COMPOSITION IN SOUTH SAN FRANCISCO BAY USING ORGANIC GEOCHEMICAL TECHNIQUES

Aquatic environments on the west coast of the United States have been subjected to increasing pollution pressure due to rapid population growth over the past century. Near-shore coastal and estuarine sediments are important repositories for organic contaminants, whose fate and effect relate directly to ecosystem health and function. The microbial community plays a critical role in the recycling of organic material, including organic contaminants. The objectives of this project are to examine spatial and temporal changes in the health and diversity of sedimentary microbial communities and changes in organic matter (OM) sources to estuaries, as inferred from chemotaxonomic indicators and stable isotopes, in response to environmental changes and contaminant loading.

We focus on a sediment core [1.2 m length] from South San Francisco Bay, a highly urbanized estuary that receives urban and agricultural runoff and wastewater discharge. We measured downcore profiles of total organic carbon (TOC), nitrogen (N), delta13C and delta15N of bulk organic matter and several classes of current use, legacy, and emerging contaminants [e.g., carbamates, anilines, triazines, organophosphates, DDT/DDD/DDE, chloracetanilides, pyrethroids, PAHs]. We found temporal environmental and ecological changes over recent decades [data ranges: TOC = 1 – 3 %, N = 0.1 – 0.2 %, d13C = -24 – -27‰, delta15N = 4 – 9].

In addition to baseline isotope and contaminant data, we are beginning to assess the impact of anthropogenic contamination on microbial populations and other OM sources through the use of lipid biomarkers. Examples of these molecular tracers include organic compound classes such as aliphatic hydrocarbons, fatty acids and sterols. We are in the process of determining biomarker distributions in the core, and relating these to the concentration profiles of organic contaminants to determine if changes in the microbial community composition can be linked to contamination and/or changes in OM sources.

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CAN ECOLOGICAL FUNCTION BE RESTORED TO CENTRAL VALLEY FLOODPLAINS? A CONCEPTUAL MODEL

Floodplains in the Central Valley provide numerous ecological benefits including essential habitat for several species of concern, such as Sacramento splittail and Chinook salmon, and are a potential source of biologically available carbon for downstream ecosystems including the Sacramento-San Joaquin delta. Thus improving the ecological function of floodplains is emerging as an important component of regional restoration strategies. To aid these efforts, we have developed a conceptual model that describes the linkages between physical (hydrologic and geomorphic) processes and ecosystem processes and responses. Central to this model is the role of hydrological variability in driving topographic diversity, ecosystem heterogeneity and ecological processes on the floodplain. We attempt to capture the extremely complex linkages between hydrological variability and ecosystem response through 'representative floods.' A representative flood encompasses a set of hydrological variables -- such as frequency, duration and magnitude -- which produces a characteristic suite of ecological benefits on floodplains that are hydrologically connected to river flows. For example, relatively infrequent, high magnitude floods drive extensive geomorphic change upon the floodplain, creating topographic and, ultimately, ecological diversity. Frequent, long duration flooding in the spring provides spawning and rearing habitat for native fish and promotes high biological productivity which can be exported to rivers and downstream ecosystems. These relatively frequent and low magnitude floods were historically common and may have provided significant contributions to the productivity of Central Valley lowland rivers and the Sacramento-San Joaquin delta. Restoration of the full range of ecologically functional floods may therefore contribute to the recovery of threatened species and ecosystem processes.

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ELEVATION RANGES FOR SALT MARSH PLANTS IN SOUTH SAN FRANCISCO BAY

Changes in the topography and ecology of the San Francisco Bay Estuary during the past 200 years have resulted in the loss of nearly 79 percent of the historic salt marshes in the region. Currently, numerous projects are being undertaken by Federal, State, and local governments in an attempt to restore wetland habitat and ecosystem function in a number of areas within the Estuary. To ensure successful restorations, there is a need for Bay-specific data concerning the elevation ranges where different species of salt marsh plants can grow.

This poster describes previously unpublished vegetation and elevation data collected in 1983 by the California State Lands Commission at three historic salt marshes (Corkscrew Marsh, Bird Island, and Palo Alto Baylands) in South San Francisco Bay. During these surveys, marsh-surface and tidal-channel elevations were measured at 962 stations by three-wire leveling to established tidal benchmark stations at each site. The elevations were referenced to Mean Lower Low Water (MLLW), relative to the National Tidal Datum Epoch (1960-78). The presence/absence of nine salt marsh species (*Atriplex patula, Jaumea carnosa, Spartina foliosa, Distichlis spicata, Limonium californicum, Salicornia virginica, Deschampsia cespitosa, Frankenia salina*, and *Grindelia stricta*), percent plant cover, and percent bare soil were recorded for square meter quadrats at 648 stations.

These highly precise and detailed elevation and plant surveys represent a snapshot of South Bay salt marsh flora before invasion by the Atlantic smooth cordgrass, *Spartina alterniflora*. Such precise elevation data are rare for relatively undisturbed marshes in San Francisco Bay and it is our hope that presentation of these historic data may facilitate wetland restoration efforts.

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SEDIMENT TRANSPORT TRENDS IN WATERSHEDS OF THE SAN MATEO PENINSULA

Sediment production and its eventual deposition is a major concern for fishery health and the maintenance of reservoirs and downstream channels. Multi-year measurements of sediment transport in several regionally-significant watersheds draining the eastern slopes of the San Mateo Peninsula provide a basis for assessing both short- and long-term inter-annual variations in transport rates and establish a framework for comparing spatial differences in these rates. Comprehensive data sets for Corte Madera Creek and Los Trancos Creek are reviewed and analyzed in light of underlying geomorphic and hydrologic considerations for the entire period from the last substantial ENSO event in Water Year 1998 through Water Year 2005. Simultaneous quantification of bedload and suspended load in conjunction with ongoing stream gaging at these sites shows total annual sediment loads that vary over several orders of magnitude within each watershed. Comparisons are made with similar data sets collected for Bear Creek (in the same watershed), the Gazos Creek watershed draining the western slopes of the Peninsula, and for San Geronimo Creek in western Marin County, demonstrating order of magnitude differences on an inter-watershed basis. Additionally, annual transport rates are expressed as landscape lowering rates to place the data in the context of the geologic-timescale uplifting that frames overall sediment generation and movement in these systems.

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SOUTH BAY SALT POND RESTORATION - WATER QUALITY

The South Bay Salt Pond (SBSP) Restoration Project provides a unique opportunity to restore habitat for a wide variety of biota. However, there are also several water quality concerns which need to be closely considered. The primary water quality concerns are mercury and dissolved oxygen (DO). Methylmercury (MeHg) is bioavailable and can accumulate in the food chain. Historic mining upstream of the area, contaminated sediments, and atmospheric deposition may provide a source of mercury from which mercury methlyation can occur. While the factors that control mercury methylation are not fully understood, wetlands are known to be significant sites of microbial methylation. Low DO levels have also been measured in managed ponds during the implementation of the Interim Stewardship Plan (ISP) for the salt ponds. This concern will continue to be considered and monitored.

Multiple factors affect these water quality issues. It appears that designing restoration projects to minimize these effects could be an option. For example, DO levels can be increased by encouraging circulation within the restoration area. Since mercury methylation is an anaerobic process, this could in turn decrease MeHg. Restoration design could incorporate aeration devices, structural design components, or other systems to increase circulation, increase DO, and minimize MeHg. The ability to hydraulically control water within the system should increase the control over several factors affecting water quality. For example, an abundance of organic matter may increase mercury methylation. It may be possible to influence methylation processes that are a function of organic matter.

The SBSP Restoration Project incorporates the restoration of over 15,000 acres within San Francisco Bay. Due especially to the restoration's large size, water quality issues associated with the restoration could be significant to the San Francisco Estuary. Adaptive management will play a significant role in adjusting the design to best address these water quality issues. Project actions will be phased, allowing for time to study the effects of the restoration and its design. These studies will provide knowledge as to how future restoration actions can be adjusted to better address water quality concerns and further the success of the SBSP restoration as a whole. This project will also provide information that can be applied to the design and implementation of future tidal marsh restoration projects throughout the San Francisco Bay Delta Estuary.

The SBSP Restoration Project is a collaborative effort with contributions from PWA, Brown and Caldwell, H.T. Harvey and Associates, EDAW, the U.S. Geological Survey, PRBO Conservation Science, and the SBSP project. It is supported by funds provided by the California State Coastal Conservancy and the Hewlett, Packard, and Moore Foundations.

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COMPARATIVE VEGETATION DEVELOPMENT IN DIFFERENT AGED BRACKISH TIDAL WETLANDS ALONG THE LOWER NAPA RIVER, SAN FRANCISCO ESTUARY, CALIFORNIA

A central goal of wetland restoration is the establishment of self-sustaining, functional ecosystems. Our research focused on one aspect of restoration success, plant community composition and structure, in a series of brackish tidal marshes along the Napa River in northern San Pablo Bay. Species richness and distribution were recorded in spring of 2004 and spring of 2005 at two restored marshes, Bull Island and Pond 2A, and one reference marsh, Coon Island. Bull Island is 25 years old and was once diked and used for farming, and Pond 2A was converted from a salt pond 9 years ago. At each site, an average of 250 randomly chosen points was visited and the cover classes for all plant species located within a circular plot with a 3m radius was recorded. Multivariate and cluster analyses were conducted to identify patterns in species association and distribution within and between marshes. Analyses indicated three principal vegetation groups: saline high marsh, brackish middle marsh and freshwater low marsh. Axis 1 scores significantly correlated to this salinity gradient. Richness increased significantly from low to high marsh at both Bull Island and Coon Island, but not Pond 2A. Species richness of the reference marsh, Coon Island, was found to be higher than that of Bull Island, 30 versus 24 species respectively. Only 17 species were sampled at Pond 2A. Aside from these differences in species number, sampling also disclosed a substantial difference between the distribution patterns of diversity on these three tidal islands. Diversity at Coon Island was concentrated along the margins of interior tidal channels and to a lesser degree in the marsh interior. Conversely, species diversity at Bull Island was largely found along upland levee edges and on former dredge spoil deposits near levee margins away from channels. This pattern was similar for the more species impoverished flora of Pond 2A. Further, much of the species diversity at Bull Island and Pond 2A consists of weedy non-native species or more common upland native species (e.g. *Baccharus pilularis*). These findings suggest that a number of native tidal wetland species require particular kinds of habitats that are not being spontaneously generated in restored tidal wetlands in the upper Napa River, at least at time scales approaching 25 years. Future tidal wetland restoration efforts may need to consider the habitat requirements of less common species and attempt to engineer features that may promote the needs of these species if restoring full plant community composition and structure is a desired goal.

