



Science News

News from the CALFED Science Program



Delta water is used to irrigate western Delta farmlands.

Science Issues Related to Delta Conveyance: An Isolated Facility

The CALFED Science Program hosted a workshop August 22, 2007, focusing on science issues for using an isolated facility as conveyance for moving Sacramento River water to the export pumps. A second workshop scheduled for September 11, 2007, will examine issues associated with various through-Delta conveyance options. Considered together, these workshops are designed to help identify the science issues and questions that need to be raised in evaluating an effective Delta-region conveyance mechanism for water project exports.

The seven specialists who participated in the workshop agreed that the current Delta conveyance system is not working. However, they also found that every conveyance option has benefits, risks, and uncertainties – an isolated facility offers no “silver bullet” or “non-impact” way for solving all Delta-based ecological and water supply problems. For example, while an isolated facility can reduce entrainment of smelt in the south Delta, if there is an intake on the lower Sacramento River, there remains the possibility that Delta smelt can be entrained there, especially in low-flow

See [Isolated Facility](#) page 5

Ecosystem Principles for Understanding the Delta

While the Delta is complex, research supported by CALFED’s Science Program is helping us understand how the Delta ecosystem works. Lead Scientist Michael Healey has synthesized this understanding into a set of 12 ecosystem principles to guide the planning for ecological sustainability in the Delta. Submitted to the Delta Vision Blue Ribbon Task Force as part of a larger context memo, these principles provide a picture of our growing scientific understanding of the Delta and ways to achieve long-term sustainability.

The Sacramento-San Joaquin Delta is the complex intersection between California’s interior waterways and the Pacific Ocean. Connecting the Sacramento, San Joaquin, Calaveras, Cosumnes, and Mokelumne watersheds, the Delta receives nearly 50 percent of the state’s runoff and is the hub of the state’s extensive water distribution infrastructure. The current Sacramento-San Joaquin

See [Ecosystem Principles](#) next page

Science News
September 2007

Also In this Issue

- [ISB Holds August Meeting: Sea-level Rise, Review of DRMS Phase 1 Report Lead Agenda](#) (pg. 4)
- [2007 Science Fellows announced](#) (pg. 6)
- [New issue of Online Estuary Journal now available](#) (pg. 6)
- [Ask a Scientist](#) (pg. 5)

CALFED Science Program

Establishing a Body of Knowledge

The CALFED Science Program’s mission is to integrate peer reviewed science into every aspect of the CALFED Bay-Delta Program. The Science Program is establishing the best scientific information possible to guide decisions and evaluate actions critical to the CALFED Program’s success.

The long-term goal of the Science Program is to establish an unbiased, relevant and authoritative body of knowledge integrated across program objectives and communicated to the scientific community, agency managers, stakeholders and the public.

If you would like to unsubscribe or subscribe to Science News, please follow this link:

http://www.calwater.ca.gov/Science_ListServes/EmailSubscriptions.htm

A publication of the

CALFED
Bay-Delta Program
Science Program

650 Capitol Mall
5th Floor
Sacramento, CA 95814
916.445.5511
science.calwater.ca.gov

Editor
Robert Ullrey
rullrey@calwater.ca.gov

Ecosystem Principles: Continued from front page

Delta is a highly changed system from its natural design, changed mainly for human uses. Water exports, farming, and controls on salinity have all played important roles in influencing the current Delta environment. Now, species extinction, species invasion, population growth, land subsidence, and rising sea level changes threaten the Delta's potential to continue providing ecological services crucial for both human and ecosystem health. The Delta of today is no longer sustainable, and in September 2006, Governor Schwarzenegger created the Delta Blue Ribbon Task Force to develop a vision for a sustainable Delta. The principles are presented below in simplified form. They may also be found in their original form together with the longer context memo at: http://deltavision.ca.gov/Context_Memos/Environment/Ecosystem_Iteration1.pdf.

