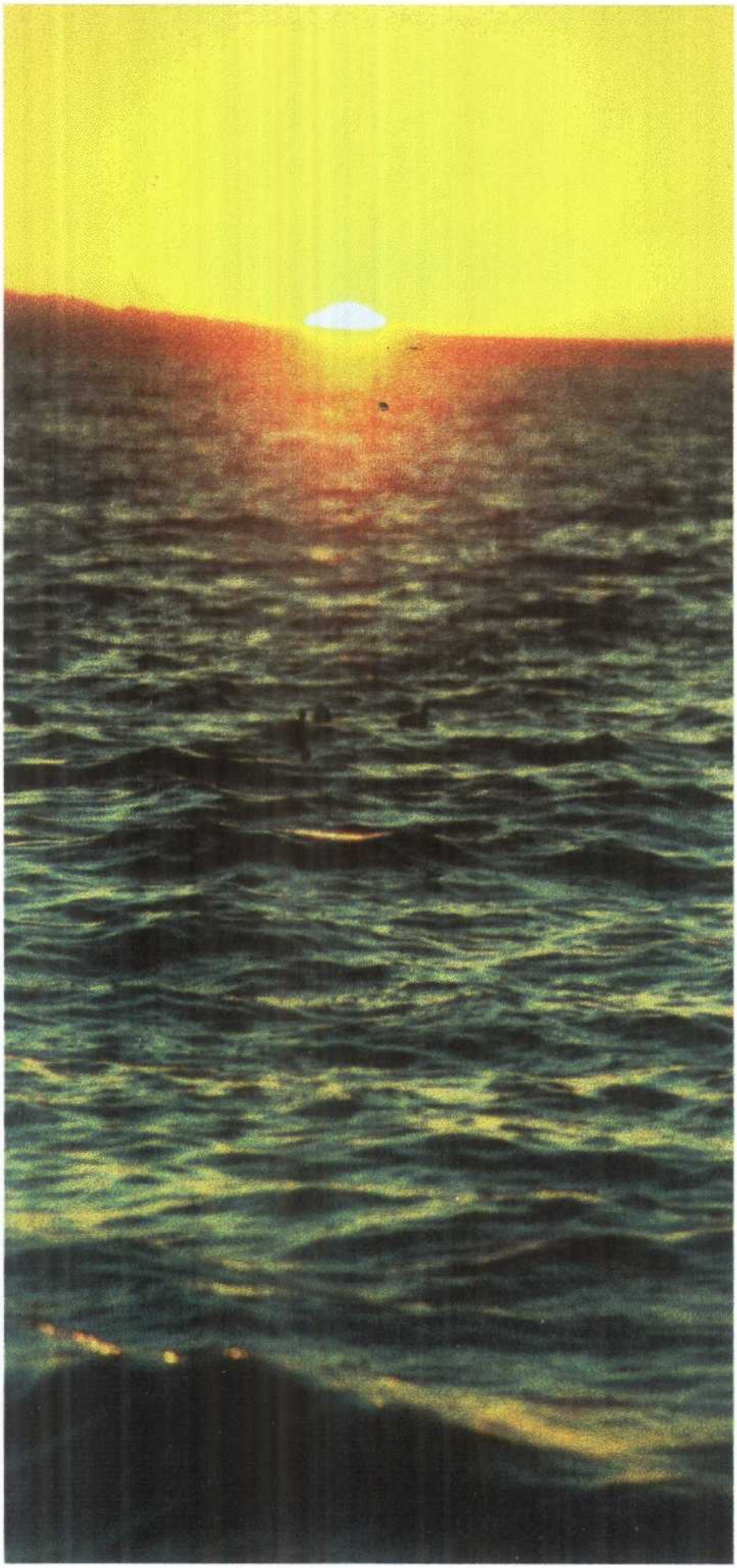


"The Salton Sea is a beautiful, valuable, and critically threatened environmental resource. The political will to save it is now greater than ever before."

Congressman
George Brown Jr.

SALTON SEA SYMPOSIUM

January 13-14, 2000

SALTON SEA
AUTHORITY

SALTON SEA SYMPOSIUM

January 13 – 14, 2000

Miracle Springs Hotel & Spa

DAY 1

Registration — **LOBBY / JOSHUA TREE** — **9:00 A.M.**

Sponsored by Valley Independent Bank

Introduction — **MIRAGE BALLROOM** — **10:00 A.M.**

Supervisor Tom Veysey
President – Salton Sea Authority Board of Directors
Congresswoman Mary Bono
Senator Dianne Feinstein
Tribute to Congressman George E. Brown, Jr. – Marta Brown

Restoration Report — **10:20 A.M.**

David Hayes, Deputy Secretary, Department of the Interior
Tom Kirk, Executive Director, Salton Sea Authority
Dr. Milton Friend, Executive Director, Salton Sea Science Subcommittee
Bill Steele, Salton Sea Program Manager, U.S. Bureau of Reclamation

Federal Legislators

Senator Dianne Feinstein
Congressional Salton Sea Task Force
Congresswoman Mary Bono
Congressman Duncan Hunter
Congressman Ken Calvert
Congressman Jerry Lewis (out of Country)

State Legislators

Assemblyman Jim Battin
Senator Dave Kelley (in Session)

Local Legislators – Salton Sea Authority Board of Directors

President Tom Veysey, Supervisor – Imperial County
Vice President Roy Wilson, Supervisor – Riverside County
Secretary Director Andy Horne, Director – Imperial Irrigation District
Director Tellis Codekas, Coachella Valley Water District
Director Don Cox, Imperial Irrigation District
Supervisor Wally Leimgruber, Imperial County
Director Dorothy Nichols, Coachella Valley Water District
Supervisor Jim Venable, Riverside County

Tribal Legislators - Torres Martinez Desert Cahuilla Tribe

Mary Belardo, Tribal Chair

LUNCH — **GRAND BALLROOM** — **12:15 P.M.**

Senator Dianne Feinstein

SALTON SEA SYMPOSIUM

DAY 1 (continued)

A Careful Balancing Act — MIRAGE BALLROOM — 2:00 P.M.

Mike Madigan – Chairman, California Water Commission – *Moderator*

Mike Bracken – *Economic Development*
Executive Director, Coachella Valley Economic Partnership

Steve Horvitz – *Recreation*
Park Superintendent – Salton Sea State Park

Dan Walsworth – *Wildlife*
Southern California/Nevada Supervisor – U.S. Fish and Wildlife Service

Brad Luckey – *Water / Agriculture*
Executive Officer – Imperial Irrigation District

Roles & Responsibilities — 3:00 P.M.

Joe Findaro, McClure Gerard & Neuenschwander, Inc. – *Moderator*

Bob Johnson – *Federal*
Regional Director, U.S. Bureau of Reclamation

Ray Hart – *State*
Deputy Director, California Department of Water Resources

Roy Wilson – *Local*
Vice President, Salton Sea Authority Board of Directors
Chairman, Riverside County Board of Supervisors

Mary Belardo – *Tribal*
Tribal Chairperson, Torres Martinez Desert Cahuilla Indians

Raymond Orbach – *University*
Chancellor, University of California – Riverside

BREAK — 4:00 P.M.

The Sea in Context — 4:15 P.M.

Phil Gruenberg, Executive Officer, Regional Water Quality Control Board – Moderator

Dan Taylor – *The Pacific Flyway*
Executive Director, Audubon Society – California

Dr. Carlos Valdes Casillas – *Colorado River Delta Area*
Instituto Technologico y de Estudios Superiores de Monterrey

Jose Angel – *Water Quality*
Senior Engineer, Regional Water Quality Control Board

WINE RECEPTION / HOST BAR / POSTER SESSION — 5:00 P.M.

JOSHUA TREE

Sponsors:
City of Desert Hot Springs
Mission Springs Water Agency
Tetra Tech

DINNER — GRAND BALLROOM — 6:30 P.M.

Congresswoman Mary Bono

SALTON SEA SYMPOSIUM

DAY 2

Registration **ATRIUM** **7:30 A.M.**

Introduction **MIRAGE BALLROOM** **8:00 – 8:15 A.M.**

Dr. Milton Friend, Executive Director, Salton Sea Science Subcommittee

Session I – Physical Environment of the Sea **8:15 – 9:50 A.M.**

John F. Elder, U.S. Geological Survey – *Moderator*

Oral Presentations:

"Geology and Seismicity of the Salton Basin." **8:15 – 8:35 A.M.**
David Miller, U.S. Geological Survey, Geologic Division, Menlo Park, CA.

"A three-dimensional hydrodynamic model of the Salton Sea." **8:35 – 8:55 A.M.**
Christopher B. Cook, Gerald T. Orlob, and David W. Huston,
University of California, Davis, CA.

"Overview of physical and chemical limnology at the Salton Sea." **8:55 – 9:15 A.M.**
G. Chris Holdren and Andrew Montano, U.S. Bureau of Reclamation,
Ecological Research and Investigations Group, Denver, CO.

"Characteristics of Salton Sea Sediments." **9:15 – 9:30 A.M.**
Richard Vogl, Douglas Lipton, Levine-Fricke-Recon, Irvine, CA.

"Contaminants in the Salton Sea and its Drainage Basin." **9:30 – 9:50 A.M.**
James G. Setmire, U.S. Geological Survey and U.S. Bureau of Reclamation, Temecula, CA.

BREAK AND POSTER SESSION **JOSHUA TREE** **9:50 – 11:00 A.M.**

Sponsored by GTE

Session II – Biological Environment of the Sea **11:00 – 2:30 P.M.**

Doyle Stephens, U.S. Geological Survey – *Moderator*

MIRAGE BALLROOM

"Overview of the Little Critters." **Stuart Hurlbert**, Department of **11:00 – 11:20 A.M.**
Biology and Center for Inland Waters, San Diego State University, San Diego, CA.

"The Salton Sea: Hotspot for Microbial Diversity" **11:20 – 12:00 P.M.**

Diatom flora of the Salton Sea **11:20 – 11:30 A.M.**
Carina Lange, Scripps Institution of Oceanography, San Diego, CA and **Mary Ann Tiffany**, San Diego State University, San Diego, CA.