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SEASONAL WETLAND DESIGN USING A SIMPLIFIED SOIL MOISTURE ACCOUNTING MODEL, BERKELEY MEADOW, BERKELEY, CALIFORNIA

Compensatory wetland creation is used to mitigate impacts associated with proposed filling of existing wetlands. The Berkeley Meadow compensatory mitigation project included creation of 3.25 acres of seasonal wetland and enhancement of 2.5 acres of existing wetlands. The mitigation project was implemented to offset fill impacts to a pre-existing 2.4 acre wetland in Oakland, California. Site-specific monthly water balance computations were used to evaluate feasibility and develop the seasonal wetland design. Refined water balance computations were coupled with an evaluation of direct precipitation and surface runoff contributions from the surrounding 19.1 acre watershed area. Ponding in the new wetlands was projected to extend from January through March for an average rainfall year. Soil saturation and surface ponding potential was assessed based on a soil moisture accounting model which tracked changes in soil moisture in the rooting zone. Mass balance techniques and water levels were used to determine projected flows through the interconnected wetland cells. The water balance was computed using inflow, outflow, precipitation, and potential evapotranspiration. The research involved a one year study to develop the final design and quantify projected performance of four constructed seasonal wetlands with regard to hydrology, water quality, and habitat quality. The created seasonal wetlands were designed and built in 2004. Staff gauges are currently being used to monitor hydrology in each wetland. The results of the water balance modeling for the sandy-clay loam soil indicated that ponding and/or saturated soil conditions could be achieved for a duration of approximately four months (December through March) during an average rainfall year. Modeled ponding depths throughout the modeled year ranged from 0-15 inches. Follow-up monitoring conducted during the first winter and spring following construction (2004-2005) have confirmed that projected water levels and the overall wetland hydrology criteria have been achieved to date.

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PINOLE CREEK WATERSHED SEDIMENT SOURCE ASSESSMENT: A SEDIMENT BUDGET APPROACH HIGHLIGHTING WATERSHED-SCALE SEDIMENT-RELATED PROCESSES AND SUPPLY TO THE BAY

In local watersheds throughout the Bay Area, landowners, stakeholders, agencies and regulators are facing many watershed-scale sediment-related issues such as excess sediment supply, degraded water quality, degraded aquatic habitat, and reduced flood conveyance. However, it is often difficult to attribute sediment to its source, whether it is from natural geologic processes, land use and management, or a combination of both. The development of a sediment budget allows for identification of sediment sources, and the estimation of magnitudes and rates of sediment supply from each of the sources to the channels. This information is key in determining solutions for controlling sediment inputs and improving management practices to address these sediment-related issues.

The San Francisco Estuary Institute in conjunction with the Contra Costa County Resource Conservation District and the USDA Natural Resources Conservation Service conducted a sediment source assessment in the Pinole Creek Watershed, western Contra Costa County, during Water Year 2004. Through mapping and field data collection, we are able to identify and characterize sources and relative magnitudes of sediment supply and storage. Sediment transport is estimated through discharge and suspended sediment measurements.

The three most dominant sediment sources in the watershed are active landslides, active gullies, and road-related sources. Sediment supply is a reflection of the naturally-erosive underlying bedrock geology overprinted with the historic and modern land management and land use. Sediment storage is occurring primarily in alluvial fans, colluvial hillslope deposits, and in fluvial terraces. Sediment is largely transported as suspended sediment, with concentrations ranging between 5.7 – 13,238 mg/L. For Water Year 2004, suspended sediment export is calculated as 252 t km^{-2}, approximately 2.5 times greater than the Bay Area average, but vastly less than other watersheds (> 1,500 t km^{-2}). Once reaching the lower watershed, virtually all of the suspended sediment is transported through the flood control channel and into San Pablo Bay.

After development of the sediment budget, and reconciliation of unquantified terms and errors, the results allow us to highlight the dominant sediment-related processes, and implement better management practices that reduce the supply of sediment to the channels. Also, because watersheds such as Pinole Creek are significant contributors of sediment to the Bay, the results provide additional data for estimating the supply of sediment to the Bay from these small local watersheds.

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SAN FRANCISCO BAY JOINT VENTURE HABITAT PROJECT TRACKING SYSTEM

The goal of the San Francisco Bay Joint Venture (SFBJV) is to protect, restore, increase and enhance all types of wetlands, riparian habitat and associated uplands throughout the San Francisco Bay region to benefit birds, fish and other wildlife. The SFBJV (www.sfbayjv.org) helps partners put habitat restoration, acquisition and enhancement projects on the ground by connecting them with the funding opportunities, information and resources they need to make projects happen. There is an exciting new tool available that will greatly enhance the conservation efforts of the SFBJV and it's partners.

Working with the SFBJV, Ducks Unlimited staff has created a comprehensive, yet user-friendly habitat project tracking system that will help the SFBJV with their facilitation role and help the partnership track regional progress towards the goals defined in *Restoring the Estuary*, the SFBJV Implementation Strategy. This database system holds information on habitat projects - acquisition, restoration, enhancement, monitoring, and associated education and outreach projects. A GIS section allows partners to map projects, perform queries and generate jpeg maps to save for use in reports and presentations. Thanks to the extensive partner input through a series of reviews and demonstrations, this system is designed to meet JV partner needs and be easy to use and update.

Partners and interested parties access project information through an interactive online user-interface. Users can view project lists based upon a number of different parameters, including activities, habitats, water regimes, species, county, and legislative district. Partners can instantaneously complete and update project details through the online editing section in order to provide up to the minute information to partners, including existing and potential project funders.

The system provides the following benefits: the ability to easily generate project maps and reports; information that can assist with project planning; a forum for better networking and information sharing; a forum for sharing project information with potential funders; and many other valuable tools and resources. The GIS functions give users the abilities to: view surrounding land uses, features, and projects; perform various queries; map and measure project sites; and much more.

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ACUTE AND SUBLETHAL EFFECTS OF LAMBDA CYHALOTHRIN ON EARLY LIFE STAGES OF CHINOOK SALMON

Little is known about the toxic effects of pyrethroid pesticides on early developmental stages of salmon. In California, pyrethroids are applied to agricultural crops year-round, but storm runoff occurs during winter and spring, when Chinook salmon embryos, alevins, and fry are rearing in the San Francisco Bay-Delta Estuary. This study is designed to measure the acute and sublethal toxicity of lambda-cyhalothrin, a pyrethroid pesticide, to salmon embryos and fry, and mimic semi-realistic exposure scenarios that may be encountered by early developmental stages of salmon in California. Research objectives are to elucidate and quantify the links of cellular indicators of exposure, stress proteins, and effect, with organism development, growth and survival.

LC_{50} experiments have revealed that lambda-cyhalothrin was more toxic to fry than to embryos. No effect on mortality, hatching success, and larval survival was observed when embryos were exposed to concentrations ranging from 0.3—5.0 ug/l (nominal) during an 96-hour, static renewal LC_{50} experiment. The 96-hour LC_{50} for fry was 0.15 ug/l (nominal). Stress protein analyses were conducted in several tissues of surviving fry. Elevated stress protein (hsp) concentrations were found in muscle (hsp70 and hsp90), brain (hsp70) and gill (hsp90) tissues.

Recently completed experiments included exposing Chinook salmon fry to multiple 2-h pulses of lambda-cyhalothrin at a sublethal concentration (2 ug/l). Following exposure, groups were transferred to clean water and reared for 6 weeks post-hatching to determine if pulse exposures of lambda-cyhalothrin affected growth. Stress protein analyses (hsp60, hsp70, hsp90) will be conducted for brain, muscle and liver tissues using Western blotting techniques following pulse exposure experiments. Growth rate and condition and hepatosomatic indices will be determined following the growth experiment.

This study will provide regulatory agencies and resource managers with information to assist in the assessment of environmental risk and the development of improved environmental quality standards thereby reducing the risk of future pesticide exposures to Chinook salmon populations.

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GEOMORPHIC FIELD-BASED METHODS FOR ASSESSING THE IMPACTS OF HYDROMODIFICATION ON STREAM CHANNELS

Balance Hydrologics developed geomorphic field-based methods for assessing existing impacts and predicting future impacts of hydromodification on stream channels that discharge to San Francisco Bay. The term "hydromodification" refers to changes to the natural streamflow hydrograph due to watershed disturbances and changes in land use, particularly urbanization. The increase in impervious area coverage and drainage density associated with urbanization reduces infiltration of rainfall and increases the peak rate and volume of runoff to local streams. These changes can negatively effect stream channel morphology, including causing reach-wide erosion of the streambanks and down-cutting of the channel bed, resulting in transport of significant volumes of sediment from upland areas downstream to the bay and estuary system.

Balance Hydrologics conducted sediment transport studies and geomorphic surveys in two different San Francisco Bay watersheds: 1) the Thompson Creek subwatershed of the Coyote Creek watershed, in eastern Santa Clara County; and 2) the Laurel Creek watershed in southern Solano County. The purpose of the field work was to compare sediment transport rates and channel conditions in urbanized (lower) and un-urbanized (upper) portions of the watershed.

Balance staff installed several continuous-recording stream gages along the main stem and tributary channels of the two watersheds and conducted stream reconnaissance surveys to evaluate channel stability and identify areas of active, reach-wide erosion. During water years 2003 through 2005, we measured streamflows and collected samples of suspended and bedload sediment at all stations to estimate sediment discharge rates. These data were also used to estimate the volume and size distribution of sediment entering and passing through the watersheds, to evaluate bank stability related to sediment transport findings, and to compare sediment transport findings between the two studied watersheds.

Preliminary results for the Thompson Creek subwatershed suggest that most of the sediment transported at the lower end of the subwatershed originates in urbanized areas along the main stem of Thompson Creek, rather than from the upper watershed. This finding is supported by numerous field observations of reach-wide incision and bank erosion in the urbanized reaches. There was less difference in sediment transport rates between the upper and lower watershed stations in the Laurel Creek watershed, presumably due to less urbanization and a more robust riparian corridor, which strengthens streambanks and provides greater resistance to hydromodification effects.

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"KEEP THE DELTA CLEAN. YOU PLAY IN IT. YOU DRINK IT TOO!" PROGRAM

The Sacramento and San Joaquin Delta (Delta) supplies drinking water to two thirds of the State's population, irrigation water for over 7 million acres of farmland, provides critical wildlife habitat and supports many recreational activities, one of the most popular being boating.

To protect the Delta's precious resources and to accommodate its rapidly growing urban and boating populations (currently 170,400 registered boats), the Contra Costa County Public Works Department (County) is partnering with the California Coastal Commission (Commission) and the Department of Boating and Waterways to implement a Proposition 13 (State Water Resources Control Board) funded program, "*Keep the Delta Clean. You Play in It. You Drink it Too!"* (Program). The Program supports the efforts of the State Water Resources Control Board and the California Bay-Delta Authority by using education and pollution prevention to preserve and protect drinking water quality, recreational activities and environmental health in the Delta. The main program highlights are listed below.

Establish Pollution Prevention Infrastructure at Five Pilot Marinas: The program is currently working with five pilot marinas in the Delta (Sugar Barge Marina, Discovery Bay Yacht Harbor, Lauritzen Yacht Harbor, Lazy M Marina, and Bethel Harbor) to establish pollution prevention policies and infrastructure including sewage pumpouts, Used Oil Recycling Centers, fish cleaning stations, pet-waste collection points, leak-proof dock boxes, and refuse/recycling systems. The drop-off centers will accept used motor oil and filters, oil absorbent bilge pillows and pads, marine batteries, and empty oil bottles from boaters and the general public.