1. Physical Environment is the Foundation of the Ecosystem

The Delta's physical environment – that is, its climate, hydrology, chemistry, and landforms – interact to determine the Delta's living environment, or ecosystem. For policy, this means sustaining any desired species or ecosystems in the Delta can only occur if the physical habitat is suitable.

2. Delta Species Thrive in a Variable Environment

Natural environments of deltas and estuaries are active and constantly changing. Organisms that live in changing environments thrive on this change. Policies for managing the Delta need to incorporate enough variability to allow for native species to flourish. Human uses of large parts of the Delta and estuary may need to be changed to provide that important and necessary variability.

3. Climate Change will Require Flexible Management

Climate and weather have an important influence on the environment of the Delta and estuary. The future climate of California is uncertain but recent models predict a warmer and dryer climate with Sierra Nevada precipitation shifting from snow to rain. Storms should be more severe and frequent, and the sea level will continue to rise.

These changes in climate will have a dramatic effect on the Delta's physical environment. Policies for managing the Delta and estuary will need to be flexible and adaptable to handle these changing, uncertain conditions. Management tools that recognize this and allow for learning as actions happen, e.g., adaptive management, need to be used.

4. Future Changes may Threaten Species

All species in the Delta have their own tolerances for habitat conditions. Temperature, salinity, amounts of dissolved oxygen, and toxic substances all have a role in influencing where a species can live. Through time, these components have changed and will continue to change, both from natural and human influences. The Delta of the future may be intolerable for many of its species.

While the loss of some species may be inevitable, conservation efforts should continue. Creative forms are needed for conservation of Delta species, including establishing refuge populations where conditions remain suitable.

5. Humans Are an Integral Part of the Delta System

Humans and the landscapes they have formed are now deeply tied into the ecosystem of the Delta, having a profound effect on how the ecosystem works. Managing how humans use the Delta's land and water is important if we want the successful conservation of desired species, and their supporting types of ecosystems.

6. Primary Production is Unusually Low in the Delta

Photosynthesis by green plants, called *primary production*, is the ultimate source of all the food eaten by the myriad organisms in the Delta. In the open waters of the Delta, primary production by microscopic aquatic plants is unusually low compared with other estuaries and this is believed to contribute to the current low abundance of species like Delta smelt and striped bass. Resource policies for the Delta must stress increasing primary production of open water systems where possible.

7. Energy Moves up the Food Chain Inefficiently

Primary production produces microscopic aquatic plant material in the open water that is supplemented by more material washing in from adjacent marshes (e.g., Suisun Marsh) or flowing downstream in the Sacramento and San Joaquin rivers. Open water primary production can be fed upon directly by small shrimp and crustaceans that are, in turn, food for fish. In the Delta, plant material from either the marshes or upstream must first be eaten by bacteria and passed through a chain of very small organisms called the *microbial loop* before it can contribute to fish food. The microbial loop is a very inefficient pathway from plants to fish, so that most of the supplemental plant material coming to the open water provides little food for fish. Management and restoration policies should stress ways to enhance the consumption path that moves food more directly to higher organisms like fish.

8. Human Actions Influence Organization of the Delta's Ecosystems

Who eats whom (predation), and competition for food are important factors in how ecosystems are organized. Often a top predator, or keystone species, is a dominant force determining the overall ecosystem structure. A dramatic example of the keystone species concept is the relationship between sea otters and sea urchins in coastal waters. When otters are absent, sea urchins can become very abundant, eating all the leafy seaweeds and

See Ecosystem next page

Ecosystem: Continued from previous page

creating an urchin barrens. When otters are present, they eat the urchins, allowing large kelps and leafy seaweeds flourish, creating a complex forest of kelps.

Humans can play the role of top predator (keystone species) in the Delta through their favoring of commercially or recreationally valuable species. When such favoritism occurs, effects can cascade through the ecosystem affecting its whole organization. Humans can also influence the ecosystem by introducing non-native species, or by changing the Delta's habitats.