Ciliate diversity in the Salton Sea **11:30 – 11:40 A.M.**
Eugene B. Small and Glenn F. Gebler, University of Maryland, College Park, MD.

Naked amoeboid protozoa of the Salton Sea **11:40 – 11:50 A.M.**
Andrew Rogerson and Gwen Hauer, Oceanographic Center Nova,
Southeastern University, Dania Beach, FL.

Cyanobacteria of the Salton Sea **11:50 – 12:00 NOON**
Anne Michelle Wood, University of Oregon, Eugene, OR.

SALTON SEA SYMPOSIUM

DAY 2 (continued)

LUNCH **GRAND BALLROOM** **12:00 – 1:30 P.M.**

Dr. Milton Friend

Session II – Biological Environment of the Sea, cont.

MIRAGE BALLROOM

"The benthic invertebrates of the Salton Sea: distribution and seasonal dynamics." **1:30 – 1:50 P.M.**
Paul Detwiler, Marie M. Coe, and Deobrah Dexter, Department of Biology, San Diego State University, San Diego, CA.

"Phytoplankton and zooplankton population dynamics in the Salton Sea." **1:50 – 2:10 P.M.**
Mary Ann Tiffany, Brand K. Swan, and Stuart H. Hurlbert, San Diego State University, San Diego, CA.

"The possible importance of algal toxins: findings and prospects." **2:10 – 2:30 P.M.**
Kristen M. Reifel, Michael P. McCoy, Mary Ann Tiffany, Stuart H. Hurlbert, and D. John Faulkner, San Diego State University and Scripps Institution of Oceanography, San Diego, CA.

BREAK AND POSTER SESSION **JOSHUA TREE** **2:30 – 3:00 P.M.**
Sponsored by Mine Reclamation Corporation

Session III: Fish, Wildlife, and Vegetation **3:00 – 4:40 P.M.**

Dick Zembal, U.S. Fish and Wildlife Service – *Moderator*

MIRAGE BALLROOM

Oral Presentations:

"Fisheries Ecology and Fish Biology of the Salton Sea." **3:00 – 3:20 P.M.**
Barry A. Costa-Pierce, Ralf Riedel, and Lucille Helvenston, Gulf Coast Research Laboratory, Institute of Marine Sciences, University of Southern Mississippi, Ocean Springs, MS and Department of Biology, San Diego State University, San Diego, CA.

"Desert Pupfish of the Salton Sea." **3:20 – 3:40 P.M.**
Ron Sutton, U.S. Bureau of Reclamation, Denver, CO.

"The Importance of the Salton Sea to Pacific Flyway Waterbirds." **3:40 – 4:00 P.M.**
Nils Warnock, W. David Shuford, and Kathy Molina, Point Reyes Bird Observatory, Stinson Beach, CA.

"The migration of eared grebes through the Salton Sea." **4:00 – 4:20 P.M.**
Joseph R. Jehl, Jr., Hubbs-SeaWorld Research Institute, San Diego, CA.

"American White Pelicans." **4:20 – 4:40 P.M.**
Daniel W. Anderson, University of California, Davis, CA.

Where Do We Go From Here? **4:40 – 5:00 P.M.**

Dr. Milton Friend, Executive Director, Salton Sea Science Subcommittee

SALTON SEA AUTHORITY

The Salton Sea Authority

is a joint powers agency formed in 1993 by

- the Coachella Valley Water District
- the Imperial Irrigation District
- Riverside County
- Imperial County

The Authority's Board of Directors is comprised of elected officials from each of these member agencies.

The Torres Martinez Desert Cahuilla Indian Tribe and Federal, State and regional agencies are also represented within the Authority.

The Authority was formed to bring together the many stakeholders interested in understanding and addressing the Sea's challenges and making the most of the Sea's opportunities. The Authority believes restoration of the Sea is a unique opportunity to improve the environment and enjoy economic benefits in doing so.

The Salton Sea Authority is committed to maintaining the Sea as an agricultural drainage reservoir, protecting and enhancing the Sea as a critical link along the Pacific Flyway, stimulating recreational use and providing an environment for economic development. Before 1997, the Authority relied on funds provided by the member agencies and a small grant to carry out its mission. Since then, the Authority has received, or will receive, over nineteen million dollars from Federal and State appropriations and a State bond measure to further its mission.

The Authority has entered into a joint agreement with our Federal partner, the U.S. Department of Interior's Bureau of Reclamation. Together, our agencies are providing the engineering and environmental analysis to provide a restoration report to Congress to meet the terms of the 1998 Salton Sea Reclamation Act. Additionally, the Salton Sea Authority has provided, through a federal appropriation, all of the funding supporting the work of the Salton Sea Science Subcommittee. Their efforts led to the greatest degree of ecological understanding of the Sea ever compiled. The Authority is now supporting a series of pilot projects. The first underway is a wildlife disease program in concert with the US Fish & Wildlife Service, Department of Fish and Game and National Wildlife Health Center. Other pilot projects will address desalinization, harvesting fish and cleaning up the shoreline.

While the Authority's budget and activities have expanded, its commitment to action, entrepreneurialism, and partnerships has not waned. Over 90% of the Authority's budget goes to contractors to provide environmental planning, scientific, engineering, construction and operation services. The Authority's ability to maximize its use of funds is furthered by inherent and fostered relationships with federal, state, tribal, environmental and other agencies and organizations.

BOARD OF DIRECTORS

Tom Veysey, President
Imperial County Board of Supervisors

Roy Wilson, Vice President
Riverside County Board of Supervisors

Andy Horne, Secretary
Imperial Irrigation District Director

Tellis Codekas, Past President
Coachella Valley Water District Director

Don Cox, Past President
Imperial Irrigation District Director

Wally Leimgruber
Imperial County Board of Supervisors

Dorothy Nichols
Coachella Valley Water District Director

Jim Venable
Riverside County Board of Supervisors

SALTON SEA AUTHORITY

Tom Kirk
Executive Director
Nadine Mupas
Executive Secretary
78-401 Highway 111 Suite T
La Quinta, CA 92253
(760) 564-4888
Fax (760) 564-5288
www.lc.usbr.gov

SALTON SEA SYMPOSIUM

Dianne Feinstein
United States Senator

Representing the People of California since 1992, Dianne Feinstein was elected with the most votes cast for a Senator in American history. As California's senior United States Senator, she has built a reputation as someone who takes on, and wins, tough battles.

She is the first woman to serve on the Senate Judiciary Committee, where she won one of the toughest battles of her career in 1994 with passage of a ban on the manufacture, sale and possession of military style assault weapons. Senator Feinstein's anticrime efforts also won her the endorsement of every major law enforcement organization in California during her 1994 reelection campaign.

She authored the California Desert Protection Act, landmark legislation that protects over 7 million acres of California desert and designates two new national parks -- Death Valley and Joshua Tree -- and one national preserve -- the Mojave.

Other legislation she has authored includes the Comprehensive Methamphetamine Control Act of 1996, legislation to create a first ever Breast Cancer Research Stamp, and coauthored the Gun Free Schools Act and the Gang Abatement Act. She also successfully brokered an agreement to save the "Headwaters Forest," protecting thousands of acres of ancient old growth redwoods in Northern California.

Senator Feinstein is a native of San Francisco. In 1969, she was elected to the San Francisco County Board of Supervisors, which also serves as the city council.

She became Mayor of San Francisco in November 1978 following the assassination of Mayor George Moscone and Supervisor Harvey Milk. The following year, she was elected to the first of two four-year terms. As the City's first woman Mayor, Dianne Feinstein managed the City's finances with a firm hand, balancing nine budgets in a row. In 1987, City and State Magazine named her the nation's "Most Effective Mayor."

Following an unsuccessful run for Governor in 1990, Dianne Feinstein was elected to the Senate in 1992 to fill the remaining two years of then-Senator Pete Wilson's term when he resigned to become California's governor. In 1994, she was elected to her first full six-year term in the Senate.

In addition to her work on the Senate Judiciary Committee, Senator Feinstein sits on the Appropriations Committee, which provides funding to government agencies and communities, and the Rules and Administration Committee, which regulates Senate procedures and campaign finance reform.

She is also chair of the Senate Cancer Coalition and Vice Chair of the National Dialogue on Cancer, a coalition of 110 major cancer organizations and scientists seeking to improve research, care, treatment, and cure for cancer.

Dianne Feinstein received a B.A. in History from Stanford University in 1955. She was born on June 22, 1933, the daughter of a respected surgeon and professor of the University of California at San Francisco Medical School.

She is married to Richard C. Blum, Chairman of Blum Capital Partners Inc., Chairman of the American Himalayan Foundation and Honorary Consul General of Nepal. Her daughter, Katherine, is a Deputy City Attorney in San Francisco. She has one granddaughter, Eileen, and three stepdaughters, Annette, Heidi and Eileen.

David J. Hayes, Acting Deputy Secretary
Department of the Interior

David J. Hayes is the Acting Deputy Secretary of the Interior. He is serving as the Deputy Secretary in an Acting capacity pending his confirmation by the United States Senate.

As the Acting Deputy Secretary, Mr. Hayes is the second in command at Interior. He is responsible for assisting Secretary Babbitt in supervising and administering the Department's bureaus and offices, including the National Park Service, the U.S. Fish & Wildlife Service, the Bureau of Reclamation, the U.S. Geological Survey, the Bureau of Indian Affairs, the Bureau of Land Management, and the Minerals Management Service. The Department has a total of approximately 70,000 employees, and an annual budget of approximately $8 billion dollars.

Mr. Hayes also has responsibility for addressing legal and policy issues of special importance to the Department. By way of example, Mr. Hayes led the Interior team that acquired the Headwaters old-growth redwood forest in Northern California. He also is leading Interior initiatives related to the Lower Colorado River (including Southern California, Nevada and Arizona water supply issues), salmon recovery, hydropower regulation, Indian water rights matters and a number of eco-system projects, including the Salton Sea (CA), Trinity River (CA), Walker Lake (NV), and others.

