From: HAYDOCKI@aol.com [mailto:HAYDOCKI@aol.com]
Sent: Tuesday, May 24, 2011 4:45 PM
To: Rogers, Pat@DeltaCouncil
Cc: haydocki@aol.com
Subject: A Request to forward my letter to DSC member Felicia Marcus

Pat Rogers
Clerk to the Delta Stewardship Council
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I would appreciate your passing this letter on to Felicia Marcus prior to the next Delta Stewardship Council Meeting

Thank you, Irwin Haydock, Ph.D.

May 24, 2011
Felicia Marcus:

On Friday, May 13th , I heard you wax eloquently about wanting to see some action in the delta that you could point to in your lifetime. I too have waited far to long to see meaningful mitigation/restoration accomplished to bring the system back from the brink. The reason for this letter is to respond to your excitement by providing a project outline that could actually be done soon to help restore the delta, well beyond just another plan. I truly believe implementing this Salinity Restraining Channel (SRC) might satisfy your passion for action, as well as my belief that the project would provide quick relief for delta. The early SRC cost estimate was in the $10's of millions, enough to excite folks' interest but barely enough to break the State's bank, and the work could be tested and constructed within a realistic 10-20 year time frame, or done quicker, better and cheaper under an Adaptive Management Program. My sense in listening on the web is you are truly intent on finding workable solutions to this State's water conundrum.

I here offer a proposal for your serious consideration that could be quickly evaluated, modeled and tested in the real world of the existing delta. I believe this project is a top candidate for restoring and maintaining a smaller but viable Delta-Estuary-Bay, thereby helping to achieve the co-equal goals set forth in the Stewardship Council's Legislative mandate. This project, a physical salinity restraining channel (SRC), would allow existing human and environmental activities to be maintained in the more natural conditions that prevailed in earlier times, but at a much smaller and more manageable scale. As an unintended(?) consequence the channel would allow more water to be diverted upstream than would otherwise have been possible, while still maintaining the salinity gradient that is the essence of the estuary itself. The channel allows for the passage of ships as well as salmon, and would be designed with well understood, features mimicking natural oceanographic phenomena that impede inflow of salty water from the bay-side. Channel Length, width and height are critical in balancing fresh-salt flows. In a word this is an oceanographer-estuarine hydrologist's solution that guides Nature rather than an engineers purely structural approach to tame Nature. I have added an early Grant Proposal and an Abstract that detail the testing necessary to prove the final design parameters. A rather formidable team (most now gone) of scientists and engineers were lined-up to plan, model and test this pilot project, but there was little interest in funding the proposal for various reasons. I

believe the time is ripe to give this idea an honest evaluation and a fair chance of being implemented as a primary solution to restore the Bay-Delta's future.

Michael Rozengurt and I previously offered this idea to the State. First, during my 1995 commission on Gov Pete Wilson's CalFed/BayDelta Science Technical Advisory Committee (about 15 members in the mid-1990's); and, second, more recently as written public comment to Gov. Arnold Schwarzenegger's Bay-Delta Blue Ribbon Commission in 2007-08. In the first case, all but one of Wilson's TAC (me) deemed it inappropriate for addition to the many other (unquestioned) proposals that were bound over for consideration by future Delta Science Advisory Groups; In the second case, the submittal was published without comment on the BlueRibbon Task Force web site (http://deltavision.ca.gov/) - no longer available in my recent search.) My letters and the referenced figures were specifically found at: http://deltavision.ca.gov/docs/9_Comment_from_Irwin_Haydock_11-30-07.pdf, and http://www.deltavision.ca.gov/StrategicPlanningProcess/ExternalSubmissions/2008-ES-3.pdf. I am certain you would be able to obtain copies of the figures from these documents from the webmaster. I have attached two key documents to this email that provide the essence of estuarine hydrodynamics and fresh-salt exchange taken from Rozengurt's many publications on this subject.