Human actions always have multiple consequences for the ecosystem. When humans act as a keystone species, their actions have far reaching implications for the whole ecosystem. Building roadways, dredging channels, or diverting water all have effects far beyond the local area. Management policies need to be seen in the context of consequences to the whole ecosystem and not just their effects on the immediate problem.

9. Influences on Species Abundance are Intricate and Complex

Everyone is asking how species like Delta smelt and striped bass have fallen to such low abundance. Abundance of any species is determined by the balance between births and deaths with populations declining when birth rates decrease, or death rates increase. Birth rates can fall depending on past or current levels of nutrition; or exposure to toxins, pesticides, or endocrine disruptors like dioxins and other pesticides. Death rates can rise because of exposure to toxins, disease, poor feeding conditions, increased exposure to predators, or competitors, as well as changes in the environment. Understanding which of these many potential causes is contributing to the decline, or the increase of a species is complex and can be virtually impossible. For species conservation policies to be successful, they need to be ecosystem based and address multiple factors. Approaches that only address a single high profile "cause" for a species decline are less likely to succeed. Maintenance of ecosystem structures and functions needed by the species of interest is essential.

10. Ecosystems are not Isolated but Interconnected with Other Ecosystems

The Delta and estuary is a unique mosaic of land and water ecosystems that act together exchanging energy, species, and material. The size, shape, arrangement, and connections among the pieces of the mosaic are critical to how the Delta and estuary function.

However, the Delta ecosystem itself is also a patch within a larger mosaic that includes the Central Valley, Sierra Nevada, coastal mountains, and Pacific Ocean. This idea of ecosystems being a mosaic of patches nested within a larger mosaic has important implications for the way humans manage and interact with their landscape. Human activity changes how patches connect, their

size and character, and how chemical and physical changes happen in and between patches.

Resource management policies need to consider this concept of ecosystem mosaics. We must look holistically at patterns of land and water use, patch size, location, connectivity, and species success. This landscape perspective should consider how patches evolve through time, and the role patches have on smaller and larger mosaics. Achieving a sustainable balance in the larger Delta mosaic is likely to involve allocating more land and water for supporting natural and semi-natural patches for the system but the size and arrangement of these patches is also critical.

11. Invasive Species Disrupt the Delta Ecosystem

Invasive species represent one of the most serious obstacles to preservation and restoration of the Delta's native species. Invasive species can disrupt the organization of an ecosystem and have serious negative effects on native species. Combined, the San Francisco Bay, Delta, and estuary ecosystems are the most invaded ecosystems in the world. Particularly damaging invaders because of their effects in changing the ecosystem are the overbite clam, the Asian clam, Brazilian waterweed, water hyacinth, perennial pepperweed, and the giant reed.

Invasive species continue to enter the Bay. A recent arrival that is likely to become a problem is the New Zealand mud snail and waiting to emerge in the wings are zebra mussels and quagga mussels.

Aggressive policies are needed to address the serious and growing problem of invasive species in the ecosystem. A multibarrier approach as recommended under the United Nations Convention on Biodiversity should be adopted. The barriers include effective regulation and monitoring to prevent new introductions, an aggressive program of eradication for newly arrived invaders where feasible, and development of efficient control programs for established invaders.

12. For a Healthy Delta, Both Human and Non-Human Uses Must be Considered

Ecosystems are complex, dynamic, and self-organizing. How humans use the Sacramento-San Joaquin Delta greatly influences the health of its ecosystem. Any sustainable vision for the Delta will include both human and the nonhuman needs. The history of resource management shows that attempts to manage nonhuman needs separate of human needs have inevitably led to a downward spiral of ecosystem health. The undesirable condition of today's Delta is a stark illustration of the failure of this approach. It's important to have a more holistic approach to ecosystem management that acknowledges dedicating a greater percentage of resources to maintaining ecosystem health. Such an approach would establish a sustainable balance between the needs of both the ecosystem and humans.