Public Education and Outreach: The Program launched an extensive outreach program including the following elements:

- 10,000 Sacramento – San Joaquin Delta Boater Kits will be distributed during the 2005 and 2006 boating seasons and surveys collected to obtain information on boater's behaviors. The kits contain a variety of useful promotional boaters items and educational information focusing on promoting clean and safe boating behaviors. Boater kits will be distributed at special events and marinas by Program staff and Delta Dockwalkers (volunteers, trained by the Commission and County staff, who train boaters and other recreators about safe and clean boating).
- 18,000 Sacramento – San Joaquin Delta Recreational Boating Maps will also be distributed in the Boater Kits and at marinas to promote environmental services, Certified Used Oil Collection Centers, marinas participating in the Absorbent Pad Exchange Program and other general marina services. The reverse side of the map colorfully displays important clean and safe boating tips.
- The Delta Chapter, of the statewide California Clean Boating Network is local forum of government, environmental, marine business, boating and academic organization working to increase and improve clean boating efforts in the Delta.

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SAN PABLO BAY WATERSHED RESTORATION PROGRAM – PROMOTING REVITALIZATION OF THE WATERSHED'S WETLANDS, RIVERS, LAKES, AND STREAMS, AND IMPROVING THE HEALTH OF SAN PABLO BAY

Congress identified the San Pablo Bay watershed under Section 503 of the Water Resources Development Act (1996) as one of thirteen watersheds nationwide that should be targeted for restoration. Important to the biological health of San Pablo Bay is the condition of streams that make up the San Pablo Bay watershed: San Pablo Creek, Las Gallinas Creek, Miller Creek, Novato Creek, Petaluma River, Sonoma Creek, and Lower Napa River. Environmental improvements for these streams have become the focus of many local groups. This interest has facilitated the creation of the San Pablo Bay Watershed Restoration Program, a collaboration of local, state, and federal organizations all focused on watershed improvements for the region.

The San Pablo Bay Watershed Restoration Program is an effort to restore the ecological vitality of the San Pablo Bay watershed. There are many opportunities to revitalize streams, rivers and wetlands in this large, northern San Francisco Bay region, and the Watershed Restoration Program (WRP) creates a framework to promote its rejuvenation. The WRP provides technical and financial assistance to individuals, nonprofit organizations, and local agencies wishing to engage in ecological restoration projects. The primary sponsors of the WRP include the U.S. Army Corps of Engineers and the California Coastal Conservancy.

The WRP has provided support to local sponsors including (1) the Friends of Gallinas Creek to conduct a restoration feasibility analysis and restoration design of urban portions of the creek; (2) the Marin Audubon Society to complete a Black Point Antenna Site investigation; (3) the Sonoma Land Trust to complete a levee stability analysis, phase I ESA's, and a remediation cost estimate for it's Sears Point property; (4) the Sonoma Ecology Center to produce its Sonoma Creek Threshold Limiting Factors Analysis; (5) the Oakland Museum to assist with creek and watershed mapping; and, (6) the Urban Creeks Council to provide hydrologic assistance on Pinole Creek..

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SALT MARSH HYDROLOGICAL AND ECOLOGICAL PERFORMANCE INDICATORS 10 YEARS AFTER RESTORING TIDAL ACTION

The San Leandro Shoreline Marshlands (SLSM) were diked bayland areas where tidal action was reintroduced in 1994. The SLSM enhancement project was a typical wetland mitigation effort for the time and had "success criteria" based on qualitative hydrologic, vegetation and wildlife response. The performance standards were met by 1999, after much fluctuation in vegetation type and coverage and in sampled populations of salt marsh harvest mice. The authors returned to the SLSM's "North Marsh" area in 2004 to re-assess how the marsh was functioning at its most important and basic level: the structure and stability of excavated tidal channels and mudflats.

We compared channel cross sections to as-built conditions, used water depth data loggers to chart inundation, and compared 2004 and 1994 aerial photographs at different tidal levels. Lastly, we repeated vegetation sampling along permanent transects set out in 1994. The excavated channels have developed a configuration much closer to natural conditions, with gradual transitions along banks and in their upland termini.

Channel surveys indicated that morphology had evolved from simple, engineered forms to ones resembling natural slough channels. Most importantly, the post restoration channel network has increased in length and extent. Tidal channels are 60 percent longer than in 1994 and in a pattern of complex brachiation, as well interconnecting with the pre-1994 drainage channels. In association with the channels we observed development of mud flats not present in 2000. A comparison of vegetation along the permanent transects over time illustrates the processes that produced this result: an early decrease in halophytes as extensive areas were flooded, followed by a recolonization that has achieved equilibrium with open tidal flats. The acquired habitat complexity, although vulnerable to invasion by non-native cordgrass, is both natural and beneficial to fish and wildlife. SLSM and similar projects can be expected to provide long-term benefits to the overall health of the estuary system.

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S.T.R.A.W. STUDENTS AND TEACHERS RESTORING A WATERSHED: A PROJECT OF THE BAY INSTITUTE

The STRAW Project coordinates and sustains a network of K-12 teachers, students, and community members as they plan and implement watershed projects leading to habitat restoration. In the 2004-2005 school year, almost 70 teachers and 1450 students received training and support in environmental project-based learning, watershed curriculum, scientific advice and support, training to integrate the arts, bird research and aquatic insect monitoring, and restored 8250 linear feet of creek bank.

STRAW completed 22 restoration days this year, with 60 classes participating. Twelve of these restorations occurred on ranches with Prunuske Chatham, Inc. (the ecological consulting firm that helped to found the Shrimp Project, the precursor of STRAW) facilitating the preparation and training for restoration. Our work on ranches included planting willow sprigs and planting native plants from containers (such as valley oak, buckeye, alder, juncus and more). STRAW students are trained to create biotechnical restoration structures such as willow wattles and willow walls to address more severe erosion problems. The Marin Resource Conservation District facilitates these restoration projects as they help landowners preserve and restore the health of their land.

Liz Lewis and her staff from the Marin County Stormwater Pollution Prevention Program (MCSTOPPP) facilitated 9 urban creek restorations with STRAW. The work included removing non-native plants such as French broom, English ivy and Himalayan blackberry, and planting native plants such as coyote bush, willow and honeysuckle along creeks in nearby parks and neighborhoods. Restoration also involves many other partners such as the Marin Conservation Corps and County, State and National Park staff.

Seventeen classes worked with Sarah Warnock, Education Director of the Point Reyes Bird Observatory (PRBO), to implement a bird component called the STRAW Bird Project. Students completed field guides, studied bird songs and learned how to successfully identify birds as part of their watershed studies. Many classes went to PRBO's Palomarin Bird Station to observe PRBO staff using the mist nets to gather data about birds. PRBO staff accompanied many STRAW classes on their restoration days, providing mini-workshops to students. PRBO monitors most of the restoration sites, finding that the restored sites had many more species of birds. For example, at the Gale Ranch in Marin County, the unrestored area had 8 species of birds while the restored area had 22 species.

STRAW staff and partners visit classes and provide training in the areas of aquatic insect studies and water quality testing. A typical unit on aquatic insects usually includes a day of classroom review about aquatic insects and their significance in the creeks, and a field day in the creek to identify and view the insects up close. Water quality studies involve chemical tests of water samples to determine the water quality of the creek. Common tests include: dissolved oxygen, temperature, pH, conductivity, turbidity, and nutrients. Our work in Marin and Sonoma counties improves the health of the Bay.

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META-ANALYSIS OF WEST STANISLAUS COUNTY PESTICIDE MONITORING STUDIES: GIS SITE SUITABILITY ANALYSIS FOR AGRICULTURAL BEST MANAGEMENT PRACTICES

The organophosphate pesticides chlorpyrifos and diazinon are used to maintain high levels of agricultural production in West Stanislaus County. Irrigation and storm water runoff carries some of the applied pesticides into surface waters, where water quality in the San Joaquin River and Delta can be impaired. New water quality regulations now require agricultural surface discharges to be monitored and management practices implemented to achieve water quality objectives. Agricultural Best Management Practices (BMPs) such as constructed wetlands, vegetated ditches, and sedimentation reservoirs are a tool used by dischargers to meet water quality criteria.

> Our metadata analysis of West Stanislaus County combines historic monitoring, pesticide application, agricultural land use, rainfall, and stream flow data to identify "hotspots" where BMPs could have the greatest impact on non-point source pollution. An exhaustive search was made for data from river and stream samples analyzed for chlorpyrifos and diazinon collected in Stanislaus County, west of the San Joaquin River. Agricultural activity, including crop patterns and pesticide use, has been well documented, making West Stanislaus County highly suitable for a meta-analysis and ultimately a Geographic Information System (GIS) mass balance model.

Previous studies have largely focused on pesticide loads from dormant orchard spraying coupled with winter rain events. Many monitoring studies were of short duration without sampling on consecutive days. A more complete picture of year-round pesticide occurrence was created by compiling all available monitoring data collected over a twelve year period. The data set included nearly 4000 individual chlorpyrifos and diazinon measurements collected from five sites on the San Joaquin River and six sites on tributary creeks. Pesticide concentrations were analyzed at each site for temporal trends. At Orestimba Creek at River Road and San Joaquin River at Crows Landing, pesticide load was calculated with available stream flow data. Daily sampling at sites on Orestimba Creek allowed for calculation of four-day average concentrations.

Monitoring conducted on Orestimba Creek at River Road was the most comprehensive. Of the 191 samples which exceeded the California Department of Fish and Game's Criterion Continuous Concentration (CCC) of 0.014 □g/L chlorpyrifos, 67% were in the dry summer season. This result contrasts with reports that winter pesticide applications are the most significant source of pesticide runoff in this region. Our meta-analysis technique is useful for the design of future monitoring programs and site selection for new BMPs.

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UTILIZING DIFFERENTIAL QUANTITATIVE MAPPING TECHNOLOGIES AND TRADITIONAL BOTANICAL KNOWLEDGE TO ASSIST BRAZILIAN WATERWEED MANAGEMENT IN THE SACRAMENTO-SAN JOAQUIN DELTA

Understanding how and why submerged macrophyte cultures of Brazilian waterweed (*Egeria densa*) react to management efforts throughout growing seasons in the Sacramento-San Joaquin Delta (SSJD) is key to realizing the best methodology to use in regulating and/or eradicating invasive growth. The semidiurnal tidal flux and significant turbidity of the SSJD waters has historically rendered empirical measurements of *Egeria* coverage and biovolume unreliable. A recently developed suite of assessment technologies, applied for the first time in Delta waters in 2003, has helped provide a breakthrough in solving this problem. Digitally recording acoustic measurements of submerged vegetation yields a very rapid, verifiable characterization of the entire water column beneath the transducer. Combining DGPS-linked tidal-corrected acoustic transects with underwater photographic surveillance and traditional physical point sampling techniques provides the most complete picture to date of submerged vegetation conditions in the Delta. Eighteen sites in the central Delta have been monitored since 2003 for submerged vegetation species, health, biomass, biocoverage, and biovolume. The goal of this ongoing monitoring approach is to better measure the efficacy of aquatic herbicides on Brazilian waterweed. Fifteen sites have been treated with aquatic herbicides and three sites serve as non-treatment controls. Each site is visited three-to-five times throughout the year depending on factors such as active ingredient used (fluridone, copper, diquat), site location, treatment approach, and treatment schedule. Acoustic analysis reveals the bottom coverage and biovolume of submerged plants. Sampling also consists of concurrent underwater photography and physical point sampling at each site to inventory plant species and health. Efficacy is determined by comparing the aggregation of acoustic-based statistical surface models of coverage and biovolume, photographs, and physical data at each treated site with control sites. The 2003 and 2004 results have *strongly* contributed to refinements in treatment approaches and monitoring.