Before entering the Administration in early 1997, Mr. Hayes practiced law for nearly twenty years in the environmental and natural resources field. Immediately prior to his federal service, he was a partner in the Washington, D.C. office of the national law firm of Latham & Watkins where he chaired the office's Environmental Department. Mr. Hayes is a former Chairman of the Board of the Environmental Law Institute, a non-profit research and publication center for environmental law and management professionals.

Mr. Hayes received an A.B. from the University of Notre Dame in 1975, summa cum laude, and a J.D. from Stanford Law School in 1978. He clerked for Judge William Jones and Judge Louis Oberdorfer on the United States District Court for the District of Columbia. He lives in Arlington, Virginia with his wife, Elizabeth, and their three children.

SALTON SEA SYMPOSIUM

Senator Dave Kelley
California Assembly, 37th District

Senator Dave Kelley, a Republican, was elected to the California State Senate in 1992 and is currently in the last two years of his second term of office representing the 37th Senate District. Before that, Dave served for fourteen years in the California Assembly, where he was first elected in 1978. Born and raised in Riverside County, he attended local schools and graduated from California State Polytechnic University, San Luis Obispo, majoring in citrus fruit production. His education was interrupted by service as a pilot in the U. S. Air Force during the Korean Conflict.

Dave has been a successful citrus rancher for over 40 years in the Hemet area, where he first became concerned with the increasingly complicated relationship between government and the agricultural industry.

Active in the Riverside County Farm Bureau since 1955, Kelley served as both president and vice president for a total of eight years, and also served on the board of directors of the California Farm Bureau Federation. Concern for the effects of property tax on agriculture led Kelley to become active in the establishment of an agricultural preserve program in Riverside County. He signed the first prime agricultural land preserve contract in the state in 1966. Later, he was appointed by then-Governor Ronald Reagan to a committee to advise the Legislature on development of a policy on open-space lands.

In 1968, the Peace Corps approached Kelley to help instruct trainees for service projects in southern India. During 1970 and 1971, he supervised replacement trainees on location in India.

Kelley has always been active in community affairs. He served as director of the Hemet-San Jacinto Basin Resource conservation District for ten years, served as president of the Century Club of Riverside County, is a member of the Hemet-San Jacinto Noon Exchange Club, the Lincoln Club of Coachella Valley, and the Farm Bureau.

Kelley currently serves on the following committees in the Senate: Agriculture & Water Resources, vice Chairman; Appropriations; Business & Profes5ions; Constitutional Amendments; Energy, Utilities and Communications; and, Transportation. He also serves as Chairman of the Senate Select Committee on Southern California water Districts' Expenditures and Governance.

Dave and his wife, Brigitte (Pronounced Brig-EE-Tah), are the parents of four grown children, and have ten grand- children. He and his wife are members of Trinity Lutheran Church in Hemet.

Jim Battin
State Assemblyman

Jim Battin represents the people of Eastern Riverside County and all of Imperial County in the California State Assembly.

He brings to the Assembly a deep concern for family values, dedication to community service and a commitment to a strong economy. Those concerns are reflected in his legislative agenda: bills that protect children, create jobs and help lift people out of poverty.

Jim's priorities are rooted in his real-life experiences. He is a father of three, a successful business executive and a tireless community volunteer. In his commitment to public service, Jim is following in the footsteps of his late father, James. F. Battin, a five-term Congressman in the 1960s, and later a U.S. District Court judge.

Jim worked as a television executive with KMIR-TV, the NBC television affiliate in Palm Desert, for 10 years before winning election with broad bipartisan support in the 80th Assembly District in 1994. He was easily re-elected to a third term in 1998.

In 1994, Jim was named Caucus Whip for the new Republican majority in the Assembly. He later served as the Republican Caucus Chairman, a job he re-assumed for the 1999-2000 session. As Caucus Chair, Jim directs Republicans' policy strategy, runs floor operations, manages the caucus and keeps members informed about legislation.

Jim has consistently advanced legislation that underscores his commitment to lower taxes and safer neighborhoods. His Assembly Bill 5 will lessen the financial burden on young families by removing the state sales tax on over the counter non-prescription medications and baby diapers. Another Battin bill, AB 54, takes aim at the crimes of gang members victimizing families across California. The bill lowers the age from 18 to 16 for which violent murderers are eligible for the death penalty.

Since coming to Sacramento, Battin has been a driving force behind reforming our criminal justice system to help keep our neighborhoods safe. Last session, the Governor signed Jim's AB 130, a bill designed to lock up repeat drunk drivers and keep them from getting behind the wheel. Another Battin bill provided language for the Governor's Juvenile Justice and Gang Violence Initiative, a ballot measure to be placed before the voters in 2000.

Jim Battin was born and raised in Montana. He attended the University of Oregon where he met his wife Mary. The Battins have lived in La Quinta for 13 years and have three children: Christopher, Bailey and Kelsey.

SALTON SEA SYMPOSIUM

Congressional Salton Sea Task Force

Congresswoman Mary Bono, R-44th District
Chair

Congresswoman Mary Bono represents California's 44th Congressional District. Bono was first elected with 64.7% of the vote in a special election on April 7, 1998, to fill the seat previously held by her late husband, the Honorable Sonny Bono, M.C. In November of 1998, the Congresswoman was reelected by an overwhelming majority to serve a full term in Congress.

The Congresswoman has been assigned to the Committee on the Judiciary, the Committee on Armed Services and the Committee on Small Business. As a member of the Judiciary Committee, Bono serves on the Courts and Intellectual Property and Immigration and Claims subcommittees. On National Security, Bono is a member of the Military Procurement and Military Personnel subcommittees.

For the Small Business Committee, Bono has been appointed to the Empowerment and Government Programs and Oversight subcommittees. In addition to serving as chair of the Congressional Salton Sea Task Force, she is a member of the Entertainment Task Force, Travel and Tourism Task Force and the Education Task Force.

A 1984 graduate of the University of Southern California, with a Bachelor of Fine Arts in Art History Degree, Mary worked her way through college, sometimes working two jobs at once. While celebrating her graduation from USC, Mary was dining with a friend at BONO restaurant when she met the restaurant's owner and her future husband, Sonny Bono. Their relationship blossomed, and in February of 1986, Mary Whitaker married Sonny Bono in Palm Springs, California.

A single-mother, Mary Bono has broad experience as a community leader. Mary has two children, Chesare Elan (10) and Chianna Maria (8). She served as first lady of the city of Palm Springs, and has been active in a wide range of community charities and service organizations. Mary was named Woman of the Year in 1993 by the San Gorgonio Chapter of the Girl Scouts of America for her assistance to victims of a tragic Girl Scout bus crash in Palm Springs. In addition, Mary served on the board of the Palm Springs International Film Festival, and played a leadership role in support of the D.A.R.E. program, Olive Crest Home for Abused Children, Tiempos de Los Ninos and many other worthwhile causes. In addition to time spent with her family, Mary's interests range from outdoor activities to a passion for computer technology.

The Congresswoman is a strong advocate of returning authority to local government, particularly in education. Bono opposes the existing federal tax structure, supports tax relief and advocates a reduction in the federal bureaucracy. A fundamental belief is the responsibility of the federal government to maintain a strong national defense and state-of-the-art armed services.

The 44th district includes the communities of Palm Springs, Moreno Valley, Palm Desert, Hemet, Cathedral City, Temecula, Blythe, Rancho Mirage, Banning, Indio, Indian Wells, Beaumont, Perris, La Quinta, Desert Hot Springs, Cabazon, Anza, Thermal, Idyllwild, Coachella, and other unincorporated areas of Riverside County.

Congressman Jerry Lewis, R-40th District

Member

Jerry Lewis, a lifelong resident of San Bernardino County and 30-year owner of a successful life insurance business, represents the 40th Congressional District of southern California, including most of San Bernardino and Inyo Counties.

Congressman Lewis is a senior member of the Appropriations Committee, which is responsible for funding all federal programs. He is chairman of the Defense Appropriations Subcommittee, the panel with jurisdiction over all national security matters including the entire Pentagon budget. In this capacity, he is a forceful advocate of critical defense and aerospace jobs in California. Lewis also serves on the Foreign Operations Appropriations Subcommittee and the Legislative Branch Appropriations Subcommittee. Lewis is also vice-chairman of the House Permanent Select Committee on Intelligence. In this capacity, he is responsible for legislative oversight and budget review of all classified U.S. intelligence and national security activities. Lewis is the immediate past Chairman of the VA-HUD and Independent Agencies Subcommittee, the panel responsible for funding federal housing, veterans affairs, NASA, the Environmental Protection Agency, the Federal Emergency Management Agency, the National Science Foundation, and other federal agencies.

In 1996, Lewis was elected Chairman of the House GOP California Delegation to lead California Republicans on legislative issues of importance to the Golden State. Lewis also serves as Co-Chair of the entire delegation and has worked successfully to unify California Republicans and Democrats to marshal the considerable clout of the 52-member delegation, the largest in the House of Representatives.

Lewis has secured federal funds for critical projects in Southern California including highway improvements along I-15 and I-40 in the high desert; a revolutionary cancer treatment center and NASA research at Loma Linda University; access road and terminal expansion at Ontario International Airport; and the construction of the Santa Ana flood control project critical to Orange, Riverside, and San Bernardino Counties.

Congressman Duncan Hunter, R-52nd District

Member

Congressman Duncan Hunter represents California's 52nd Congressional District, consisting of eastern San Diego County and Imperial County. He is a Vietnam veteran, who served in the 173rd Airborne and 75th Army Rangers. In 1973, he attended Western State University Law School in San Diego on the G.I. Bill, while also working at farming and construction.

He then opened a law office in Barrio Logan San Diego, assisting many in the Hispanic community free of charge and without government compensation. Hunter was practicing law there when he was asked to run againstCongressman Lionel Van Deerlin. In 1980, against the 18-year incumbent and in a 2 to 1 Democrat district, Hunter won the Congressional seat.

As Chairman of the House Armed Services Subcommittee on Military Procurement, Hunter presides over $60 billion in annual authorization for acquisition of military weapon systems and components, including full scale development and systems transition; military application of nuclear energy; and related legislative oversight.