ISB Holds August Meeting: Sea-level Rise, Review of DRMS Draft Phase 1 Report Head Board's Agenda

The CALFED Independent Science Board (ISB) has responsibility for oversight of the science used to inform decision-making in the Bay-Delta system. Their meeting held August 28-29 included concerns about how sea level rise is predicted and used in Delta planning, and discussion of the findings by the Independent Review Panel (IRP) for the Delta Risk Management Strategy (DRMS) Draft Phase I Report.

From a request by Lead Scientist Mike Healey, the ISB examined the array of sea level rise projections available in published reports and, based on current scientific understanding, advised the Science Program about which projections were most appropriate for incorporating into on-going planning for the Delta. Current practice is to use the estimates of the Intergovernmental Panel on Climate Change (IPCC) for estimating sea level rise in the future. However, the most recent IPCC numbers, the fourth assessment, have lessened the amount of increase of sea level rise and do not address the dynamic instability of the polar ice sheets. This has led many to regard the IPCC numbers as too

The most recent IPCC numbers have lessened the amount of increase of sea level rise and do not address the dynamic instability of the polar ice sheets

conservative. The ISB has sent a memo to the CALFED Lead Scientist highlighting their concerns about the adequacy of current sea level rise models. The ISB first observes that current projections of sea level rise by the IPCC are likely very conservative as the models used to develop these projections underestimate recent measured sea level rise. Second, extrapolation from empirical models of sea level rise yield significantly higher estimates for sea level over the next few decades than the IPCC projections. The ISB suggests that the empirical projections are probably a better basis for short to mid term planning. And third, neither approach to estimating future sea levels takes account of melting of ice in Greenland and Antarctica, which recent studies suggest is accelerating. The memo can be found at http://science.calwater.ca.gov/ISB_response_letter.pdf.

Johnnie Moore, chair of the DRMS Independent Review Panel told ISB members that there were substan-

tial reasons for concern about the DRMS Draft Phase 1 Report. Major issues noted by the IRP include lack of transparency of analyses, limited actual analyses carried through to the end, limited treatment of uncertainty, lack of integration of analyses, lack of robust methodology for assessing impacts on aquatic resources. The IRP was concerned that, unless major issues are addressed, this document may not be a good basis for informing the DRMS Draft Phase 2 Report or other high-level policy decisions. The ISB received the report from the IRP and discussed the review with Johnnie Moore. The ISB has requested a response from the DRMS authors regarding the major issues in the IRP report. You can read the letter to the Department of Water Resources at http://science.calwater.ca.gov/ISB_response_letter_DRMS. A conference call meeting is scheduled for September 25 from 1- 4 pm to discuss the DRMS authors' response to the ISB letter.

The ISB's next scheduled in-person meeting is on October 24-25, 2007 in Sacramento. To read more about the August ISB meeting, visit http://science.calwater.ca.gov/sci_tools/isb.shtml. To view the webcast of the meetings, visit: <http://www.visualwebcaster.com/event.asp?regd=y&id=40693>.

Upcoming Science Program Events

Independent Science Board Conference Call

September 25, 2007, 1-4pm

For more information, visit: http://science.calwater.ca.gov/sci_tools/isb.shtml.

In-Person Public Meeting

October 24-25, 2007

CALFED, 650 Capitol Mall, 5th floor, Sacramento, CA.

For more information, visit: http://science.calwater.ca.gov/sci_tools/isb.shtml.

8th Biennial State of the Estuary Conference

October 16-18, 2007

Scottish Rite Center, 1547 Lakeside Drive, Oakland, CA.

For more information, visit: <http://sfep.abag.ca.gov/soe>.

Upcoming Events of interest

Delta Vision Blue Ribbon Task Force

September 20-21, 2007

West Sacramento City Hall Galleria, 1110 West Capitol Ave, West Sacramento, CA

October 25-26, 2007

West Sacramento City Hall Galleria, 1110 West Capitol Ave, West Sacramento, CA

For more information on Delta Vision events, visit: <http://www.deltavision.ca.gov>.

California Colloquium on Water

October 9, 2007, 5:30 - 7:00pm

University of California, Berkeley Wurster Hall, Room 112 Berkeley, California.