Felicia, why is this SRC Pilot Project a good idea? First, I have spent my life as an aquatic scientist in both salt and fresh waters. I have reached an age (73) where I consider myself a fully fledged ecologist with a good understanding of how watersheds (rivers-deltas-estuaries-bays-and coastal zones) function. From this view I have come to the conclusion that we cannot restore the Delta to anywhere near its former glory. But, by careful adaptive management and collaboration, we can reach a compromise of a functional ecosystem that provides for the co-equal goals to be met, and for the Delta-as-Place to exist in a sustainable state. This will require strong, honest, and transparent science, and a realization that for too long we have oversubscribed the waters of the delta to humans over the environment. There is clearly a limit to what we can take; Michael Rozengurt has analyzed and declared this surplus to be no more that 25-30% of the long-term average unimpaired natural flow. But, it is my professional opinion that a properly sized and positioned Salinity Restraining Channel (SRC) would allow this limit to be successfully scaled down to accommodate alternative future flows that satisfy our societies' multiple goals for a sustainable delta. Limited further study of this proposed Pilot Project can quickly accomplish this.

I could provide much more to convince you of my background and experience in this field, including my lifelong friendship with a mentor, Dorothy Green, in our long struggle to correct California's water problems. But, this should be enough to lay out the pertinent facts for you to make the decision to build a new solution. Let's build something in our lifetime to solve an acknowledged problem that cry's out for a unique, new approach. Let me know if I can be of further service. I wish you well in your continuing quest with the Delta Stewardship Council.

Sincerely,

Irwin Haydock, Ph.D.
Haydocki@aol.com

STATEMENT
The Restraining Channel that Can Avert Salinization of Sacramento - San Joaquin Delta under Current and Planned Freshwater Diversions.

Michael A. Rozengurt, Phd, PE

Abstract from invitational presentations at International meetings at Water Symposium -97 (Sweden, Stockholm) and the American Institute of Hydrology: *Agonizing Watershed-Coastal Seas Ecosystems: Critical Review of Alternatives.*

Common Remarks.

Cumulative effects of inland water withdrawals of millions of acre feet have resulted in chronic depletion of the spring runoff ranging from -35 to -90%, as opposed to its natural ±25 to 30% of the perennial norm (average more than 55 years) that have Notably increased an anomalous predominance of years of subnormal wetness or critical dry regardless of watershed runoffs despite unimpaired runoff normalcy. Runoff depletion has resulted in an impeded functioning of a river-coastal ecosystem continuum accompanied by the salinization of the surface and ground water supply as well as the loss of millions of tons of oxygen, organic and inorganic matter, and sediments vital to the survival of deltas-coastal ecosystems the world over. This has triggered accumulation of entropy whose visible indicators are: salt intrusion into the deltas, increase detention time of natural and man-induced pollutants, hypoxia and anoxia (in summer particularly), eutrophication, and a precipitous decline of commercial and recreational catches of valuable fish. In short, man's perceived needs have ignored the scales of ecological tolerance and limitations of ecosystems and have created the new, artificial environment on a global scale, namely: **"the impounded river-delta-estuary-coastal seas."** A massive salt accumulation in formerly fresh and brackish water bodies has degraded their quality and accelerated the despoliation of habitats (example: the Mediterranean Basin, west Pacific, north and central Atlantic, etc.)

Background.

Estuaries are the intermediate, complex link within delta- coastal sea ecosystems where continual variable confluence, interaction and mixing processes between river flow (delta outflow) and seawater inputs takes place. These processes result in the development of specific mixed water masses and, related to them, spatio – temporal distribution of their regime and biochemical characteristics which provide for the unique diversities and biological productivity of estuarine organisms.

Thus, the major factors controlling brackish water regimes of estuaries are the volume of fresh and salt water participating in the exchange between a river and sea. These regime elements as well as tide oscillations and winds are the moving forces, which are responsible for development of specific seasonal circulation patterns and surface, intermediate and deep layers The interaction between controlling factors and the moving forces determine the intensity of mixing, advection, and spatia-temporal distribution of hydrological and biological characteristics suitable the survival of the estuarine biota regardless of the unique hydrophysical, geophysical, and morphometric differences among estuaries.

For example, The Sacramento - San Joaquin unimpaired river spring discharges had been vital for preserving optimal hydrophysical and biological environment of the Delta - Bay ecosystem, for they had entrained many times the volume of estuarine brackish waters. This, in turn, had maintained a definite rate of salinity in the four transition zones in the Delta-Bay.