Since assuming the chairmanship in January 1995, Hunter has successfully worked to restore procurement spending cut by the Clinton Administration. Congressman Hunter continues to focus his efforts on implementation of a ballistic missile defense system, revitalization of U.S. strategic bomber forces, upgrading U.S. sealift capabilities and deployment of the next generation of nuclear attack submarines. At his direction, the Department of Defense has begun streamlining the acquisition process by cutting the Pentagon's procurement workforce.

The 52nd District encompasses nearly all of the California-Mexico border. In 1988, Hunter wrote legislation making the military the lead agency in illegal drug interdiction. With its passage, he has followed by obtaining military units for building roads and fencing on the border with Mexico. This construction, which continues today, was begun in 1990 and has resulted in over 40 miles of border roads and fence in California.

He remains committed to sealing the U.S. border to illegal alien and drug traffic.

Congressman Hunter lives in Alpine with his wife Lynne and their two sons, Duncan Duane and Sam.

Congressman Ken Calvert, R-43rd District

Member

Ken Calvert, Republican of Corona, California, returned to the U.S. House of Representatives for his fourth term following the November 3, 1998 elections. He represents California's 43rd congressional district, which encompasses western Riverside County, including the cities of Riverside, Corona, Norco, Lake Elsinore and Murrieta.

Ken serves on the Science Committee and is the Chairman of the Subcommittee on Energy and Environment and a member of the Subcommittee on Space. He is also a member of the Resources Committee, where he serves on the Water and Power Subcommittee, and the Agriculture Committee, where he is a member of the Livestock and Horticulture Subcommittee.

During Ken's first three terms in Congress, he worked hard to keep March Air Reserve Base as a major employer in Riverside, and to bring new industry to the district. His first bill signed into law gives states more money to use on
education through a simplified collection process of oil and gas royalties, adding an additional $33 million over seven years which could be used to improve our nation's schools. His second bill signed into law, introduced as a result of
vandalism at Riverside National Cemetery, increases the penalties for desecrating our national cemeteries.

Ken's conservative beliefs are evident in his strong support for small business, lower taxes, a leaner, less intrusive federal government, and the elimination of unfunded federal mandates. His voting record reflects these beliefs, earning him 100 percent ratings by the Christian Coalition, the Chamber of Commerce, and the National Tax-Limitation Committee.

Ken Calvert grew up in Corona and attended neighborhood public schools, graduating in 1971 from Corona High School. After two years at Chaffey College in Alta Loma, he enrolled in San Diego State University, where he received a Bachelor's degree in Economics in 1975.

After graduation, Ken returned to Corona and became the general manager of a restaurant, a position he held for five years before moving into a career in real estate. He served as Chairman of the Riverside County Republican Party from 1984-1988, and past president of the Corona Rotary Club and the Corona Chamber of Commerce.

SALTON SEA SYMPOSIUM

SALTON SEA AUTHORITY

BOARD OF DIRECTORS

Tom Veysey
President

Tom Veysey, who is immediate past chairman of the Imperial County Board of Supervisors, serves as chair of the Salton Sea Authority Board.

He was elected to the Imperial County Board of Supervisors in 1996. Prior to that, he served on the Imperial County Planning Commission. He also is a member of the Imperial Grain Growers, Orita Growers Association, Stockman's Club of Brawley and the Calipatria State Prison Community Advisory Committee.

He currently chairs Imperial County's Public Protection Committee and is a member of the Administrative Services Committee. He is also a member of the Southern California Association of Governments (SCAG), the Imperial Valley Arts Council, and the Sexual Assault Response Team (SART).

Veysey holds a Bachelor's degree in farm management from Cal Poly, San Luis Obispo. He and his wife, Millie, live in rural Brawley. They have three children.

Roy Wilson
Riverside County Supervisor

Roy Wilson is Chairman of the Riverside County Board of Supervisors.

He was first elected to represent the 4th District in 1994 and was reelected in June 1998. The fourth district is the largest geographic region in the County, stretching from the North Palm Springs area south to the Salton Sea and east to the Colorado River and the California/Arizona border. The district covers more than 5,000 of the County's 7,300 square miles.

Prior to becoming a County Supervisor, Roy spent more than 33 years in higher education as an administrator and professor at California State University, Stanislaus (6 years) and College of the Desert (27 years). During more than 20 of those years at College of the Desert, Roy served in municipal government as a Planning Commissioner (3 years) and a City Council member (17 years) for the City of Palm Desert. He served four terms as Mayor of the city.

His civic duties also include 11 years as a governing board member for the South Coast Air Quality Management District, 20 years on the Riverside County Transportation Commission, and 4 years on the Mojave Desert Air Quality Management District. He currently serves as Chairman of the Coachella Valley Association of Governments and is immediate past Chairman of the SunLine Transit Agency.

In addition to civic duties, Roy has been active in professional journalism organizations, his teaching specialty. He has served as President of the California/Arizona Journalism Association of Community Colleges and President of the national Community College Journalism Association. In 1995, Roy was inducted into the Community College Journalism Association's Hall of Fame in Washington, D.C. Roy is the author of a textbook used throughout the United States and in Canada, which is now in its fourth edition. ***Mass Media/Mass Culture,*** is published by McGraw-Hill, the largest publisher of textbooks in the world. Because of time constraints imposed by his duties on the Board of Supervisors, Roy was joined for the development of the fourth edition by a co-author, his brother, a professor of mass communication and journalism at California State University, Fresno.

Roy holds bachelor and master's degrees from California State Universities and a doctorate in higher education from the University of Southern California.

Although Roy doesn't find much spare time, when he does, he enjoys visiting with his family, which includes five children and ten grandchildren. He also enjoys reading, traveling and hiking around his mountain cabin in Idyllwild.

.ndy Horne

Imperial Irrigation District Director Andy Horne was elected in November 1998. He represents Division I of IID, which includes the El Centro area.

Mr. Horne is a real estate agent. He was graduated from Central Union High School in El Centro and holds a Bachelor of Arts in history from the University of California, Riverside.

As an IID director, Mr. Horne serves on a number of study groups, including those focusing on: the budget; groundwater; public affairs; the Salton Sea; and the conservation and transfer agreement between IID and the San Diego County Water Authority.

He is a past president of the El Centro Rotary Club, the El Centro Chamber of Commerce & Visitors Bureau and the Imperial Valley Board of Realtors. He also is a former trustee of the McCabe Union School District in rural El Centro.
Mr. Horne and his wife, Alexa, live in rural El Centro. They have three children, Betsy, Stafford and Matthew.

Tellis Codekas

Tellis Codekas, Coachella Valley Water District president, has been active in the water community since 1976 when he was first seated on the CVWD Board of Directors.

In addition to running his family farming business, as A second generation date grower, he was senior vice president of Tenneco West in charge of dried fruit operations until his retirement in 1986.

A native of New York, Codekas moved to the Coachella Valley in 1941. He majored in business at the University of Portland and University of California, Los Angeles and returned to the Coachella Valley in 1950 to enter the family farming business.

Codekas was selected vice president of the CVWD shortly after he was seated on the board in 1976 and held that position until 1988 when he was elected president. He has been active in state, national and regional water organizations including the Association of California Water Agencies (ACWA), the national Water Resources Association and the Colorado River Users Association.

Governor Wilson appointed him as a member of she Colorado River Board of California in 1998. Prior to that, he served as an alternate member since 1981.

Don Cox

Don H. Cox is a member of the Imperial Irrigation District Board of Directors, representing Division 4, which includes the city of Brawley.

Cox was elected to the board in 1989 and re-elected in 1992 and 1996. He served as vice president in 1990 and 1995, and president in 1991 and 1997. He serves on the District's Water, Budget, EPA, Geothermal, Salton Sea, Energy and Salton Sea Emergency study groups.

He also served as a member of the Colorado River Board of California, as a member of the IID Water Conservation Advisory Board, as a director of the California Regional Water Quality Control Board, as a director of the California Farm Water Coalition and as a member of the Association of California Water Agencies Water Rights Committee.

He also has served as chairperson of the Salton Sea Authority.

Cox served in the United States Navy during World War II and earned a degree in agricultural economies from the University of California, Berkeley. He is a member of the Imperial Valley Vegetable Growers Association and several cotton boards.

Cox's term of office on the board expires on December 31, 2000.

Wally Leimgruber

Wally Leimgruber was elected to the Imperial County Board of Supervisors in 1998 to represent District No. 5 and is chairman of the board. Wally and his wife Marjie also own and operate a successful farming business in Holtville.

Born in Calexico, Wally Leimgruber was raised on the family farm. Graduating from Holtville High School in 1971, he continued on with his farming roots, starting his own farming business in 1972. Wally Leimgruber has been happily married to the former Marjie Dahm for 25 years and they have two children, Amy and Matthew, both currently attending California universities.

Wally and Marjie have been heavily involved in the community from coaching athletics to being members of the Pioneers Museum, Imperial Valley Swiss Club and the Navy League.

The Leimgruber family has also been active participants in 4-H, FFA and the American Field Service.

Dorothy Nichols

Dorothy Nichols, a retired cosmetologist, has served as a board member of the Coachella Valley Water District since 19[illegible]. A resident of Desert Ranch since 1966, Dorothy became involved in water issues when her husband Paul became a CVWD board member in 1971. In 1987, her constituents asked her to fill the seat vacated by Paul's death.

After being seated on the board, she has successfully won reelection to represent division IV of the district. Her division includes the eastern lower valley from east Indio to Bombay Beach in Imperial County near the southeastern tip of the Salton Sea. It includes Hot Mineral Spa, Bombay Beach, North Shore, Mecca, most of Coachella and a portion of Indio.

Dorothy has been active in state and national water organizations including Colorado River Users Association, National Water Resources Association and Association of California Water Agencies.

James Venable

Riverside County Supervisor

Jim Venable was born on a ranch in Hemet, California, right in the heart of Riverside County. He spent his entire life in the Third District, graduating from Hemet High School in 1954. He has seen this county grow and is committed to assuring that our children enjoy the quality of life with parks, schools and neighborhoods that he enjoyed as a child. Jim and his wife, Mary, raised eight children and have 20 grandchildren.