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HABITAT MAKES A DIFFERENCE: METHYL MERCURY EXPORT FROM TWO WETLANDS ON TWITCHELL ISLAND.

Wetland ecosystems provide habitat to many species and perform multiple functions in chemical and hydrologic cycles. In the Bay-Delta, however, they are major contributors of methyl mercury to the system. Considering that over 5,500 hectares of wetland restoration is planned for the Bay-Delta, it is important to evaluate which aspects of wetland design affect methyl mercury production. The sediment-water flux of methyl mercury in two 2.7 hectare experimental ponds on Twitchell Island was examined from June 2003 to the summer of 2005. The adjacent ponds had different vegetation densities, depths, and hydrologic conditions. In late spring, the methyl mercury flux from the west pond reached 41 ng m^{-2} d^{-1} while the flux from the east pond was 3 ng m^{-2} d^{-1}. If restored wetlands are similar to the west pond with respect the methyl mercury production, they could contribute a significant amount of methyl mercury to the Bay-Delta. Conversely, wetlands that are similar to the east pond could contribute far less methyl mercury.

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THE CALIFORNIA WATER AND ENVIRONMENTAL MODELING FORUM: PROMOTING EXCELLENCE AND CONSENSUS IN WATER AND ENVIRONMENTAL MODELING

Water is one of California's most valuable and coveted natural resources. Competition among user groups (urban, agricultural, environmental, and recreational) coupled with the ongoing need to ensure water quality has made water management an increasingly complicated, controversial task. Stakeholders and policy makers now seek quantitative analyses based on data and computer-generated analytical tools (models) to better understand and help resolve water resource and environmental problems.

In the past, stakeholders often developed their own models independently, with little input from policy managers, the end-users of modeling results. At the same time, there was little discussion between modelers and technical experts to resolve methodology differences or to address discrepancies in model results analyses. Consequently, conflicting results presented in water rights hearings and other proceedings have been difficult to resolve.

Recognizing that credible technical analysis is vital to successful collaboration and consensus, a group of water industry professionals teamed up in 1994 to establish the California Water and Environmental Modeling Forum (CWEMF). This non-profit, non-partisan organization is dedicated to improving the usefulness of models for analyzing California's water-related problems with emphasis in the San Francisco Bay-Delta watershed. By establishing an open forum to exchange ideas and pool professional resources, CWEMF actively fosters a cooperative atmosphere among modelers, water stakeholders, and policy makers. As part of its mission, the CWEMF offers the following services to its members:

- Facilitates open, constructive discussion of conflicting opinions on physical, chemical, biological and economic modeling;
- Conducts problem-solving workshops to address technical disagreements;
- Organizes technical training and educational workshops on a wide range of water resources and environmental issues;
- Coordinates model development, refinement, and use through interagency model user groups; and
- Orchestrates and manages impartial peer reviews of models to document strengths and weaknesses, suggest improvements, and identify appropriate applications.

CWEMF members include engineers, biologists and economists from over 45 water organizations representing federal, state and local governments, universities, environmental organizations, private consultants, water user agencies and the general public.

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NON-DESTRUCTIVE METHODS FOR ESTIMATING PRODUCTIVITY OF DOMINANT VEGETATION IN TIDAL MARSHES OF SAN FRANCISCO BAY, CALIFORNIA

The study focused on developing highly reliable but non-destructive methods for measuring productivity of dominant plant species in tidal wetlands of northern San Francisco Bay. This research is part of the Integrated Regional Wetland Monitoring Program (IRWM), a multidisciplinary project providing detailed investigation of ecosystem processes in the northern San Francisco Bay. Four marshes were chosen that varied in seasonal patterns of substrate salinity. Three were located along the Napa River and one just west of the confluence of the Sacramento and San Joaquin Rivers. All sites are tidal, but the seasonal peaks in salinity range from close to freshwater to nearly seawater levels. At the end of the growing season in 2004, multiple 0.25 m^2 plots were established in stands of the following species: *Scirpus maritimus, S. americanus*, *S. californicus*, *S. acutus*, *Typha angustifolia, T. domingensis*, and *Salicornia virginica*. Not all of the species were sampled at each site. Three methodologies were tested against harvested biomass: leaf area index (LAI) measured with a LiCor LAI 2000, average plant height, and individual plant height and stem density. Within each plot, the leaf area index (LAI) and average height per species were measured, and all standing biomass was collected. In the lab, the samples were sorted by species and, for all *Scirpus* spp., the stem density was counted and plants sorted according to 10 cm height classes. All plants were dried and weighed to determine biomass. Average plant height had no significant relationship with biomass, regardless of species. A significant positive relationship occurred between LAI and biomass for *S. virginica, S. virginica/S. maritimus* mixed plots, and both *Typha* species (R^2 ranging from 0.71 to 0.81). LAI was not strongly related to biomass for the *Scirpus* species; however, both stem density and height were significantly correlated to biomass for all four species (R^2 ranging from 0.81 to 0.96).

These results suggest that accurate non-destructive sampling methods can be developed to estimate species-level productivity. Further testing and modification of these methodologies is occurring during the 2005 growing season, including a more in-depth investigation into *S. virginica* productivity, and site-level productivity estimates will be calculated based on vegetation maps, incorporating natural and restored sites in northern San Francisco Bay and the western Delta. Productivity is a key variable to an understanding of nutrient dynamics in the San Francisco Estuary and developing non-destructive sampling techniques is important for gaining insight into this variable while minimizing impacts on tidal wetland habitats. This could be of great importance to future long term monitoring of the health of the San Francisco Estuary.

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RETHINKING FLOOD CONTROL IN THE LOWER WALNUT CREEK WATERSHED IN CONTRA COSTA COUNTY

The Walnut Creek watershed in central Contra Costa County experienced a rapid transition from its agricultural roots to a suburban future in the 1950 and 1960's. To accommodate the transformation the Contra Costa County Flood Control and Water Conservation District (Flood Control District) and the US Army Corps of Engineers (Corps) built substantial flood protection infrastructure along Walnut Creek and many of its tributaries. These facilities protected existing and new communities from flooding, but also obliterated the natural creeks and associated riparian habitat. Now the Flood Control District and the Corps are working together to reassess flood control options within the lower five miles of Walnut Creek. The goal is to optimize the restoration of wetlands, water quality, wildlife habitat, flood protection, aesthetic resources, and recreational opportunities within the lower Walnut Creek watershed.

Building upon the 1992 "Walnut Creek Channel Recreation and Revegetation Plan", developed through a multiple stakeholder planning effort, the Flood Control District and the Corps are reevaluating the design of the Corps-built flood control facilities. Options under consideration include:

- Breaching and/or relocating portions of the existing levee system to include additional floodplains near the mouth of the creek. These floodplains and tidally influenced areas will then be restored to create additional wetlands, wildlife habitat, and stormwater capacity.
- Construction of flood walls in areas where levee setbacks are impossible due to adjacent development. The floodwalls will increase capacity to allow for more riparian vegetation, such as cottonwoods at the top of bank, to grow along the stream.
- Removal of silt from sections of the creek to restore flood capacity. Some silt bars are more than 15-feet tall and have significantly reduced the channel's stormwater conveyance capacity.
- Restoration of fish and other aquatic wildlife habitat, including creation of fish passage over the first of many drop structures to allow anadromous fish to migrate further upstream.
- Restoration of a remnant section of Walnut Creek to enhance wildlife habitat, water quality, and recreational opportunities.

The Corps and the District are currently analyzing the hydrology and the sediment loading of the overall Walnut Creek watershed as well as the salmonid habitat to determine the spawning potential within the lower reaches of the creek. Once these and other issues have been thoroughly studied (estimated to be another five year process), the Corps and the District will narrow and identify restoration options that will address the issues and meet the project goals. With luck and continued federal funding, the construction of these restoration efforts should commence by 2015.

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CULTURAL SENSITIVITY IN THE EXPANSION OF A NEEDED STORMWATER DETENTION BASIN

The communities along the lower reaches of Tice Creek in Central Contra Costa County have experience flooding even during moderate storm events (5 – 10 years in frequency). After the latest flood event in December 2002, the community had had enough. The Contra Costa County Flood Control and Water Conservation District (Flood Control District) had previously studied flood protection options within the Tice Creek watershed and the options were difficult. Either expand the capacity of lower Tice creek by widening the creek, causing the destruction of the natural riparian habitat and possible removal of entire rows of houses, or expand a detention basin in a location upstream known to have had previous occupation by a Native American tribe, the Saklans. The community chose the latter option and the Flood Control District promised the community to expand the detention basin located at the entrance of the Rossmoor retirement community within two years.

The Flood Control District hired David Chavez and Associates to conduct exploratory excavations within the area slated for expansion. These initial test pits revealed two discreet sets of human remains, indicating the potential for a complex archaeological site. The scope of the excavation was beyond what David Chavez and his firm were prepared to handle at that time, so the Flood Control District hired another firm, William Self Associates, to conduct the full-scale resource recovery archaeological excavation. The excavation, initiated in late spring, continued throughout the construction of the detention basin expansion. The contract for the expansion of the detention basin stipulated special conditions regarding excavation techniques to protect cultural resources and human remains (no digging more than 6 inches deep at a time and no “teeth” used in the excavating equipment) and a Native American representative monitored the project during both construction and archaeological excavation. Exposure of cultural resources and/or human remains stipulated work stoppage at that location to allow for full recovery of the finds.

The archaeological site indicates continuous occupation of the area for approximately 5,000 years, unique cultural features seen nowhere else, and 27 human burials. Disturbance to additional burials was avoided through a partial redesign of the basin. All of the burials were removed from the site with great care, washed by descendants of the tribe, and have been reinterred, along with the cultural artifacts associated with the burials (the grave goods), at a location within the completed detention basin that will not be subject to future disturbance. The more unique cultural features that are not directly associated with the burials may join the collections at the Archaeological Studies Center at Sonoma State University to be available for future research.

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PRESERVING AND RESTORING CREEKS AND PROVIDING FLOOD PROTECTION IN PLEASANT HILL, CA

Contra Costa County Flood Control and Water Conservation District, the City of Pleasant Hill, the United States Army Corps of Engineers, and many other partners are developing a watershed-based plan to preserve and restore existing natural creeks and riparian areas and provide relief from chronic flooding for citizens within the Grayson and Murderers Creek watershed within Contra Costa County. Residents within the watershed are flooded even during moderate storm events. The Federal Emergency Management Agency recently added 800 parcels (mostly homes) to the 100-year floodplain, requiring homeowners to pay expensive flood insurance. Traditional flood control programs would convey stormwater, but at an unacceptable environmental cost of the loss of natural creeks and their associated riparian area. Innovative and collaborative solutions were required to solve the flooding problems, while protecting and restoring the natural creek habitats.