Tracking the Nation's Ground Water Reserves. For more information: <http://www.lib.berkeley.edu/WRCA/ccow.html>.

Isolated Facility: *Continued from front page*

years. How the system will be operated is critical to estimating its effects. From an ecological perspective it is difficult to say whether a particular species will benefit from, or be harmed by, the construction and operation of an isolated facility.

The panelists also observed that there are trade-offs. While an isolated facility will improve export water quality, most designs will allow more poor quality San Joaquin River water to flow into the Delta. Moving intakes to the Sacramento River will do nothing to solve San Joaquin in-valley issues like selenium, salt accumulation, or pesticide runoff, and may increase the impact of pollution in the South Delta.

The panel agreed that we know a lot more now than we did in 1982 about the physical and biological dynamics of the Delta ecosystem and are in a better position to analyze the effects of various management tools like an isolated facility. For example, the CALFED Bay-Delta science infrastructure is able to evaluate the effects of proposed alternatives for export and conveyance. However, it cannot provide “the answer” with regard to conveyance infrastructure construction options. The panel agreed this ultimately would be a policy choice.

Traditional approaches to public funding for an isolated facility (e.g., bond financing) are inadequate for underwriting “up-front” construction costs. A system of soliciting up-front user financing could provide an alternative that would employ market mechanisms to establish important aspects of size and operation.

Hydrodynamic modeling is critical for full evaluation of analyz-

ing alternate conveyance systems in the Delta. Existing modeling capacity in the Delta will benefit from improved coordination and revitalization. Bay-Delta water quality discussions need to consider more completely the effects of the Bay and coastal-ocean habitats since the Delta and the Bay are intimately interconnected.

Finally, if an isolated facility is to be pursued, a flexible, modular approach for designing and constructing it is important for maintaining an adaptive management capability over the period of transition from the current through-Delta system, and must continue for the lifetime of water conveyance management.

Workshop panel Members were Dan Odenweller, Regional Water Quality Control Board; Dennis Majors, Metropolitan Water District of Southern California; William Bennett, University of California, Davis; Samuel Luoma, United States Geological Survey; Richard Howitt, University of California, Davis; Wim Kimmerer, San Francisco State University; and Jerry Johns, Department of Water Resources. The workshop was moderated by CALFED Lead Scientist Michael Healey.

The report is available on the CALFED Science Program website http://science.calwater.ca.gov/pdf/workshops/workshop_ci_summary_draft_090707.pdf. The webcast is available at <http://www.visualwebcaster.com/event.asp?regd=y&id=41793>

In the Next Issue:
Part 2 of Science Related to Delta Conveyance:
Through-Delta Conveyance

Question:

What is the historic spawning habitat for Delta smelt? How far up each tributary do they now spawn and how does that compare to the historic spawning habitat?

Allison B., Stockton, CA

Answer:

We really do not know the historic or current range of spawning habitat for Delta smelt. We do know that Delta smelt prefer to live in brackish water but spawn in freshwater. Spawning occurs between February and June each year and is most active from mid-April through May. Actual spawning locations are not known and must be guessed at from the locations where spawned-out adults or very young larvae are captured. In dry years the fish spawn in the Sacramento River, particularly around Prospect Island, and in Barker and Lindsey sloughs. In wet years their spawning distribution is broader, including most of the Delta, Suisun Marsh, and the Napa River. The eggs are adhesive and are probably stuck to rocks or gravel until they hatch. Eggs hatch in about 10 days at 60 degrees. The distribution of spawning is governed mainly by salinity in the Delta and upper estuary so that changes in freshwater flows into the Delta influence where smelt spawn.

To have your question considered for Science News, email the Science News editor Robert Ullrey at rullrey@calwater.ca.gov. You must include your: real name, postal address, and daytime phone number. If your question is selected, you will receive a token memento from the CALFED Science Program.