Jim has always been an innovator in both the aviation and racing fields. He learned to fly at the age of 14 and started crop dusting at the age of 16, amassing over 20,000 hours of flying time. Jim's father started an aircraft business in 1947, and Jim took over that business in 1960. Hemet Valley Flying Service was the pioneer company in fighting fires from the air and became the largest aerial fire fighting company in the United States, with offices operating worldwide. Jim retired from this business in 1996.

Jim also raced cars and pick-up trucks for over 20 years, winning many championships in the off-road circuit. In 1986, he stopped driving himself and built a nationally-known racing team using unknown young drivers, many of whom have become famous today in the Indy Car and NASCAR circuit. Jim was also the creator and designer of the NASCAR Craftsman Truck Series.

After these accomplishments in the private sector, Jim decided to put his energies into public life and to work tow[illegible] improving his community. He was elected to the Hemet City Council in 1993 and again in 1994. He was sworn into office [illegible] the Third District Supervisor for Riverside County in January 1997. The Third District covers 1398 square miles in the central portion of the county and includes the cities of Banning, Beaumont, Calimesa, Canyon Lake, Desert Hot Springs, Hemet and San Jacinto and the unincorporated communities of Anza, Aguanga, Cabazon, Cherry Valley, Homeland, Idyllwild, Menifee Valley, Romoland and Winchester.

Since taking office as Third District Supervisor, Jim's mission statement has been: "To honestly, fairly, and promptly serve his constituents; to foster unity among all business, community and governmental entities within the District; and to work together with the other members of the Board of Supervisors to build a strong economic base throughout Riverside County."

SALTON SEA SYMPOSIUM

William J. (Bill) Steele

Salton Sea Study Manager, Bureau of Reclamation

Bill Steele has worked for the Bureau of Reclamation for 20 of the last 24 years. For the past 18 months, Mr. Steele has served on detail as the Salton Sea Program Manager. In this position he has served as the Federal lead responsible for the overall coordination of activities among multi-agency groups established to develop alternatives to address the environmental needs of the Salton Sea and prepare the appropriate environmental compliance documents.

Prior to this assignment, Mr. Steele was assigned to the Bureau of Reclamation's Washington, D.C. Office of Policy. While in that position, his assignments included a wide range of activities related to Native American issues, Federal Highway funding on federal lands, and the Interagency Watershed Program under the direction of EPA.

Mr. Steele initially moved to the Washington Office in 1990, where he was involved with all segments of Reclamation's annual programming and budget process including the formulation, justification, review, and presentation of Reclamation's annual budget request to Congress. He also served as the Chief, New Programmatic Budget Structure Work Group. The task of this group was to review and recommend to the Commissioner new approaches to more programmatically explain and characterize Reclamation's new water resources management initiatives.

He also served for six years as Special Staff to Reclamation's Senior Policy Management Team's, Budget Review Committee, which is responsible for the development of all out-year budget proposals.

In addition to his assignment with the Bureau's Washington Office, Mr. Steele's experience includes: four years as a private consultant; two and one-half years as the Regional Planning Officer, Lower Missouri Region, Bureau of Reclamation, Denver, Colorado; six and one-half years as the Chief, Economics, Social, and Lands Resources Branch, Southwest Region, Bureau of Reclamation, Amarillo, Texas; one and one-half years as a senior economist, Southwest Region, Bureau of Reclamation, Amarillo, Texas; and three years as Chief, Division of Planning, South Carolina Water Resources Commission, Columbia, South Carolina.

In addition to his permanent assignments, Mr. Steele was requested to serve for the Bureau of Reclamation a one-year detail (1978–1979) to the U.S. Water Resources Council, Washington, D.C. to work on refining the Federal Principles and Standards for Water and Related Resources Planning.

In the summer of 1982, he was selected by the Bureau of Reclamation to participate in the Department of Interior – Department Managerial Development Program. His formal education includes a Bachelor of Science degree in Agricultural Economics and Master of Science in Resource Economics with a minor in City and Regional Planning, both from Clemson University, Clemson, South Carolina.

Mr. Steele is married and has three children. His family resides in Manassas, Virginia.

Milton Friend

Executive Director

Salton Sea Science Subcommittee, U.S. Department of Interior

Dr. Milton Friend has served as Executive Director of the Salton Sea Science Subcommittee since 1998. Prior to accepting the Salton Sea assignment, he was the director of the U.S. Geological Survey's National Wildlife Health Center in Madison, Wisconsin, which he established in 1975.

He also has served as an adjunct professor in the Department of Animal Health and Biomedical Sciences at the University of Wisconsin—Madison since 1987.

Dr. Friend has authored more than 100 scientific articles as well as an award winning field guide to wildlife diseases.

He has conducted field investigations and consulted on wildlife health issues throughout the world. His professional specialties are wildlife disease, disease ecology, wildlife ecology, wildlife management and epidemiology.

He maintains his office at the USGS Water Resources Division's Wisconsin headquarters.

Dr. Milton Friend received his Doctorate in Veterinary Science with a minor in Wildlife Ecology/Epidemiology from the University of Wisconsin.

SALTON SEA

AUTHORITY

Thomas J. Kirk III

Executive Director

Tom Kirk is the Executive Director of the Salton Sea Authority.

Mr. Kirk's professional background includes land, environmental and infrastructure planning as a consultant and as the Supervising Director of the Coachella Valley Association of Governments. Mr. Kirk was a fellow at the University of California Transportation Center and graduated No. 1 in his class with a master's degree in regional planning from the University of California, Berkeley.

He also graduated *magna cum laude* from the University of California, Los Angeles and is a public affairs graduate of the Coro Foundation. He has received numerous local, national and academic awards for his work. Mr. Kirk is also chairman of the La Quinta Planning Commission and is active in youth and adult sports.

SALTON SEA SYMPOSIUM

Alphabetical List of Day One Panelists & Speakers

Jose L. Angel, P E.
Chief of Basin Planning Section
California Regional Water Quality Control Board, Colorado River Basin

Jose is the Regional Board's Senior Engineer responsible for region-wide watershed Management Activities and development and implementation of TMDLs for the Salton Sea Watershed.

He has a Bachelor of Science Degree in Civil Engineering from the California State University-Fresno. He is also a California Registered Civil Engineer and a Hazardous Materials Specialist. Currently, Jose is the Program Manager for the monitoring program for the New River at the International Boundary and a member of the Binational Technical Committee for the Mexicali/New River Sanitation Program.

He has been a guest lecturer at the School of Engineering of the California State University-Fresno and has authored and co-authored several reports and publications on water quality impacts associated with discharges of wastewater into surface waters. For the last ten years, he has focused on development, implementation, and enforcement of Pollution control mechanisms to protect and restore water quality.

Mary Belardo
Tribal Chairperson
Torres Martinez Desert Cahuilla Indians

Mary Belardo has been Chairwoman for the Torres Martinez Desert Cahuilla for a total of 7 years.

She is involved in many Native American organizations including Bureau of Indian Affairs Advisory Board, Indian Child Family Services Board, California Indian Manpower Board, member of the Advisory Council on California Indian Policy, board member of the Tribal Business Information Center and a member of the USEPA National Tribal Operations Committee.

Also affiliated with several non-native groups, i.e., Salton Sea Authority, Coachella Valley Health Care Connection, Desert Breast Health Coalition, the Empowerment Zone and newly appointed to Imperial Irrigation District's community advisory board.

Mother of Dr. Frederick A. Johnson II and Terria Johnson, and grandmother Elka Medina.

Michael Bracken
Executive Director
Coachella Valley Economic Partnership

Michael Bracken is the Executive Director of the Coachella Valley Economic Partnership, which is a private-public venture of over 100 stakeholders in the Coachella Valley Region.

Michael brings over six years of experience in Local government and economic development to the position. His day-to-day responsibilities include the management of a marketing program designed to entice business relocation to the Coachella Valley. The annual budget for the non-profit corporation is about $500,000.

He has previously served in positions for the Cities of San Bernardino, Lancaster, Indio and Hesperia. He holds a Bachelor's in Business Administration and a Master's in Public Administration from California State University at San

Bernardino. During his college years, Michael was an NCAA athlete in the sport of Cross County and was a founder of Sigma Phi Epsilon Fraternity at Cal State San Bernardino.

His current activities also include participation on the City of Banning City Council where he serves as Vice-Chair of the Community Redevelopment Agency and as the alternate to the Riverside County Transportation Commission. Additionally, Michael serves as a member of the Board of Directors for the CDC Small Business Finance Corporation and is an adjunct Professor of Public Administration for California State University San Bernardino, teaching a graduate-level course he helped design in the Management of Local Economic Development.

Dr. Carlos Valdes Casillas

Instituto Technologico y de Estudios Superiores de Monterrey

Dr. Carlos Valdés-Casillas has been a professor at the Conservation Center for the Utilization of Natural Resources at the Monterey Institute of Technology and Advanced Studies, Guaymas Campus, Mexico, since 1992. He has served as the organization's director for the past two years. His current research priority is the delta of the Colorado River, where he leads an interdisciplinary team of biologists and sociologists in a science-based, community-implemented wetland restoration plan. Dr. Valdés has worked throughout Mexico on design of protected natural areas, coastal marine resource management, geographic information systems, and regional resource evaluation and planning. He received his doctorate in natural resource planning from Oregon State University.<O:P</O:P

Joe Findaro

McClure Gerard & Neuenschwander, Inc.

Joe Findaro is a Principal at McClure, Gerard & Neuenschwander, Inc. (MGN). He has been working on energy, natural resources, environmental, and Native American matters in Washington and at the state level for over 17 years.

He has extensive experience working with Congress, the Department of the Interior, the Environmental Protection Agency, the Department of Energy and the Office of Management and Budget. During the Reagan Administration, Findaro served as a Deputy Assistant Secretary for Water and Science at the U.S. Department of the Interior, where he directed internal programs and external affairs organizations for the Bureau of Reclamation, the Bureau of Mines, and the U.S. Geological Survey.

Thereafter, he was the Director of Federal Affairs for the Entergy Corporation, an electric utility holding company with operations in Louisiana, Mississippi and Arkansas. At the state level, he has handled energy, natural resources, tribal and environmental issues in the California Governor's Washington Office and as Counsel to the New York State Senate Committee on Environmental Conservation.