The City of Pleasant Hill (City) and the Contra Costa County Flood Control and Water Conservation District (Flood Control District) joined forces with other partners including the Mount Diablo Unified School District, the City of Walnut Creek, Contra Costa County, Pleasant Hill Recreation and Park District, and local citizens to form a task force to develop and identify options for ecologically-sustainable flood protection. The task force developed eleven options and prioritized the top three. All involve allowing minor to moderate storm events to continue to flow through the existing creek system to ensure its continued hydrologic function along with an array of restoration efforts along the natural creeks. Each option outlines the use of existing and new stormdrain networks underneath existing or planned roadways to transport excessive flows to one or more detention basins and then to previously constructed flood protection facilities. The basin(s) would also provide recreational opportunities to the local schools and residents in form of multi-use ball fields.

Both the City and the Flood Control District have also been working with the US Army Corps of Engineers (Corps) to determine if federal funding is possible for these flood protection improvements. The Corps is evaluating the costs and the benefits, in financial, ecological, and social terms, of the proposed array of improvements. As these federal studies are completed, the City, the Flood Control District, and all of the other partners will be able to develop a comprehensive financing plan to implement the flood protection improvements and creek enhancements. Estimated costs are approximately $35 million with a proposed commencement of construction in 2010.

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POTENTIAL DEGRADATION OF WATER QUALITY BY BIRD FECES IN AND AROUND MANAGED WETLANDS

The South San Francisco Bay salt pond restoration is a multi-faceted project with a major goal of habitat restoration – particularly habitats that support resident and migratory birds. Another restoration goal is to provide public access and recreation in the project area. Parts of the Alviso ponds, a publicly accessible section of the Don Edwards National Wildlife Refuge within the project area, are currently home to year-around bird residents and large numbers of seasonally migrating or wintering waterfowl.

Bird feces carry fecal indicator bacteria [FIB; specifically total coliforms (TC), *Escherichia coli* (EC), and *Enterococcus* (ENT)] identical to the FIB in human waste. Although FIB are not pathogens, epidemiological data indicate that exposure to FIB during recreation in water has been correlated with an increased risk of various diseases, including gastrointestinal and respiratory illnesses. Although these studies were conducted in sewage- and urban runoff-polluted waters, not specifically in bird feces-polluted waters, such waters may also pose a threat to human health. There are a number of enteric zoonoses that potentially can be transmitted from birds to humans, including salmonellosis and campylobacterosis (etiologic agents *Salmonella* spp. and *Campylobacter* spp., respectively), which have been isolated from bird feces that were deposited along wetlands in southern California.

Because of the large, seasonal bird populations in the Alviso pond system and the fact that some of the Alviso ponds now discharge to sloughs, there is potential for the discharge to be of a reduced quality, as indicated by FIB. In addition, recreation on or around the ponds creates a potential route of human exposure to FIB and zoonoses by way of slough and pond water.

Preliminary sampling for FIB in October 2004 demonstrated that at least one sample from every Alviso pond tested (A3W, A5, A7, A9, and A10) exceeded the California State single sample marine recreational contact standards (REC-1) set for the FIB - TC, EC and(or) ENT. In addition, two samples collected from Alviso Slough exceeded the standards for all three FIB.

Further study is required to elucidate the relationship between bird use of these wetlands and FIB concentrations. Our continuing research is designed to answer the following questions: 1) Do the FIB concentrations in the ponds vary seasonally with bird use? 2) Are these ponds potential sources or sinks of FIB to San Francisco Bay or to other specific recreational areas? 3) Are zoonoses present in the ponds that could be detrimental to human health? The answers to these questions will allow us to understand how bird use can affect water quality in the ponds and the potential need for regulation of public access around the ponds or pond discharge to the sloughs, based on FIB concentrations.

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FISHERIES AND AQUATIC HABITAT COLLABORATIVE EFFORT: AN INNOVATIVE APPROACH TO RESOLVING A WATER RIGHTS COMPLAINT THAT BALANCES WATER SUPPLY OPERATIONS AND PROTECTS FISHERIES FOR THE STEVENS CREEK, COYOTE CREEK AND GUADALUPE RIVER WATERSHEDS.

This poster features the resulting settlement characteristics that balance water supply and fisheries protection interests in three South Bay stream systems. SCVWD manages Santa Clara County' s wholesale drinking water supply, coordinates flood protection and serves as the steward for the counties streams. In July of 1996 a water rights complaint was filed against SCVWD with the State Water Board. The complaint alleged that the SCVWD did not operate their reservoirs to be protective of fisheries, particularly steelhead and Chinook salmon.

Instead of going to court, SCVWD worked with CA Department of Fish & Game to establish a collaborative process to negotiate a settlement that was acceptable to all of the parties. This collaborative effort was called the Fisheries and Aquatic Habitat Collaborative Effort or FAHCE.

Representatives of 4 regulatory agencies, the SCVWD, the 5 groups that filed the complaint and the City of San Jose worked together for five years in the FAHCE process to evaluate all the technical issues- both scientific and operational—required to produce the draft *Settlement Agreement*. In March of 2003, a draft *Settlement Agreement* was initialed by all parties. Environmental documents are currently being prepared to take the complaint back to the State Board for final resolution.

The settlement program formally folds together the stream's environmental and water supply functions. The agreement includes new operational rule curves for seven of SCVWD's reservoirs. These rule curves provide for distribution of available water to adequate depth and temperature in designated reaches to allow for salmonid spawning and rearing. Extensive modeling was conducted to determine the length of the designated reaches that could be provided over a range of most wet and dry years. The agreement also specifies habitat restoration to increase the biotic potential of the streams. The agreement incorporates a multi-faceted balance between water supply, water temperature, spawning gravels, riparian cover, geomorphic evaluation and improvements to fish passage.

In the draft *Settlement Agreement,* SCVWD commits to spent $42 million for each of three 10-year periods after the complaint is resolved to the satisfaction of the State Board. In the urbanized areas that ring San Francisco Bay, innovative techniques such as FAHCE provide a mechanism for balancing the interests of providing and delivering adequate water supply to our human populations and protecting anadromous fisheries.

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DECKER ISLAND HABITAT DEVELOPMENT/LEVEE IMPROVEMENT PROJECT

The Decker Island Habitat Development/Levee Improvement Project offers a rare opportunity to develop habitat that existed prior to dredging the Sacramento River and provides material necessary for levee reinforcement on several western Delta Islands. Decker Island is approximately 20 feet above sea level because of spoils that were deposited on the original marshland when the Sacramento River was dredged and straightened at Horseshoe Bend between 1917-1937. Exotic weeds and grasses developed on the dry, upland site, providing little habitat value. The project's two phases developed 26 acres of fish and wildlife habitat at the northern tip of Decker Island. Phase I was completed in December 2000 and created approximately 13.5 acres of habitat while providing material for Delta levee improvement projects. Phase 2 was constructed in 2004 and created 12 additional acres of similar habitat. The material excavated from Decker Island was barged to various islands including Twitchell, Bradford, Jersey and Webb Tract providing proximately 600,000 cubic yards of material to improve threatened levees.

Decker Island habitats consist of a vegetated terrace and uplands with deep primary channels cut through the Island and open to Horseshoe Bend. The terrace and uplands were constructed to an approximate elevation of +2 to 7 feet and the channel depths to -3.5 to -7 feet to ensure that water is present during low tide. These elevations were determined based on results of completed habitat development projects in the Delta and consultation with the Department of Fish and Game, United States Fish and Wildlife Service, and the National Marine Fisheries Service. Trees, shrubs, and other vegetation have been planted in the excavated areas on Decker Island. The Project creates a mosaic of different habitats with varying vegetation canopy layers, vegetation type edges, and water/land interfaces. The Project restores tidal perennial aquatic, tidal freshwater emergent, valley/foothill riparian, upland scrub, and grassland habitats. Together, these habitats are designed to function within the Delta's natural hydrodynamic processes.

The project enhances estuarine habitats thereby meeting "the net habitat improvement" mandate of the SB34/AB360 program. Additionally, the Project's levee integrity, water quality, water supply reliability, threatened and endangered species, and local land use protection benefits are consistent with the objectives of the California Bay Delta Authority, CVPIA, Regional Water Quality Control Board, as well as the State and federal Endangered Species Acts.

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INTEGRATED REGIONAL WETLAND MONITORING PILOT PROJECT – OVERALL PROJECT PURPOSE

Problem Statement: Regional tidal marsh restoration efforts aim to support and recover populations of plant, fish and wildlife species. These ecological support functions follow successful establishment of a variety of ecological processes in restoration projects. In order to understand the effectiveness of tidal marsh restoration efforts regionally, we must determine which processes are in fact important to establish and the means by which we can measure and quantify these processes.

Approach: The California Bay-Delta Authority Science Program's Integrated Regional Wetland Monitoring Pilot Project (IRWM) utilizes a five-element strategy. (1) IRWM is multi-disciplinary, intensive monitoring program covering physical processes, landscape ecology, vegetation, birds, fish, invertebrates, primary production, and nutrients. (2) IRWM established a series of core and component conceptual models that describe the current state of knowledge and define a suite of hypotheses. (3) IRWM developed sampling and data QA/QC and management programs to test these hypotheses, to develop data sets to address the ecological process question, and to evaluate different approaches to restoration monitoring. (4) IRWM selected a suite of six sites (four restoration and two natural) spanning the western Delta to San Pablo Bay based on set of criteria tied to the conceptual models. (5) IRWM will integrate results across disciplines and thereby begin to address the fundamental ecological process question.

Results: IRWM initiated field sampling in fall 2003 and will complete its sampling in fall 2005. Team specific posters and presentations of initial results are presented as part of the 2005 State of the Estuary conference. IRWM methods and results, including data, aerial imagery, GIS and mapping products, are posted for the public at www.irwm.org as data are finalized.

Conclusions / Relevance: IRWM will contribute an essential strategic element to tidal marsh restoration monitoring in the Bay and Delta in support of ongoing public investment in land acquisition and restoration.

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IRWM PHYSICAL PROCESSES MONITORING IN RESTORED AND REFERENCE TIDAL MARSHLANDS

The California Bay-Delta Authority Science Program's Integrated Regional Wetland Monitoring (IRWM) Pilot Project is a multi-disciplinary, intensive monitoring program covering physical processes, landscape ecology, vegetation, birds, fish, invertebrates, primary production, and nutrients. The IRWM Physical Processes Team (PPT) conceptual model serves as one of two core IRWM models. This model proposes: (1) estuarine salinity gradient, inundation regime, and sediment supply are fundamental external forcing functions on tidal marshes, and (2) these forcing functions, in combination with baseline site conditions, affect tidal marsh restoration trajectories.

To test this hypothesis and in support of work by other IRWM teams, we deployed equipment and instrumentation to measure a number of physical parameters considered indicators of physical processes driving abiotic and biotic marsh evolution. Autonomous monitoring instruments within the main channel entering each site measure conductivity, temperature, depth, and suspended sediment concentration (CTDS stations). Sensors at several marsh plain locations measure water level and temperature. We installed piezometers (pore-water salinity) and conducted topographic surveys and soil sampling (Total N, Total C, grain size, organic matter, and bulk density) in conjunction with the Plant Team sampling efforts.