Historically, here, as in many other similar ecosystems, the deltaic zone had played and exclusive role as the heart of the entire coastal embayment. For normally rivers receive millions of tons of elements from river watersheds and produces, circulates, and processes an additional organic and inorganic increment within its body which greatly influences the richness of estuarine habitats. That is why an excessive reduction of flows is one of major cause of pending piscatorial and other resources' despoliation of deltas and adjacent water bodies the world over.

Statement.

Cascade of dams and perennial diversions of freshwater has caused a number of negative impacts on the hydrochemical and biological status of the Sacramento-San Joaquin Delta of San Francisco Bay ecosystem. The average depletion of spring and annual runoffs to the Delta due to upper and low rivers, and deltaic diversions exceed **75** and **55%** of their corresponding norms (computed more than 55 years). As a result, the frequencies of occurrence of man-induced years of subnormal and critical anomalous wetness have increased several

times regardless of volumes of would be unimpaired spring runoff (no dams and storage) The similar events have been typified the alteration of integrated annual river disharges. At the same time, late summer- fall sanitary and agricultural releases have caused a new phenomenon, namely, the regulated runoffs have become almost equal or higher then the spring regulated runoff. Yet, this inverse, intra-annual redistribution of wetness, undocumented for unimpaired runoffs in recent historical time, has not brought any improvements in water quality or biological productivity of deltaic – estuarine ecosystem. On contrary, spring cumulative, chronic runoff deficits compounded by the Delta inner water conveyance facilities (about **200MAF**, and up to **600 MAF**- a total water withdrawals from the Bay balance over last 25 - 30 years) have futher aggravated the ecosystem regime and, both have made the delta environment broken. Subsequently, these irrevocable losses of freshwater have triggered a **massive landward marine water intrusion into the Bay and the Delta, for potential capacity of remnants of regulated runoff to repulse a salty water have diminished. This has put the operation of fresh water intakes as well as the nursery ground of deltaic- upper Bay water body in peril.** At present, these and other negative regime modifications have already caused the deterioration of water quality and a dramatic drop in migration, spawning, breeding, and catches of valuable semi-anadromous and anadromous fish.

Statement of Issue or Problem:

The intrusion of sea water into estuaries and river deltas has become a major cause of salinization of delta-estuary ecosystems in the United States and throughout the world. Increasing amounts of fresh waters are being diverted from rivers and deltas for agricultural, municipal and industrial uses and thus, estuaries such as San Francisco Bay have experienced up to a 65 percent loss in fresh water inflows which used to serve to "flush" the Bay from salt accumulated in the basin due to sea water intrusion and agricultural and municipal drainage water discharges. Increases in salinity adversely affect fish spawning, nursery and habitat areas. Fresh water withdrawals also modify velocity distributions in in the waterways, thus altering patterns of sediment transport and pollutant dispersion; drinking water supplies are also affected as brackish water moves inland to fill adjacent wells and fresh water aquifers; and agricultural production is negatively impacted as reduced quality of irrigation water leads to the loss of croplands. With the inevitable increase in water consumption in the rivers' watershed, and the deepening of shipping channel in the northern part of San Francisco Bay, adverse impacts of salty water intrusion into the Delta will become even more acute (especially in summer). Therefore, in the absence of radical, immediate remedial measures the continuation of salt accumulation in the upper Bay and southern part of the Delta will lead eventually to the elimination of the Delta's agricultural, industrial, and municipal water supplies intakes, living resources, and trigger a massive erosion of Delta levees. The case of San Francisco Bay is a typical example of such development. Since 1944 nearly 400 million acre-feet of water has been diverted from the Sacramento-San
Joaquin Delta resulting in salt water intrusion into the Delta. Thus, the quality of agricultural water derived from the Delta has declined significantly. Furthermore, Contra Costa County which pumps its water supply for over 300,000 residents from the Delta has experienced a serious decline in the quality of their drinking water. The increase in salinity and decreased flows to San Francisco Bay has also seriously affected the fisheries in the region. Sport catches of salmon, striped bass and shad have declined to as little as 10-30 percent of levels of 20 years ago despite a great increase in sport fishing effort, improved treatment of sewage discharges, and massive hatchery releases. Other estuaries/deltas that have experienced degradation problems due to salt water intrusion include the Mississippi River Delta where salt water has recently intruded as far upstream as the intakes for New Orleans' water supply. Texas lagoons/estuaries have also experienced a serious water quality decline due to salt water intrusion as have the Nile River in Africa and the Sea of Azov in the USSR.