Findaro is an instructor in environmental law and policy at Catholic University. He has been active in every Republican Presidential campaign since Ronald Reagan was elected in 1980. Findaro was graduated from Fordham University School of Law, and Tufts University, summa cum laude.

McClure, Gerard & Neuenschwander, Inc. provides a select clientele with strategic planning, issues analysis, business development, personal government relations and active, hands-on lobbying. The firm is particularly knowledgeable dealing in energy, natural resources, environmental and Native American issues.

MGN monitors government activities through close personal contact with policymakers at all levels. MGN forecasts government's future directions, advises its clients and implements appropriate strategies to further its clients' goals. This often involves shaping and securing passage of future legislation, developing federal issues documents, obtaining and protecting Congressional appropriations for its clients' programs, or working to change government regulations.

Phil Gruenberg

Executive Officer, Regional Water Quality Control Board

Phil Gruenberg has been executive officer of the Regional Water Quality Control Board since 1989.

Gruenberg, who lived in the Imperial Valley from 1953 through 1967, graduated from California State University at Long Beach in 1975. He holds a B.S. Degree in Marine Biology.

Gruenberg began work for the regional board as a student assistant in 1972.

The Regional Water Quality Control Board is responsible for water pollution control within California's Colorado River/Salton Sea watershed. The regional board has an extensive history of involvement in the New River pollution problem and Salton Sea water quality problems.

Raymond D. Hart
Deputy Director
California State Department of Water Resources

Mr. Hart has a Civil Engineering degree from the University of California at Davis, and is a registered Civil and Geotechnical Engineer in the State of California. He currently serves as Deputy Director of California's Department of Water Resources overseeing and providing policy direction for the Divisions of Flood Management, Safety of Dams, Planning and Local Assistance, and Information Systems and Services Office, as well as The Reclamation Board.

His 22 years of increasingly responsible experience with the Department include positions in the Divisions of Safety of Dams, Fiscal Services, Planning, Local Assistance, the State Water Project Analysis Office, and Executive.

Mr. Hart was the principal author and program manager for the 1993 California Water Plan Update which established new methods for developing and reporting regional water budgets while greatly expanding public outreach during the entire development process. The public outreach and advisory processes established by Mr. Hart have recently been incorporated into California law so that all future California Water Plan Updates are done with public involvement. More recently, he oversaw the development and publication of the 1998 California Water Plan Update.

In addition to Mr. Hart's statewide water management planning responsibilities, he is responsible for managing the State's response during flood emergencies. He directed the efforts leading to the 1997 Governor's Flood Emergency Action Team's 30-day and final reports for improving flood management in California's Central Valley. He successfully sought and received new funding from the State Legislature to improve the Department of Water Resources emergency response capabilities, which proved invaluable in reducing the impacts of flooding during the 1998 El Niño flood year. He also led the efforts to facilitate flood control maintenance work of local agencies by engaging the U.S. Army Corps of Engineers in gaining consistent application of its regulatory authorities.

More recently, Mr. Hart directed the Department of Water Resources' $20 million effort to replace its legacy business information systems with new commercial off-the-shelf software. This new Enterprise Resources Planning software, which integrates human resources with financial, budgeting, controlling, and purchasing for all the Department's operations, was successfully implemented on time and on budget.

- Member of the American Society of Civil Engineers
- Past Board Member of the Interstate Council on Water Policy, a national organization of state and regional water management agencies
- Past Board Member of the California Utilities Emergency Association

Steve Horvitz
Park Superintendent
Salton Sea State Park

Steve Horvitz, Park Superintendent for Salton Sea State Park, has worked for California State Parks since 1974.

Past assignments include Millerton Lake, Malibu, Castle Crags, Bodega Bay, and others. Currently he is the Superintendent of the Salton Sea Sector that includes the Salton Sea State Recreation Area, Picacho State Recreation Area and Indio Hills Palms.

Steve is a Board Member of the Coachella Valley Mountains Conservancy, Fringe-toed Lizard Preserve and active with numerous environmental groups within the Coachella, Imperial and Yuma Valleys. He has been the Superintendent of the Salton Sea Sector since 1991.

His educational background is in Wildlife Biology and Resource Conservation.

Robert W. Johnson
Regional Director
Lower Colorado Region, Bureau of Reclamation

Robert W. (Bob) Johnson is the Regional Director of the Bureau of Reclamation's Lower Colorado Region. Headquartered in Boulder City, Nevada, the Region encompasses southern Nevada, southern California, most of Arizona, and small portions of Utah and New Mexico.

The Region's programs include management of the last 700 miles of the Colorado River, extending from Lee's Ferry in northern Arizona to the Mexican border. The Region serves as Water Master of the Lower Colorado River on behalf of the Secretary of the Interior. In addition, the Region provides states, Indian Tribes, and local water resources entities assistance with the planning and development of programs and projects to help meet local water needs.

Johnson is responsible for directing all of Reclamation's programs and activities in Southern Nevada, Southern California, and Arizona. He supervises and works with Area Office managers in these states to develop and manage Region wide policies and guidance for all Regional programs.

A Reclamation employee since 1975, Johnson has held several managerial positions, including Deputy Regional Director and Chief of the Water, Land and Power Operations Division in the Lower Colorado Region. He also served in a management position in the Office of the Commissioner in Washington D.C. He began his Reclamation career at Reclamation's Mid-Pacific Regional Office in Sacramento, California.

Johnson has received numerous awards during his career, including the Department of the Interior's Meritorious Service Award, the second highest Departmental award for career employees. Johnson received the award for his expertise and accomplishments in formulating policies related to economic and financial management issues on several of Reclamation's largest projects.

Johnson is a graduate of the University of Nevada-Reno, with a Master of Science degree in agriculture and resource economics.

Johnson, a native Nevadan, is married and has two children

Robert Bradford Luckey
Executive Officer
Imperial Irrigation District

Brad Luckey is the Executive Officer of the Imperial Irrigation District.

IID hired Luckey on November 1, 1999. His primary function, under the direction of the Board of Directors, is to advance the interest, rights and plans of the District involving all relationships with private and governmental entities, industry, community groups and the general public.

He will also provide general assistance to the general manager so that policies of the Board of Directors are fulfilled.

Luckey was the chief executive officer, operations manager and owner of Luckey Farms, a diversified farming operation that produces alfalfa, alfalfa seed, wheat, cotton, Sudan grass, market onions, processing onions and carrots.

A member of the Tolerance Reassessment Advisory Committee for the EPA and USDA, Luckey is also a member of the Imperial County Farm Bureau Board of Directors; the University of California Desert Research and Extension Center Research Advisory Committee; the University of California Agriculture and Natural Resources Advisory Board to the Joint Policy Council; Planters Ginning Company Inc. Board of Directors and Imperial Grain Growers Inc. Board of Directors, where he is also past president.

Luckey served as a supervisor for the Imperial County Board of Supervisors from January 1993 through December 1996. He was a member of the IID Water Conservation Advisory Board from March 1980 through May 1989 and a board member of the Imperial County Retirement System from July 1994 through December 1996.

A native of Brawley, California, Luckey attended California State Polytechnic University, San Luis Obispo from September 1972 to June 1976. He majored in agricultural business management and agricultural engineering.

Luckey is a patron member of the Western Water Foundation, a founding member of the California Alfalfa and Forage Association and a member of the Brawley Chamber of Commerce.

Mike Madigan
Chairman
California Water Commission

Mike Madigan is employed by the City of San Diego to coordinate the East Village Development Project, including the new San Diego Padres Ballpark. He previously worked for 21 years for Pardee Construction Company where he retired as Senior Vice President, Development Coordination.

Prior to his association with Pardee, Mike served San Diego Mayor Pete Wilson for 5-1/2 years as Assistant for Program and Policy Development. He is a native San Diegan, former Naval Officer and a graduate of San Diego State University. He is chairman of the Bay Delta Advisory Council (BDAC), successor to the Bay Delta Oversight Council (BDOC, of which he was also chairman; Chairman of the California Water Commission; a member of the Board of Directors of the San Diego County Water Authority; Treasurer, Board of Trustees of Children's Hospital, and Health Center of San Diego and Chairman of the San Diego Library Commission.

Mike is past Chairman of the Board of the Greater San Diego Chamber of Commerce, the San Diego Armed Services YMCA, *the* San Diego Coalition for Equality, Board of Trustees of Children's Hospital and Health Center of San Diego, and the San Diego County Water Authority. He is also a past president of the San Diego County Council of the Boy Scouts of America and of the San Diego County Unit of the American Cancer Society.

Raymond L Orbach
Chancellor
University of California, Redlands

Dr. Raymond L. Orbach has been Chancellor at UC Riverside since April 20, 1992, where he is also Professor of Physics.

Chancellor Orbach received his Bachelor of Science degree in Physics from the California Institute of Technology in 1956. He received his Ph.D. degree in Physics from the University of California, Berkeley, in 1960 and was elected to Phi Beta Kappa. He was a National Science Foundation Postdoctoral Fellow at Oxford University the following year. He was then an Assistant Professor of Physics at Harvard University before going to UCLA as Associate Professor of Physics in 1963. For the ten years prior to coming to UCR he was also Provost of the College of Letters and Science at UCLA.

Chancellor Orbach's research in theoretical and experimental physics has been supported by the National Science Foundation and the Office of Naval Research and has resulted in the publication of 235 scientific articles. He was elected Faculty Research Lecturer at UCLA for the year 1989-90. He was the Andrew Lawson Memorial Lecturer at UCR for 1991-92. He has held a National Science Foundation Senior Postdoctoral Fellowship, two Alfred P. Sloan Foundation Fellowships, and a John Simon Guggenheim Memorial Foundation Fellowship.

Chancellor Orbach has a strong commitment to teaching. He has postdoctoral, graduate, and undergraduate students working in his laboratory, and he teaches the calculus-based Freshman Physics at UCR each winter quarter.

Michael J. Spear
Manager, California/Nevada Operations
U.S. Fish and Wildlife Service

Michael J. Spear, a native of San Francisco, became manager of the California/Nevada Operations Office of the U.S. Fish and Wildlife Service in 1998. In that capacity, he directs FWS resource conservation activities in California and Nevada.