We have begun generating a variety of analytical products to describe hydroperiod (inundation regime), salinity regime and sediment supply. Initial analyses focus upon temporal trends in water quality and hydrologic data, we will subsequently characterize physical processes metrics based upon marsh elevation and geomorphology. Statistical analyses will be used to determine within and between marsh variation and to assess the importance of these different parameters in driving biotic and abiotic marsh evolution. These data are complimentary to other data we are collecting on geomorphology and sediment chemistry.

The IRWM physical monitoring will yield a suite of data collection and analytical methods applicable throughout the region and it will support the understanding, in conjunction with all the IRWM teams, of the role of external forcing functions in affecting tidal marsh associated ecological processes at multiple scales.

For more information on monitoring efforts and results visit www.irwm.org.

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INVASIVE SPARTINA CONTROL STRATEGY: ADAPTIVE MANAGEMENT TO MINIMIZE IMPACTS TO THE ENDANGERED CALIFORNIA CLAPPER RAIL

Four non-native species of *Spartina* ("cordgrass") have invaded the San Francisco Estuary. Documented impacts of the *Spartina* invasion include the conversion of tidal flats to high marsh, loss of shorebird foraging habitat, alteration of marsh hydrology, and possible local extinction of native *S. foliosa* due to the emergence of an extremely fertile *S. alterniflora x foliosa* hybrid swarm. In 2000, the State Coastal Conservancy established a regionally coordinated partnership, the Invasive Spartina Project (ISP), in an effort to eradicate non-native *Spartina* from the San Francisco Estuary and restore native marsh habitat. The endangered California clapper rail (*Rallus longirostris obsoletus*) is a tidal marsh-dependent bird whose distribution is restricted to the San Francisco Estuary. The native *S. foliosa* is a critical component of clapper rail habitat, but the rail also occupies habitat dominated by the non-native *S. alterniflora* and hybrids. In fact, recent surveys found that the most highly invaded areas in Central and South San Francisco Bay had some of the highest clapper rail densities in the region.

The ISP, working with USFWS, developed a method of quantifying temporary impacts to marsh habitat that may be caused by removal of non-native cordgrass, and assessing whether these impacts will affect California clapper rail populations. In areas where temporary impacts were found to be potentially significant to clapper rail, the ISP is developing special control strategies intended to reduce those impacts. Depending on location, control strategies may include phasing cordgrass removal over a number of years, strategically planting native high marsh vegetation, or constructing new habitat features to improve value of the marsh to clapper rails. In coming years, the ISP intends to regularly collect and use clapper rail survey and habitat data to (1) evaluate the effectiveness of the *Spartina* control and clapper rail impact-reduction strategies, (2) improve understanding of clapper rail use of *Spartina* and the short-term effects of non-native *Spartina* removal on clapper rail populations, and (3) adapt each subsequent season's *Spartina* control strategy to improve efficacy and reduce undesired side effects.

The results of ongoing clapper rail studies associated with the ISP's *Spartina* Control Program will be valuable sources of information for other restoration activities in the San Francisco Estuary, by providing more detailed information than has been previously available on clapper rail habitat associations at several spatial scales.

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INTEGRATION OF FLUVIAL AND COASTAL FLOOD MANAGEMENT WITH WETLAND RESTORATION FOR THE SOUTH BAY SALT PONDS RESTORATION PROJECT

The proposed South Bay Salt Ponds Restoration Project (SBSP) provides an opportunity to comprehensively link coastal and fluvial flood management and wetland restoration within the South San Francisco Bay. Currently, flood protection is provided through individual fluvial flood control projects managed by local agencies (such as water districts) and indirectly through an existing salt pond levee system, which provides a measure of coastal flood protection. A number of creeks flow between the salt ponds (separated from the ponds by levees) before discharging to the Bay. The SBSP project proposes the restoration of former salt ponds to tidal wetland and open water managed for ecosystem benefits.

From a flood-management perspective, there are multiple approaches to reduce fluvial flooding: providing increased channel-flow conveyance and/or providing increased flood storage (detention). Conveyance and flood storage are provided by increasing the width or depth of the channel/floodplain system, providing additional cross-sectional area for flow. Removal or breaching and lowering of channel levees between the creeks and the ponds will allow tidal exchange between the ponds and the Bay via the associated channels, increasing flow velocities and the potential for channel scour. Scour and expansion of channel cross-sections will increase flood flow conveyance and thereby reduce upstream water levels/flood hazards.

Flooding impacts may also be reduced by providing temporary storage of floodwater within the ponds. Conversion of ponds to muted tidal or seasonal wetland with flood-flow diversion will increase storage of fluvial flood waters, decreasing in-channel water levels and reducing flood hazards in the tributary channel, an important consideration during very high tides.

The salt ponds and associated levees currently provide limited protection against coastal flooding by sheltering inland areas from direct wave attack and providing coastal floodplain storage when Bay waters overtop the salt pond levees. Restoration of tidal wetlands will reduce the coastal floodplain storage function of the ponds, but will provide flood management benefits by attenuating wave energy and reducing wave runup on new proposed flood protection levees landward of the ponds. Development of mudflats and marshes will provide natural wave breaks.

The integration of flood management and wetland restoration is key to achieving the SBSP project objective of maintaining or improving levels of flood protection. This study is supported by funds provided by the California State Coastal Conservancy and the Resources Legacy Fund in cooperation with the Packard, Hewlett and Moore Foundations.

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AVIAN USE OF A MANAGED POND: A CASE STUDY IN SOUTH SAN FRANCISCO BAY

Worldwide, salt ponds provide habitat for millions of nesting, foraging and roosting waterbirds. Within the United States, the San Francisco Bay area contains the most important salt pond complexes for waterbirds, supporting significant populations of both waterfowl and shorebirds during migration and the winter months. The current plan to restore tidal action to all or some of the existing salt ponds in the San Francisco Bay places an important emphasis on understanding the significance of managed ponds for migrant, wintering, and resident waterbirds.

We analyzed a decade of waterbird numbers at a managed pond to look at use by avian species and changes due to tide, season, pond water levels, and pond salinity. From these surveys, we know that large numbers of shorebirds, gulls and waterfowl used the managed pond for wintering and migratory stopover habitat. Preliminary analysis indicates that year, season, taxonomic grouping, and pond water level was important in determining the numbers and species of birds utilizing the managed pond. Our findings suggest that the Reach 1A waterbird pond functions similarly to other ponds located in the San Francisco Bay salt pond complexes with shorebirds and dabbling ducks as some of the most numerous species.

Sediment deposition, as a result of repeated seasonal flooding, has progressively silted in the pond basin and made it difficult to manage water levels and salinity regimes in the pond. This results in a draw-down of water levels during the summer months, causing islands with nesting birds to land-bridge and drying out the shallow foraging areas used by shorebirds.

The water intake system relying solely on variable monthly tidal cycles is unreliable. Adequate high tides often do not coincide with periods of warm weather, when water levels must be increased to compensate for evaporative water loss. At some point, the pond basin will have to be dredged to restore the deep-water habitat used by waterfowl and to prevent land bridging of the islands where avocets and mallards nest.
Active management of this pond, likely in perpetuity, is necessary to maintain both shallow and deeper water habitats for both waterfowl and shorebirds. These results stress the importance of management and long-term planning in all Bay-Delta restoration projects, and point to the importance of design and adaptive management for the salt pond restoration project.

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FISH-X_2 RELATIONSHIPS EXAMINED: A BEHAVIORAL PARTICLE TRACKING MODEL FOR SAN FRANCISCO ESTUARY

Previous work has shown that the abundance of starry flounder and *Crangon franciscorum* shrimp populations correlate with high freshwater flow conditions in the San Francisco Estuary. We are examining the possible physical mechanisms behind this by creating a behavioral particle tracking model to simulate movement of larval fish and shrimp within the estuary. The behavioral model is a Lagrangian computer simulation tracking the advection and dispersion of neutrally buoyant particles with biologically-determined vertical velocities. TRIM-3D hydrodynamic simulations supply the velocities and vertical eddy diffusivity for our model. The results of this model will aid in the design of the next phase of work to examine the mechanisms underlying positive relationships between fish and shrimp abundance or survival and freshwater flows, the "fish-X_2" relationships. This is of vital interest to the managers of California's water resources.

Flounder and shrimp migrate as larvae from outside the Golden Gate up to the Low Salinity Zone to rear. Since tidal currents are strong, we expect that larval swimming in the horizontal plane will have a negligible effect on where they end up. We are interested in how their axial migration may be influenced by gravitational circulation, which is strengthened in the lower estuary by high freshwater flows, or by the vertical swimming behavior of larvae. Vertical migration can influence the axial and lateral movements of larvae within the estuary through the interaction between tidally-varying vertical position of larvae and vertical variability in strength and direction of tidal and residual currents. These results are being compared to a null model in which particles are randomly distributed in the water column, or maintain a constant depth.

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BIOACCUMULATION AND CHRONIC TOXICITY OF DIETARY L-SELENOMETHIONINE IN JUVENILE WHITE STURGEON (ACIPENSER TRANSMONTANUS)

An 8-week growth trial was conducted to determine the sensitivity of juvenile white sturgeon to the toxicological effects of elevated dietary selenium (Se). Fish were fed diets supplemented with Se in the form of L-selenomethionine (Se-Met), resulting in dietary concentrations of 0.4, 9.6, 20.5, 41.7, 89.8, and 191.1 µg Se/g diet. The kinetics of Se accumulation and the effect of dietary SeMet on swimming activity, survival, growth, whole body proximate composition, and tissue pathology were determined.

A significant decrease ($p<0.05$) in swimming activity was observed in sturgeon fed 41.7-191.1 µg Se/g diet. Survival of sturgeon among treatment groups did not differ significantly throughout the growth trial with a mean survival rate of 99 ± 0.43% across all groups. Sturgeon fed ≥41.7 µg Se/g diet experienced significant ($p<0.05$) decreases in growth rate when compared to fish fed 0.4-20.5 µg Se/g diet. Whole body protein and lipid contents were negatively correlated with dietary Se concentrations while ash and moisture contents were positively correlated with dietary Se concentrations. Selenium accumulated in the kidney, liver, muscle, gill, gonad, and plasma in a dose-dependent manner, with the highest Se concentrations found in the liver and kidneys.

Histopathological alterations in the liver and kidneys were observed in sturgeon fed ≥20.5 µg Se/g diet. Liver lesions included glycogen depletion, hepatocellular vacuolar degeneration and necrosis, cystic bile ducts, and hepatocellular and bile ductural hyperplasia. Kidney lesions included tubular dilation, tubular cell degeneration and necrosis, and nephroselenosis with either eosinophilic or basophilic cast materials observed in the lumen.