The purpose of the investigation proposed herein is to develop one specific solution concept for the restraining of salinity in estuaries: the Salinity Restraining Channel (SRC). Preliminary studies have shown that the SRC can be an effective, non-intrusive method of preventing salinity from reaching unacceptable levels. The channel operates on the basis of well defined hydraulic principles and is compatible with natural fish migration, sediment load transport and navigation requirements. The proposed channel (figures 1,2) will have walls above the high-high tidal level and will be built with a channel width and depth that is suitable for navigation. The overall hydraulic resistance of the channel can be increased by induced turbulence and enhanced energy dissipation through the emplacement of certain structures on the bottom and walls of the structure.

Goal.

In order to preserve the impaired but reasonable salinity balance of the Delta - Suisin Bay the following solution is proposed: to built in the operational shipping channel in the northern or southern part of Suisun Bay or in San Pablo Strait the salinity restraining channel (SRC) as a means of protecting the Sacramento - San Joaquin Delta or upper San Francisco Bay and the Delta in particular, from further degradation due to salt intrusion.

Preliminary studies, based on SRC patent (attached, 1974) have shown that the SRC can be an effective, non-intrusive method of preventing salinity from reaching unacceptable concentration in fresh water bodies. It should be emphasized that the Hydrodynamics Institute of the Academy of Sciences of the Ukrainian Republic executed in 1973 numerous tests on a physical model of the Dniester estuary where a salt intrusion substantially degraded water quality of the Dniester delta and its fishery. It was demonstrated that salt intrusion for the Dniester estuary can be reduced by several times if SRC of the length about two miles will be built into the existing shipping canal (Rozengurt et al., 1978).

Objectives.

Some of the benefits associated with the development of SRC will be :
(1) reduce the intensity and the probability of occurrence of saltwater intrusion in the Delta as much as three to five and more times, and preserve fresh water surplus of adjacent wells and aquifers,
2) enhance water quality for inner conveyance facilities and deltaic irrigation network,
(3) provide a tolerant environment for fish, and
(4) the open connection necessary for recreational boating and commercial shipping.

Project description.

The **SRC** is relatively simple in concept, consisting of two constraining walls, extending above the high tide (see attached drawing), and have the current width and depth that is suitable for navigation. the desirable intensity of Delta Regulated Outflow entrainment and mixing of landwater and its final salt concentration can determine the length of the SRC walls. Note that **since time immemorial** the **Delta Outflow Hydraulic Head** have been responsible for "producing" and maintaining the **Hydrostatic Pressure and Hydraulic Gradient** that construed a ***natural fresh and brackish water seaward barriers*** against an aggressive, landward intervention along the shipping channel much denser, marine water into a significant part of an estuary and the Delta.
The **SRC** can substantially reduce the salt concentration of avant- and delta water body on the basis of above-mentioned, well defined hydraulic properties of river emptying in coastal embayments, for normally the highest percentage of much less dense, delta outflow tends to gush through the shipping channel then over surrounding shallows. However, under conditions of permanent runoff depletion the hydraulic gradient have been gradually dwindling and, as a result, the underlying, much dense, estuarine landward flux has managed to fill in the significant volume of the shipping channel and even spill over its submersible walls and spread over the Bay's shallows. Therefore, the major task of the **SRC** will be to partially restore, under conditions of runoff regulations, the reasonable hydraulic head at the deltaic side at least during April-May-June flooding in order to enforce the repulsion of salt wedge from the Delta and Susuin Bay shipping channel. In this case , the **SRC** can maintain optimal hydrological regime compatible with a natural scheme of water and salt exchange between adjacent basins, and provide the remnants of sediment transport, fish migration, and navigation requirements. The main effect can be accomplished by narrowing the channel while allowing it significant length. Still certain techniques could be found to increase overall efficiency of the structure without affecting its discharge capacity.
Note that the overall hydraulic resistance of the **SRC** can be increased by intensified turbulence and salt water flux energy dissipation through the displacement of small structures on the bottom or slightly protruding plates from its walls. Since the SRC will be a passive structure not requiring energy or a special personal, it would have no associated operating costs. The approximate length of a channel of about two to four miles can effectively resist salt intrusion in avant-delta and Suisun Bay.