He is a graduate of the U.S. Naval Academy and also holds an MBA from Stanford University.
Previously he served as Regional Director, Pacific Region, FWS; Assistant Director – Ecological Services, FWS; Regional Director, Southwest Region, FWS Associate Director -- Environment, FWS; Assistant Director – Planning and Budget, FWS; Office of Program Development, Dept. of Interior; U.S. Department of Health, Education and Welfare and in the U.S. Navy's Nuclear Submarine Program.

Daniel Taylor
Executive Director
National Audubon Society-California

Daniel Taylor serves as Executive Director for the National Audubon Society-California. He leads the conservation and education efforts for the Audubon state program that includes 53 local chapters and 67,000 members.

Before assuming the post as State Director, Mr. Taylor served as western regional representative of the National Audubon Society for 17 years. His duties included leading National Audubon's work on protecting Mono Lake, endangered species protection, forest conservation.

A California native, he received an AB degree in zoology from University of California, Davis, and an MA in Biology with emphasis in plant ecology from California State University, Fullerton.

Mr. Taylor is the immediate past chair of the Central Valley Habitat Joint Venture, a creation of the North American Waterfowl Plan. He has served on several state commissions including the California Timberlands Task Force, as established by SB 1580, and the Upper Sacramento River Fisheries and Riparian Habitat Advisory Council, as established by SB 1086.

He is married and the father of a fifteen-year-old son.

The mission of the National Audubon Society-California is to conserve and restore California's natural ecosystems, focusing on birds, other wildlife, and their habitats for the benefit of humanity and the earth's biological diversity. Priority issues for Audubon in California include the Salton Sea, San Francisco Bay, and wetlands conservation throughout the state.

SALTON SEA SYMPOSIUM

POSTERS

Presented in the Joshua Tree Room

Session 1

"Seasonal variation of nutrient, major ion, and metal concentrations in the Salton Sea, 1999." Andrew Montano and G. Chris Holdren, U.S. Bureau of Reclamation, Ecological Research and Investigations Group, Denver, CO.

"Nutrient dynamics in the Salton Sea--Implications from calcium, uranium, molybdenum, and selenium." Roy Schroeder, U.S. Geological Survey, Water Resources Division, San Diego, CA and William H. Orem, U.S. Geological Survey, Reston, VA.

"Characteristics of Salton Sea sediments." Richard Vogl, Douglas Lipton, Levine-Fricke-Recon, Irvine, CA.

"Reconstruction of prehistoric Lake Cahuilla and early American environments in southeast California using GIS." Tim Krantz, Joseph Buckles, and Kazuyuki Kashiwase, Salton Sea Database Program, University of Redlands, Redlands, CA.

"Earthquakes: planning for ground-rupture hazards." David Miller, U.S. Geological Survey, Geologic Division, Menlo Park, CA.

Session 2

"Ectoparasites of Fish and Invertebrates of the Salton Sea." Boris Kuperman, Victoria Matey, San Diego State University, San Diego, CA.

"Invertebrates of the Salton Sea: A Scanning Electron Microscopy Portfolio." Boris Kuperman and Victoria Matey, San Diego State University, San Diego, CA.

"Water in the Desert: Nutrient control, fish harvesting, etc." Stuart Hurlbert, San Diego State University, San Diego, CA.

"Diatoms of the Salton Sea." Carina Lange, Mary Ann Tiffany, Scripps Institution of Oceanography, San Diego, CA and San Diego State University, San Diego, CA

"*Chattonella* cf. *marina*, **A potentially Toxic Raphidophycean Alga in the Salton Sea."** Mary Ann Tiffany et al., San Diego State University, San Diego, CA.

"*Pleurochrysis pseudoroscoffensis*, Surface Film Dweller in the Salton Sea." Kris Reifel et al., San Diego State University, San Diego, CA.

"Sampling the Bottom-Dwelling Animals of the Salton Sea." Deborah Dexter et al., San Diego State University, San Diego, CA.

"Oxygen, temperature and mixing regime of the Salton Sea, 1997-1999." Brandon Swan et al. San Diego State University, San Diego, CA.

"Studies on the skeletal development of Hermesinium adriaticum, a flagellate from Salton Sea, California." Mary Ann Tiffany, San Diego State University, San Diego, CA.

Session 3

"Population surveys and preliminary contaminant analysis of birds on the Salton Sea." Douglas Barnum, USGS Western Ecological Research Center, Delano, CA.

"Salton Sea wetland habitats." Tim Krantz, University of Redlands, Redlands, CA.

"The Salton Sea Database Program." Tim Krantz, University of Redlands, Redlands, CA.

"Avian diseases of the Salton Sea." Milt Friend, Salton Sea Science Subcommittee, Madison, WI.

"Salton Sea Desert Pupfish Movement Study." Ron Sutton, Bureau of Reclamation, Denver, CO.

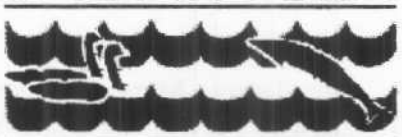
"Eared grebe mortality at the Salton Sea in the 1990s: Review of findings and new studies." J. Christian Franson, Lynn Creekmore, Carol Meteyer, Tonie Rock, and Mark Wolcott, National Wildlife Health Center, Madison, WI.

"Avian botulism in fish-eating birds at the Salton Sea." Tonie E. Rocke and Pauline Nol, USGS, National Wildlife Health Center, Madison, WI.

"A bacterial pathogen reconnaissance of the Salton Sea." Mark J. Wolcott and Brenda M. Berlowski, National Wildlife Health Center, Madison, WI.

Interactive display by the University of Redlands, Redlands, CA.

SALTON SEA

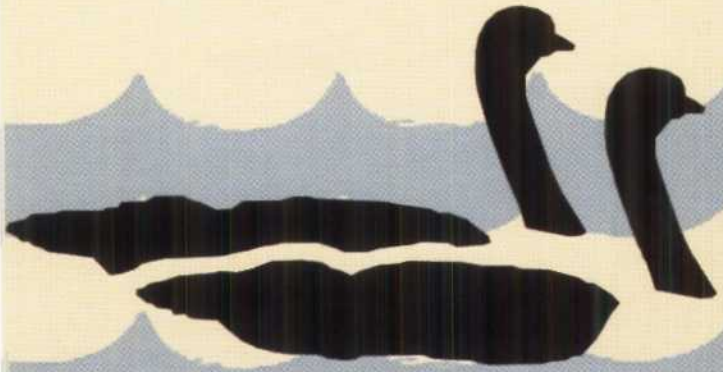


AUTHORITY

Debunking the Myths

Restoration of the Salton Sea is a unique opportunity to improve the environment and enjoy economic benefits of a major natural resource. The Salton Sea Authority stands committed to maintaining the Sea as a critical link along the Pacific Flyway, stimulating recreational use and providing an environment for economic development, and maintaining the Sea as an agricultural drainage reservoir.

As we begin to realize these goals, everyone involved in this effort can also assist by helping to dispel the numerous myths about the Sea that have spread throughout the country. These myths have made it more difficult to define the Sea's problems, explore and understand the Sea's possibilities and take the steps necessary to travel from understanding the problems to creating the possibilities.



Myths and Realities

Myth No. 1

"Given its man-made origin, the Sea should simply dry up and revert to its dusty and dry natural beginnings. Dust to Dust."

The Facts

This myth begins with the factual history of the Sea. Massive flooding in 1905 caused the Colorado River to break through an irrigation canal head works and flow freely into the Salton Basin for a year and a half. Man's "intervention" may have been to stop, in 1907, what had been a natural process for thousands of years.

Myth No.1 assumes that a static, dry, "natural" state exists in the basin. It does not. There have been numerous occurrences of flooding of the Salton Trough by the Colorado River since the mid-1800's. There have been at least 4 previous Salton Seas of greater magnitude during historic times. The last Lake Cahiaulla disappeared around 300-500 years ago.

Indians made use of a massive Sea's bounty during the 1500's, leaving behind artifacts recording their practices. Each time and countless times before, the Colorado River has meandered west and filled the Salton Basin with fresh water.

Drainage from 500,000 acres of farms in the two Valleys now sustains the Sea. The Sea is a designated Federal repository of agricultural run-off and agriculture is a billion dollar mainstay of the Valleys' economies. Agricultural use will continue into the future.

Myth No. 2

"The Salton Sea is a Marginal Ecological Resource"

The Facts

The Sea is increasingly important to the Pacific Flyway because over 92% of the wetlands that provided habitat value to birds along the Pacific Flyway in California have disappeared.

Several million birds migrate and inhabit the area every year. The Sea provides wintering habitat for over 450,000 ducks and up to 30,000 Snow and Ross geese. In fact, over 400 species of birds have been spotted at and around the Sea,, more than any other place in the U.S. other than the Gulf Coast of Texas. Endangered species also make the Sea their home, including the Brown Pelican and Yuma Clapper Rail.

The U.S. Fish and Wildlife Service was prepared to de-list the Brown Pelican until 1400 died at the Salton Sea in 1996, decimating approximately 1/3 of the California population. This and other bird die-offs is a significant issue but must be put into perspective with the safe, healthy refuge the Sea provides to millions of other birds every year.

Myth No. 3

"The Salton Sea is a Marginal Economic Resource."

The Facts

Before 1985, the Sea's State Park had more visitor days per year than did Yosemite National Park and press reports from the 1960's highlight the popularity of the Sea as a recreational destination. Complaints about overcrowding and conflict between boats and swimmers on the 350+ square-mile lake were common.

A 1985 California Fish and Game study found that the Sea was more productive (fish caught per angler hour) than any California marine fishery and equal to the most productive freshwater fisheries. A study now underway indicates that the fishery may be the most productive in the world.

Business and academic interests have suggested that a restored Sea could drive the regional economy for years to come.

Myth No. 4

"Mexicali Pollution is causing all of the problems at Salton Sea."

The Facts

While much publicized, water carried by the New Rive from Mexico is not a major contributor to the Sea's problems. In fact, only about 12% of the Sea's inflow originates in Mexico.