The maximum dietary Se concentration to prevent chronic Se toxicity (<8 weeks) was estimated to be approximately 10 µg Se/g diet. Se concentrations in the food sources of wild white sturgeon in the San Francisco (S.F.) Bay-Delta are above concentrations that caused toxicity in white sturgeon in the present study. Increased loading of Se into the S.F. Bay-Delta would greatly increase the risk of Se toxicity in white sturgeon. Therefore, the disposal of the Se-laden irrigation drainage into the S.F. Bay-Delta does not appear to be a sustainable solution for managing the irrigation drainage from the Central Valley. Studies exploring the effects of Se toxicity in more sensitive life stages and the interactive effects between Se and other stressors are needed in order to determine if the proposed dietary threshold should be further reduced in order to minimize the potential for declines in the white sturgeon population of the S.F. Bay-Delta.

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EFFECT OF DIETARY METHYLMERCURY AND SELENIUM ON SPLITTAIL LARVAE

The consequences of methylmercury (MeHg) and selenium (Se) contamination of food webs in the San Francisco Estuary have received greatest attention in the past decade. Despite presence at very low concentration in surface water, MeHg and Se are reproductive toxicants that are readily bioaccumulated and biomagnified to sublethal or toxic concentrations in aquatic food webs. Dietary uptakes of MeHg and Se might be the major uptakes route in wild fishes. However, knowledge of the effect, either singly or combined, of MeHg and Se in native fishes of California is lacking. The objective of this study is to investigate the interactive effect of dietary MeHg and Seleno-Methionine on Sacramento splittail (*Pogonichthys amcrolepidotus*) larvae.

Twelve test diets containing three levels of dietary Se (0.4, 8 and 30 mg/kg feed), four levels of MeHg (0, 0.1, 5, or 10 mg/kg feed), and two replicates per diet treatment were fed to 21-d splittail larvae (40 fish/ replicate) for four weeks in 2-L beakers placed in an environmental water bath at 25°C. Fish were fed twice daily with a feeding rate of 40, 30, 25 and 20% of body weight per day during the 1^{st}, 2^{nd}, 3^{rd} and 4^{th} week, respectively. Survival, growth, MeHg and Se tissue concentrations, gross morphology, metallothionein and heat stress protein expressions, and histopathology are currently assessed.

Acute MeHg and Se toxicities, mortality, and impaired growth performance (as measured by body length, body weight, and condition factor) were not observed at the end of the 4^{th} week of dietary exposure. However, there was a significant positive response of MeHg and Se tissue levels in fish to dietary concentrations. When fed the highest levels of dietary Se, supplementation with dietary MeHg significantly increased Se accumulation in fish. In contrast, MeHg accumulations in fish fed medium and high MeHg decreased when fish were also fed medium and high levels of dietary Se. This result indicates antagonistic effects of MeHg and Se. An evaluation of the effect of dietary treatments on stress protein (HSP70) and metallothionein expressions and histopathology is in progress.

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ANALYSES OF CULLINAN RANCH WETLAND RESTORATION ALTERNATIVES

Hydrodynamic modeling and geomorphic analysis tools were applied to the Cullinan Ranch restoration project which is being proposed by the U.S. Fish and Wildlife Service. The objective of the project is to restore approximately 1,500 acres of diked baylands back to historic salt marsh habitat for the benefit of endangered species, as well as migratory water birds. The site is located in an area of the Napa River Delta that was historically defined by a network of meandering sloughs and extensive estuarine tidal marshes. Agricultural practices over the past century have resulted in subsidence by as much as six feet.

The acquisition of the Napa Sonoma Salt Ponds by the Department of Fish and Game, planned restoration efforts in the immediate vicinity (Pond 3 and American Canal), and closure of the Mare Island Naval Shipyard which has reduced the need for maintenance dredging of Napa River provided excellent opportunities for restoration of Cullinan Ranch and re-creation of tidal marsh habitat for endangered species and shorebirds.

State of the art numerical models in combination with geomorphic data and analyses were applied to formulate and analyze alternatives for the environmental documentation. Two dimensional hydrodynamic models were developed for the site and the Napa-Sonoma Marsh Complex. The restoration options were developed in a phased manner based on results of each successive modeling run. Restoration of the entire 1500 acre site was first analyzed, which produced significant tidal damping in the system coupled with high channel velocities. Geomorphic analysis tools were subsequently applied to estimate changes in channel morphology over time and resultant changes in tidal prism. Restoration options were developed to reduce these effects by adjusting size and location of restoration, varying the number and size of breaches, and widening Dutchman Slough near its mouth. Rates of sedimentation and anticipated sedimentation patterns were prepared based on a combination of model results and field data from other projects.

Study results show that the existing sloughs are inadequate to accommodate the large tidal prism as a result of the restoration. Integrating other restoration projects, such as Pond 3 (to the north of the site), with the Ranch project will reduce tidal damping in the system, and will allow for better circulation and predictability of marsh and channel evolution. The estimated time to reach high marsh elevations varied from 40 – 100 years for various restoration options.

The analysis and findings are relevant to the several other restoration projects which are envisioned in the San Francisco Estuary. It provides a method which integrates sophisticated analytical tools with experience from other projects (empirical) that could be used for other similar projects in the Bay.

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UNDERSTANDING AND REDUCING HUMAN EXPOSURE TO MERCURY IN THE CALIFORNIA DELTA WATERSHED

A study of blood mercury levels in U.S. women of childbearing age (NHANES) found that approximately 6% may be exposed to mercury at levels of health concern. This exposure is mainly due to consumption of fish. National health advisories recommend that women of childbearing age limit consumption of all fish, regardless of source, because of mercury contamination. In California, elevated levels of mercury have been found in the Sacramento-San Joaquin Delta, an area with abundant fishing and an ethnically-diverse population.

To improve our understanding of fish consumption practices of California women, the California Department of Health Services interviewed 500 women at a Women, Infants, and Children (WIC) clinic in the Delta. The survey was conducted in five languages with the assistance of WIC staff. The women were asked detailed questions about their commercial and sport fish intake, their awareness of health advisories about fish, and whether or not children in their household ate commercial and sport fish. Fish intake was high compared to that of women statewide. Nearly all women (95%) ate fish from commercial sources. Twenty-five percent reported eating more than the FDA advisory level of two meals of fish per week. Over 30% of women ate locally-caught fish. Consumption of locally caught fish was especially high in Asian and Pacific Islander (API) populations, with 13% of all API, and one quarter of all Cambodian participants, consuming above the EPA advisory of one meal a week for locally-caught fish. Only 30% of women were correctly aware of any health advisory for fish. Pregnancy status, ethnicity, age, and correct awareness of any health advisory are all significant predictors of fish consumption. These results will be discussed in further detail.

The findings from this survey are informing the California Department of Health Services' efforts to raise awareness about fish contamination in the Delta. These efforts include developing culturally-appropriate health education materials, convening a local stakeholder advisory group, and distributing mini-grants to community-based organizations that work with ethnic populations who may be at higher risk of consuming high levels of mercury in fish. Information gained from outreach to local fish-consuming populations is also helping to guide a three-year Delta watershed fish sampling and monitoring project (the "Fish Mercury Project" funded by CALFED). This project will result in new health advisories for the watershed that reflect actual fish consumption patterns.

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IMPACTS OF FIRE ON PLANT SPECIES DIVERSITY IN TWO BRACKISH TIDAL WETLANDS ALONG THE UPPER SAN FRANCISCO BAY ESTUARY

As tidal wetlands have disappeared in the San Francisco Bay Estuary, concern about the loss of species diversity in this region has increased. While large-scale wetland restoration focuses on the long-term recovery of these species, the dynamics that stimulate and maintain species diversity in the Estuary are poorly understood. These tidal wetlands are dominated by long-lived species in genera such as *Scirpus*, *Typha*, *Spartina*, and *Salicornia*. Restoration activities generally promote these dominants rather than less common, more specialized plants that are also part of tidal wetland assemblages. Two wetland sites, Brown's Island, a remnant historic wetland, and Lower Sherman Island, a naturally restored wetland, are located at the junction of the western Delta and eastern Suisun Bay in a species-rich, brackish salinity zone. In fall 2003, we used 162 burned and 196 unburned randomly-located 3-m diameter vegetation relevés to sample a large spring 2002 burn from Browns Island. In spring 2004, another fire burned a large area of Sherman Island. Similar random, plot-based surveys were conducted in burned and unburned areas, both before and after the burn. Based on these data, burned areas host significantly higher species diversity and enhance the frequency and abundance of one group of annual and short-lived perennial species. These species appear to opportunistically exploit the post-fire conditions of reduced thatch and increased nutrients. Dominant species in these areas survived, however, and are already returning to their former status. These findings suggest that fire could be used as a management tool to promote species diversity in restored and historic brackish tidal wetlands in the upper San Francisco Estuary.

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NITROGEN SOURCES AND CYCLING IN THE SAN FRANCISCO BAY ESTUARY: A NITRATE DUAL ISOTOPIC COMPOSITION APPROACH

Nitrate dual isotopic composition ($\delta^{15}N$ and $\delta^{18}O$) is used for the first time within the estuarine system of San Francisco (SF) Bay, CA. Spatial variability in the isotopes suggests multiple sources of nitrate (NO_3) to the Bay ecosystem including seawater, several distinct rivers and creeks and sewage effluent. The spatial distribution of nitrate from these sources is heavily modulated by the hydrodynamics of the estuary. Mixing along the estuarine salinity gradient is the main control on the spatial variations in isotopic composition of nitrate within the northern arm of SF Bay. However, due mostly to the long residence time during the summer study period, the nitrate isotopic composition in the southern arm of SF Bay exhibited a combination of source mixing and phytoplankton drawdown. Very low $\delta^{18}O_{NO3}$ values (as low as -6.1‰) at the Sacramento- San Joaquin River Delta region give rise to a wide range of $\delta^{18}O_{NO3}$ values in the SF Bay system. The range in $\delta^{18}O_{NO3}$ values is more than twice that of $\delta^{15}N_{NO3}$, suggesting that $\delta^{18}O_{NO3}$ is an even more sensitive tool for tracing nitrate sources and cycling than $\delta^{15}N_{NO3}$.

These results serve as a baseline for future studies of nitrate dynamics within the San Francisco Bay Estuary and further highlight the utility of nitrate dual isotopic composition for tracing this important contaminant in aquatic systems. Additionally, the use of the dual isotopic signature of NO_3 sheds light on water column N recycling processes. Furthermore, the spatial gradient in $\delta^{15}N_{NO3}$ is of particular use to ecologists using nitrogen isotopes in foodweb research and facilitates the inter-comparison of foodwebs within different regions of the ecosystem.

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SAN FRANCISCO BAY JOINT VENTURE HABITAT GOALS ACCOMPLISHMENTS

The San Francisco Bay Joint Venture (SFBJV), one of 14 habitat Joint Ventures nationally, is a Bay Area partnership of public agencies, environmental organizations, the business and agricultural community and local governments all working to protect, restore, increase and enhance the wetlands and watersheds of the San Francisco Estuary.

In 2001, the Joint Venture Management Board adopted an implementation strategy, based on the *Habitat Goals Report,* called *Restoring the Estuary,* with specific habitat goals for protecting over 200,000 acres of San Francisco Bay's tidal flats, marshes, lagoons and seasonal wetlands during a 20-year period. As of June 2005, Joint Venture partners have been responsible for the acquisition of nearly 40,000 acres of wetlands, representing almost half of our total acquisition goals. To date, of the 129,000 restoration and enhancement acres goal, only 6,000 have been realized.