Conclusion.

In our view, any statement claiming that it is possible to restore a historical deltaic water quality or population of estuarine-dependent fish should be considered erroneous, for neither historical (unimpaired) runoff, nor historical migration routes are available for spawning and fish maturity. **We can not restore but we can mitigate the existing problems for years to come**.
The proposed SRC (a total cost of construction would be not less then $15 -25 million**)** could give water management a flexible opporunity to the planning water storage and conveyance facilities out of the Delta, which, at the same time, in concert with SRC can ensure the enviromental, economic, and societal concerns of Northern California about the enhancement and preservation of water quality and living resources of the Delta- Bay.
This solution might serve the many different interests concerned with the enhancement and conservation of the Delta ecosystem without disrupting agriculture, fishery, and recreational and commercial navigation, and will serve the needs of both Northern and Southern California. The proposed project will require the expenditure of approximately $100,000 for hydraulic evaluation of SRC different versions.

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PROJECT TITLE: Development of a Physical Model of a Salinity Restraining Channel to Control Salinity into Estuaries. Case of Study: San Francisco Bay

STATEMENT OF ISSUE OR PROBLEM: The intrusion of sea water into estuaries and river deltas has become a major cause of salinization of delta-estuary ecosystems in the United States and throughout the world. Increasing amounts of fresh waters are being diverted from rivers and deltas for agricultural, municipal and industrial uses and thus, estuaries such as San Francisco Bay have experienced up to a 65 percent loss in fresh water inflows which used to serve to "flush" the Bay from salt accumulated in the basin due to sea water intrusion and agricultural and municipal drainage water discharges. Increases in salinity adversely affect fish spawning, nursery and habitat areas. Fresh water withdrawals also modify velocity distributions in in the waterways, thus altering patterns of sediment transport and pollutant dispersion; drinking water supplies are also affected as brackish water moves inland to fill adjacent wells and fresh water aquifers; and agricultural production is negatively impacted as reduced quality of irrigation water leads to the loss of croplands.

The case of San Francisco Bay is a typical example of such development. Since 1944 nearly 400 million acre-feet of water has been diverted from the Sacramento-San Joaquin Delta resulting in salt water intrusion into the Delta. Thus, the quality of agricultural water derived from the Delta has declined significantly. Furthermore, Contra Costa County which pumps its water supply for over 300,000 residents from the Delta has experienced a serious decline in the quality of their drinking water. The increase in salinity and decreased flows to San Francisco Bay has also seriously affected the fisheries in the region. Sport catches of salmon, striped bass and shad have declined to as little as 10-30 percent of levels of 20 years ago despite a great increase in sport fishing effort, improved treatment of sewage discharges, and massive hatchery releases.

Other estuaries/deltas that have experienced degradation problems due to salt water intrusion include the Mississippi River Delta where salt water has recently intruded as far upstream as the intakes for New Orleans' water supply. Texas lagoons/estuaries have also experienced a serious water quality decline due to salt water intrusion as have the Nile River in Africa and the Sea of Azov in the USSR.

The purpose of the investigation proposed herein is to develop one specific solution concept for the restraining of salinity in estuaries: the Salinity Restraining Channel (SRC). Preliminary studies have shown that the SRC can be an effective, non-intrusive method of preventing salinity from reaching unacceptable levels. The channel operates on the basis of well defined hydraulic principles and is compatible with natural fish migration, sediment load transport and navigation requirements.

The proposed channel (figures 1,2) will have walls above the high-high tidal level and will be built with a channel width and depth that is suitable for navigation. The overall hydraulic resistance of the channel can be increased by induced turbulence and enhanced energy dissipation through the emplacement of certain structures on the bottom and walls of the structure.