CALFED 2007 Science Fellows Named

The CALFED Science Program has announced its Science Fellows Class of 2007. This year two postdoctoral and two graduate fellows were selected. Science Fellows are brought together with agency scientists and senior research mentors to work collaboratively on data analysis and research projects relevant to ecosystem management and water supply reliability. This year's CALFED Science Fellows are:

Postdoctoral Fellows:

Alex Fremier, postdoctoral fellow from State University of New York, studying, *Modeling Physical Drivers and Age Structure of Cottonwood Forest Habitat: An Integrated Systems Approach*.

Susan Lang, postdoctoral fellow from the University of California, San Diego, studying, *Investigating the Lower Trophic Levels of Suisun Bay Food Web: A Biomarker-Specific Isotope Approach*.

Graduate Fellows:

Susanne Brander, graduate fellow from the University of California, Davis, studying, *Endocrine Disruption in the Delta: Confirming Sites Known Estrogenicity with Outplants, Histology, and Choriogenin Level Measurements*.

Sarah Hughes, graduate fellow from the University of California, Santa Barbara, studying, *Environmental Water: Developing Indicators and Identifying Opportunities*.

Two additional fellows maybe added contingent on acceptance of their revised proposals.

The goals of the CALFED Science Fellows Program are to bring highly qualified scientific talent to help advance the state of scientific knowledge on ecosystems and river systems in the Sacramento and San Joaquin watersheds, the Sacramento-San Joaquin Delta, and San Francisco Bay. The fellows program helps provide long-term support for the training and development of scientists able to work in multidisciplinary, field-oriented research for supporting resource management; and promotes scientific partnerships across agencies, research institutions, and non-profit organizations.

Funds are awarded by the California Sea Grant through a cooperative agreement with the CALFED Science Program and administered by the university, college or research institution with which the fellow or research mentors are affiliated.

For more information on the Science Fellows program, visit: <http://www.csgc.ucsd.edu/EDUCATION/CALFED/CALFED-Indx.html>

Past issues of Science News are available at:
http://science.calwater.ca.gov/sci_news.shtml

New Issue of Online Journal Available

The July 2007 issue of *San Francisco Estuary and Watershed Science* is now available. This issue looks at how both native and non-native fish use floodplains, the historic and present distributions of salmon and steelhead trout in Calaveras River, and the effects of flow diversions within the Delta on habitat and water quality. To view or download the latest issue, visit: <http://repositories.cdlib.org/jmie/sfews/vol5/iss3>.

CALFED scientist Peter Moyle is lead author of the article on how fish use floodplains. "Patterns in the Use of a Restored California Floodplain by Native and Alien Fishes" studied how both native and not native fish used floodplains in the Cosumnes River for seven years. They found a constant pattern of floodplain use by spawners and foragers. At the end of the flood season, non-native fish dominated the use of floodplains as native fish left before becoming stranded. Their findings have led to the recommendations that floodplains managed for native fish should have regular, extensive early season flooding; complete drainage by the end of the season with few areas of permanent water; and should support a mosaic of habitats.

Nancy Monsen leads the article on the "Effects of Flow Diversions on Water and Habitat Quality: Examples from California's Highly Manipulated Sacramento-San Joaquin Delta." Monsen's article argues that the Delta is a mixing zone of assorted waters from rivers, agriculture, and the San Francisco Estuary. How these waters mix varies depending on natural hydrodynamics and diversions. Using simulation modeling, the authors looked at how three specific water diversions affected overall water quality in the Delta. They found that each diversion had implications for habitat quality or drinking water quality, exemplifying the importance of anticipating system-wide changes induced by singular flow changes.

The final article, "Historic and Present Distributions of Chinook Salmon and Steelhead in the Calaveras River" by Glenda Marsh examined spawning conditions before and after the installation of New Hogan Dam in 1964. She found that today and historically, both salmon and steelhead used the river for spawning. Of significance was that possible spring spawning runs of Chinook salmon stopped after the dam's construction. Marsh found that reduced high flow events from in-stream barriers and river regulation have led to fewer opportunities for salmon to move upstream to spawn. However, upstream areas still provide good spawning habitats and improved migration conditions could allow salmon to return.