The purpose of the poster is threefold:

1) To provide an assessment of detailed habitat accomplishments in comparison to targeted goals as they relate to each wetland habitat type;
2) To assess types of wetlands habitats that should be pursued through acquisition, restoration, or enhancement to further achieve established goals;
3) To state and acknowledge partner accomplishments and to state the case for ongoing support of wetland restoration and enhancement. The summary reflects over 70 completed wetland protection, restoration, or enhancement projects.

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BEAR CREEK WATER QUALITY STUDY, 1999–2002, WOODSIDE, SAN MATEO COUNTY, CALIFORNIA

Understanding existing surface water quality can assist local efforts to improve conditions for fish and other aquatic biota. From October 1999 through September 2002, Balance Hydrologics conducted a study of flows and water quality in the Bear Creek subwatershed, which forms the northwestern headwaters of San Francisquito Creek, where restoration of steelhead habitat has been the focus of substantial efforts over the past decade. Balance staff established three continuous-record stations and also monitored five partial-record stations in the Bear Creek subwatershed. We measured streamflows and collected water quality samples during both wet- and dry-weather conditions. Laboratory analyses showed only a single detection of the organophosphate pesticide, diazinon. Of the four metals analyzed (cadmium, copper, lead and zinc), dissolved copper concentrations exhibited a strong "first-flush" pattern, while dissolved lead was detected repeatedly only in Dry Creek, which receives large volumes of highway runoff. Nitrogen was detected primarily as nitrate, not ammonia, and varied spatially within the watershed. Suspended sediment discharge measured during high and intermediate flow conditions was typical of creeks in the San Francisquito Creek watershed. Water temperatures at all stations were regularly below the upper temperature threshold for optimal steelhead habitat. Balance staff continue to monitor streamflows and water quality at the downstream-most station on Bear Creek at Sand Hill Road, as part of the joint Stanford University-City of Palo Alto long-term monitoring and assessment program (LTMAP) network.

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DAILY MONITORING OF ESTUARINE WATER QUALITY (EUTROPHICATION AND PHYTOPLANKTON BLOOMS) IN SAN FRANCISCO BAY

To evaluate the state of water quality in the San Francisco Bay a number of monitoring studies (mostly state or federally organized) are in progress that use ship based measurements that are collected monthly. Few studies measure the water quality on shorter time scales and are real-time automated systems. For the last two years we have been making almost daily measurements of dissolved inorganic nutrients (nitrate, ammonium, silicate and phosphate), phytoplankton abundance (chlorophyll) and size spectra; with some of these parameters being measured continuously using automated sampling, in situ sensors and on-line instrumentation.

High concentrations of nutrients occur in the estuary, at non limiting eutrophic levels; with elevated ammonium levels probably from anthropogenic sources. This eutrophication (e.g. high DIN) does not result in the negative side effects common in other estuaries (anoxia and harmful algal blooms) but may instead negatively influence the food chain for sensitive upper trophic level organisms that rely on phytoplankton. SF Bay (and the Delta) are characterized by high nutrients, low growth where there exists other limits on phytoplankton growth and bloom development. Our daily data indicate that the relationship between ammonium levels and growth limitation may be linked. Seasonal phytoplankton blooms in spring and fall are accompanied by lower than average ammonium concentrations but high nitrate values. Nitrate drawdown follows, as first ammonium then nitrate is used for phytoplankton growth. The anthropogenic levels of ammonium likely inhibit access by phytoplankton to the high nitrate levels. Once these ammonium levels are reduced (as can be tracked with daily measurements), chlorophyll levels start to increase. The sources of the ammonium include waste water treatment plants (the product of secondary treatment) and agricultural practices; however these sources are magnified when precipitation is low and fresh water dilution effects are minimal.

These type of data provide an example of how daily and possibly hourly monitoring of the SF estuary and Delta can provide a more detailed view of water quality, eutrophication and phytoplankton processes for management purposes. The scientific and management implications of both collected data and future development of in situ real-time monitoring of water quality parameters could prove to be useful tools for state agencies (e.g. Regional Water Quality Boards, Department of Fish and Game). Our results are relevant to Bay-Delta Program goals and objectives as they support the use and development of science-based techniques to monitor water quality in SF Bay.

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THE DELTA MERCURY TMDL: REDUCING METHYLMERCURY IN FISH AND WATER

Section 303(d) of the federal Clean Water Act requires States to identify water bodies that do not meet their designated beneficial uses and to develop programs to eliminate impairments. States refer to the correction program as a Total Maximum Daily Load (TMDL) program. A TMDL is the total maximum daily load of a pollutant that a water body can assimilate and still attain beneficial uses. The Central Valley Regional Water Quality Control Board listed the Sacramento-San Joaquin Delta Estuary (Delta) as impaired by mercury because of the presence of fish consumption advisories. The Delta mercury TMDL program addresses the sources of two constituents, methylmercury and total mercury. The program focuses on methylmercury because statistically significant, positive correlations have been found between methylmercury levels in water and fish tissue in the Delta. The program also addresses total mercury because (1) methylmercury production has been found to be a function of the total mercury content of sediment and (2) the mercury TMDL control program for San Francisco Bay has assigned a load reduction of 110 kg/yr of total mercury to water leaving the Delta. The poster reviews the draft mercury TMDL for the Delta.

Key elements of the TMDL include: (1) definition of the extent of mercury impairment, (2) development of fish tissue methylmercury targets, (3) calculation of the mathematical linkage between water and fish methylmercury levels, (4) identification and quantification of methyl and total mercury sources, and (5) recommendations for source load allocation and implementation strategies. The methylmercury linkage and source analyses divide the Delta into eight regions based on hydrologic characteristics and mixing of the source waters. A hydrology-based methylmercury TMDL is proposed as it more accurately reflects concentrations and sources of methylmercury and the extent of fish impairment. Fish tissue concentrations are greater than recommended as safe by the USEPA and USFWS in all areas except the central Delta. Reductions in fish methylmercury levels required to meet the recommended numeric targets for wildlife and human health protection range between 1 and 80 percent. The linkage analysis predicts that reducing the annual average unfiltered methylmercury concentration to 0.07 ng/l will result in safe fish tissue levels. Methylmercury allocations for the sources in each Delta region are made in terms of the existing assimilative capacity of the different Delta regions. Total mercury allocations developed to meet the San Francisco Bay TMDL allocation to the Central Valley are made in terms of the largest sources of highly contaminated sediment.

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SPRING-SUPPORTED WETLAND AND RIPARIAN HABITAT, A CORE FOR MANAGING BEDROCK GROUND WATER

Wells drawing ground water from bedrock joints may provide adequate yields for municipal water systems but uncertainty as to the capacity of the aquifer is a risk which often constrains projects at both investment and permitting levels. Unlike sediment basins and alluvial valleys, predicting storage in fractured and jointed bedrock is inherently difficult to impossible, even with extensive field work and considerable data available for analysis. Conventional methods of modeling these aquifers may fundamentally be inapplicable or, when useful, have high levels of uncertainty..

Montara Water and Sanitary District is contending with a number of challenges unique to coastal water systems, especially those with aging infrastructure that rely on the collection of local ground-water supplies. The District has recently completed a bedrock well that unlike many other bedrock wells in San Mateo County is very high yielding and draws ground water from deep, regional joints in Montara Mountain, an aquifer that is only slightly developed. Several independent lines of evidence indicate that the well appears to draw on a large body and/or interconnected sources of ground water within the mountain, and nearly all of the contributing area has little or no potential sources of contamination.

One way of responsibly approaching the effects of well drawdown to the springs, riparian vegetation and wetlands in the vicinity of the well would be to limit drawdown at indicator sites to a level known to not be harmful to riparian species. Such guidelines were developed for similar granitic soils and alluvium along the Carmel River by the Monterey Peninsula Water Management District, which has used them successfully over the past 18 years. The guidelines have short-term as well as seasonal thresholds of significance for drawdown. Given that the highest drawdown rate occurs following the onset of pumping, the rate of pumping is to be ramped up gradually after June 1 to avoid exceeding short-term thresholds of significance, otherwise nominal effects are anticipated prior to this date when soil water is readily available. An adaptive management program is proposed, beginning with applying the guidelines, monitoring responses, and using the results to evaluate whether further drawdown might be tolerated. To implement this program, the District is monitoring shallow wells near springs and creeks, and developing a wetland and riparian vegetation monitoring scheme to assess drawdown responses while pumping the well. Additional monitoring is also proposed for outlying watersheds.

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METHYLMERCURY IN SAN FRANCISCO BAY SURFACE SEDIMENTS

Surface sediment samples (0-5cm) were collected for the San Francisco Estuary Regional Monitoring Program for Trace Substances (RMP) from sites distributed throughout the estuary in the summers of 2002 to 2004. Trace pollutants including mercury, methylmercury, and a suite of ancillary sediment parameters (TOC, TN, grain size, porewater pH, redox potential) were measured in the field or in the laboratory. Reports in the literature have shown correlations of MeHg to total mercury, TOC, and grain size (%fines) in sediments, some of the relationships examined in samples collected for the RMP. However, total mercury and TOC showed only weak relationships to methylmercury in RMP samples. Of the measured ancillary parameters, sediment total nitrogen and surface redox potential (Eh) were found to be among the factors most strongly correlated to methylmercury concentrations. The activity of sulfate reducing bacteria under anaerobic conditions is expected to produce the majority of methylmercury found in estuarine sediments, and the correlation of these parameters with sediment methylmercury support this expectation. These findings suggest options other than reducing total mercury concentrations for managing ecosystem methylmercury exposure.

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2004 INVASIVE SPARTINA PROJECT MONITORING PROGRAM RESULTS

The purpose of the 2004 Invasive *Spartina* Project Monitoring Program was (1) to assess the current distribution of introduced *Spartina* species in the San Francisco Estuary, (2) to quantify net acreage for each of four non-native *Spartina* species, (3) to determine the spread since the 2001 Estuary-wide inventory, and (4) determine the control efficacy at sites treated in 2003. The mapping project was a field-based effort, utilizing GPS units to collect location and ecological data for each found population of invasive *Spartina*. In addition to detailed field mapping, aerial photos and ground truthing were utilized to map highly infested marshes. Genetic testing was conducted by the U.C Davis Spartina Lab to confirm identification of *S. alterniflora* hybrids. In 2003, the S*partina* invasion at a subset of 28 sites, stratified across the Estuary by latitude and marsh type, was examined. In 2003, the average percent increase in area since 2001 for *S. alterniflora* hybrids was 329%. According to average percent increase across the sampling sites of 2003, the net acreage of *S. alterniflora* hybrids bay-wide was estimated to be 2,012 acres. The more labor-intensive estuary-wide inventory of 2004 will be compared to the estimates calculated from the stratified sampling methods used in 2003. The 2004 surveys found no new invasion sites, just spread of known locations. 2003 treatment site monitoring indicated that manual methods of *Spartina* control – digging or covering with geo-textile fabric – were effective at removing or killing the smaller populations of *Spartina* species.