HOW WILL THE STUDY BE USED: This study will be used to assist environmental planners, managers and scientists in assessing the viability and practicality of using the SRC as a method to control salt water intrusion into estuaries. The collection and analysis of data related to the problem of salinity intrusion in the San Francisco Bay estuary will provide a sound basis for the formulation and experimental development of the restraining channel concept and will also answer important environmental questions with immediate practical applications. The establishment of statistically validated river and delta flow regimes needed to protect the chemical quality of water and the balance of the ecosystem will provide policy makers with an important planning tool; it will allow a rational determination of acceptable levels of seasonal and annual freshwater diversions, which will in turn lead to a reassessment of agricultural, industrial and municipal water uses. Those who may benefit from the project include :

* The State of California and its water planners, environmental engineers, and biologists (Bureau of Reclamation, Department of Water Resources, Department of Fish and Game).

* Federal Agencies charged with the regulation of waterways and natural resources (U.S. Army Corps of Engineers, U.S. Geological Survey, U.S. Fish and Wildlife Service).

* Environmental organizations, both public and private (Regional Water Quality Boards, Sierra Club, Oceanic Society, Save San Francisco Bay Association).

OVERALL PROJECT GOAL: The proposed investigation will establish the viability of the Salinity Restraining Channel as a means of protecting estuarine environments, the Sacramento/San Joaquin Delta and upper San Francisco Bay estuary in particular, from further degradation due to salt intrusion. The project will use San Francisco Bay estuary as an example but generalized formulations will also be developed to allow implementation of the SRC concept in any estuary. Some of the benefits associated with the development of a salt restraining will be enhanced water quality and fisheries in the estuary, enhanced water quality in adjacent wells and aquifers, increased irrigation water quality and the potential of increased diversions without further negative impact on the estuary. This work will also lead to an improved understanding of the mechanics of salt water intrusion in estuaries and to the improvement of numerical hydrodynamic and salinity models which will prove to be useful to both researchers and educators who deal with coastal environments.

APPROACH TO BE USED: A two year study is proposed for the development of a physical model of a salinity restraining channel for the upper San Francisco Bay. (1) The first year will focus on the gathering and analysis of necessary data, the assessment of salt intrusion mechanisms, the definition of parameters related to the restraining channel and the derivation of empirical and theoretical expressions to define the interaction of the salinity restraining channel with its estuarine environment. (2) The second year will be devoted primarily to the experimental evaluation of the SRC concept, the assessment of study findings and reformulation of governing equations, and the documentation and dissemination of the results of the investigation.

The data gathering and analysis will have as its primary aims : * The evaluation and comparison of watershed and discharge variables for unimpaired and regulated conditions of river inflow and delta outflow.

* The development of statistical basis for making freshwater availability predictions.

* The statistical analysis of the relationship between freshwater diversion and salt intrusion in the delta.

* The development of a statistical basis for determining the effects of seasonal freshwater diversions from the river watershed , and for relating tolerance levels of biota to salt concentration fluctuations.

* The definition of horizontal and vertical velocity distribution s at various locations within the Bay, particularly in the Carquinez strait, where the salinity restraining channel will be initially tested.

* The selection of tidal hydrodynamic and salinity models applicable to the San Francisco Bay estuary, and their calibration and verification.

The analytical study of the salinity restraining channel will have as its primary aim the formulation of equations governing the dynamics of the channel's interaction with the environment. The ultimate goal will be reached progressively as the various oceanographic and hydrodynamic parameters are individually examined and their correlation established. The data compiled for the San Francisco Bay estuary will be used as a basis for the theoretical definition of the SRC.

Research tasks that will be undertaken to theoretically define a salinity restraining channel applicable to the San Francisco Bay estuary include:

* Assessment of the scale of seasonal mechanisms of water and salt exchange within the ecosystem to establish the laws governing the dynamics of salt intrusion parameters.

* Assessment of the effects of impermeable internal barriers within the Carquinez Strait on tidal fluctuations and salinity levels in Suisun Bay, to define theoretically advantageous geometric configurations for the restraining channel.

* Assessment of hydraulic and structural design requirements for the salinity restraining channel, to define its potential effects on navigation, sediment movement, and Carquinez Strait bathymetry.

* Derivation of equations to predict the effects of variable SRC configuration on salt intrusion into the delta for different rates of freshwater discharge.

* Derivation of equations to predict salt content stabilization time for the San Francisco Bay estuary relative to different rates of freshwater discharge.