By the time water containing human and industrial wastes crosses the border and traverses the 60 miles to its delta at the Sea, the New River's water quality is nearly equivalent to that of the nearby Alamo River's. Waste from Mexico undergoes natural treatment in the River and is diluted by agricultural drainwater from the Imperial Valley. Additionally a wastewater treatment plant is being constructed in Mexicali to improve water quality in the New River.

Myth #5

"The Sea is a Toxic Dump Created by Agriculture"

The Facts

Pesticides are not found at any significant level in the Sea. Pesticide levels are periodically found to be high at some drains, but the Sea's shear volume and most pesticides' ability to biodegrade seems to limit their impact pact.

This was further validated with two independent studies conducted by the Salton Sea Science Subcommittee. This research indicated there were no pesticides detected in the sediment and water quality of the Salton Sea. A third study found extremely low levels of contaminants in the Sea's barnacles, a finding which surprised the researchers because the levels were much lower than found in the waters of San Diego.

Selenium is another concern. Selenium is a naturally occurring element in Colorado River water, the source of the vast majority of the Sea's water, not in the soils of the Imperial and Coachella Valleys. The infamous culprit at Kesterson reservoir in central California is found at about 1 microgram per liter in the Sea water, with some localized areas with higher concentrations. For comparison, the federal standard is 5 micrograms per liter and at Kesterson the level was about 80 micrograms per liter.

Then what are the Sea's actual problems?

The Facts

One is its immensity and complexity. It is California's largest inland body of water and supports an ecosystem of introduced and endemic biota. Another is its location. Far from urban centers and the usually vigilant eye of environmental interest, the Sea has been largely ignored. With the recent massive bird die-offs, the environmental community is waking to the Sea's problems and possibilities (the Audubon Society has made the Sea a #1 priority).

We do not know all that there is to know about the Sea. But we do know its problems include bird disease outbreaks, fluctuating surface levels, nutrient-rich water., algal blooms and fish kills. We are also certain of at least one factor that has and continues to contribute to the Sea's downward spiral of ecological and economic health: salinity. The Sea's salinity has steadily increased over the years. Now at 44 parts per thousand, or 25 0/o greater than the ocean, the hyper-saline environment is jeopardizing the survival of fish and will ultimately jeopardize the survival of much of the Sea's biological bounty.

And that is why we must act while there is still time to develop short term and ultimately long term solutions to restoring Sea. We must not cave in to the myths that have contributed to public confusion for so many years now. The Sea's immensity, complexity and remoteness may in the past have combined to create the Sea's greatest threat: uncertainty leading to unease resulting in inaction.

However, the knowledge developed from the extensive research on the real problems, coupled with the political will to take responsible action have made it a new day.

SALTON SEA AUTHORITY

The History and Culture of the Sea

SALTON SEA Restoration Project

SEA FACTS

The history of the Salton Sea area has been scrutinized in the last decade more closely, perhaps, than ever before, especially as the culture and history of the region's land and people are studied for environmental impacts. Although there may have been no historical events of global significance associated with the Sea, the creation of the Sea itself and the rise of the region's agricultural industry are two very important chapters in local and California history.

From an anthropological standpoint, the Salton Basin is rich in Native American history. Nine different Native American groups have occupied the area around the Salton Sea Basin, including the Cahuilla people, from whom the members of the present-day Torres Martinez Desert Cahuilla Indians are descended. When the Spanish made contact with the Cahuilla people in 1774, there were about 6,000 members of the tribe. In 1876, the US government established the 24,800-acre Torres Martinez Desert Cahuilla Indian Reservation; thirty years later, nearly half of the reservation was submerged when the basin flooded with Colorado River water to form the Salton Sea.

The University of California's Bancroft Library maintains a collection of Imperial County photographs from the turn of the 20th century. Many of the photographers were amateurs, who nonetheless often captured images of daily life of the Native American and early nonnative residents. At right is a photo of Antonio Martinez, a full-blooded Cahuilla man from Indio. A typical Desert Cahuilla Indian dwelling (below) was made of brush secured to a frame of branches.

Photos courtesy of Bancroft Library, University of California

Although Native Americans had occupied the Salton Basin for at least 12,000 years, it wasn't until 1771 that the first Europeans laid eyes on the Imperial Valley. As early as 1853, the valley was recognized as a potential garden spot in the desert, if only it could be adequately irrigated. This dream became reality with the building of the Imperial Canal in 1901. This event led to an agricultural boom in the Imperial Valley, and land speculators moved in, spawning such new towns as Calexico, Heber, Imperial, and Brawley. But in only three years, the canal could no longer supply the valley with water—its flow had become blocked with silt. The temporary diversion of the Colorado River that was constructed to replace the water from the blocked canal was breached

The History and Culture of the Sea (continued)

in 1905 during a flood, which proved to be the most significant natural event since Lake Cahuilla dried up: by the time the breach had been repaired, the overflow had created the Salton Sea.

Repairing the breach was an impressive engineering feat in itself. A railroad trestle, destroyed by the flood waters, was replaced by two trestles built across the breach to allow railcars to bring in fill material. Carloads of boulders, gravel, and sand were brought in 24 hours a day to build a dike, which, sixteen months later, would cut off the flow of Colorado River water to the Sea.

In 1911, the Imperial Irrigation District was established and began promoting a new canal to supply water to the valley. Congress authorized building the All-American Canal in 1928, and by 1942 the canal was supplying the Imperial Valley with water; the Coachella branch of the canal began carrying water in 1948. Today, the agricultural industry uses approximately 98 percent of the region's water supply.

As early as 1907, one of the first recreational pastimes that was promoted for the Salton Sea was sport fishing. When it began to catch on, the California Department of Fish and Game started stocking the Sea with game fish. By the 1950s, all manner of recreational pursuits had been promoted, including hunting, swimming, boating, water-skiing, birding, and hiking. With the recreational enthusiasts came other kinds of tourists, and with the tourists came hotels, resorts, restaurants, marinas, and a state park.

Today it's up to the Salton Sea Authority and the US Bureau of Reclamation, along with the many stakeholders and residents of the Salton Sea area, to find ways to make sure that the Sea has a future.

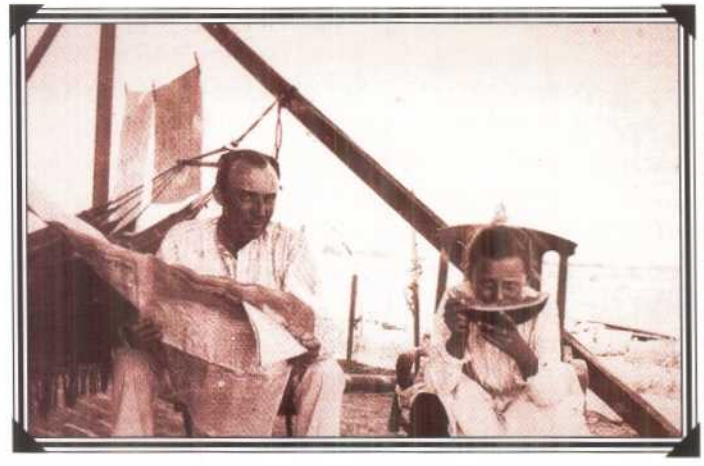
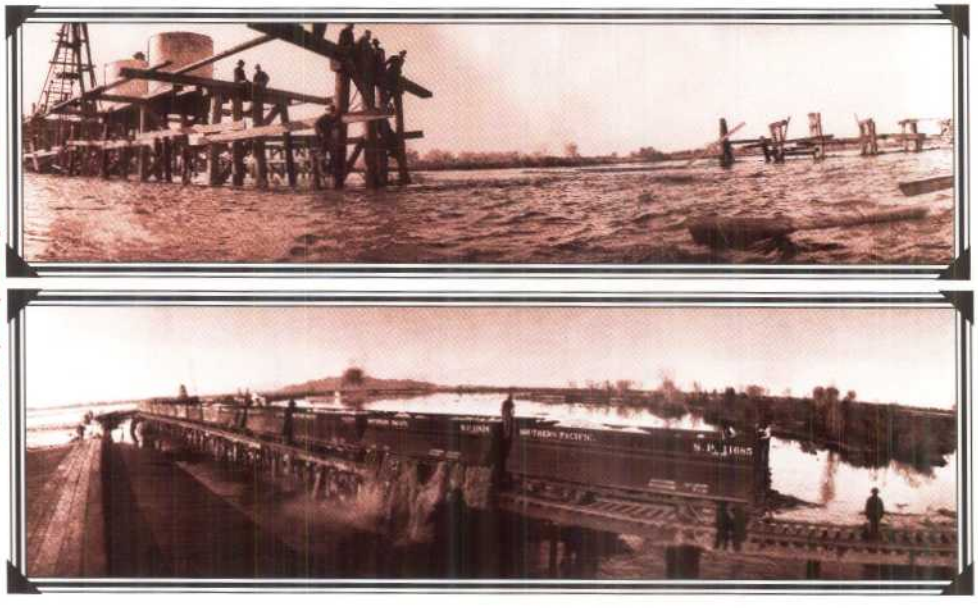


Photo courtesy of Bancroft Library, University of California

Mr. F. S. Miller reads while his daughter enjoys a slice of watermelon. Mr. Miller built Brawley's first hotel, The Bungalow, and the first school building, which doubled as a church on Sundays. Before moving to a new home, the Miller family lived in a tent "until the scare about the Colorado River overflowing and the danger of it flooding the Imperial Valley. Then the fun was all over and fear filled our souls."



Photos courtesy of Imperial Irrigation District

When the Colorado River breached, the force of the water all but destroyed the railway trestle that ran across one of its banks (top left). To mend the breach, two trestles were built; then carloads of boulders, gravel, and sand were brought in 24 hours a day to contain the outflow (below left).

The Geography of the Sea

SALTON SEA Restoration Project

SEA FACTS

"Partly cloudy, highs near 105. With the humidity and heat, a chance of isolated thunderstorms in the area this afternoon through Thursday."

—Forecast for Imperial Valley, July 7, 1999

Typical summer weather? Yes it is, for this southeastern corner of California. An unlikely setting for the largest lake in California? Well, yes and no. In fact, the Salton Sea area is part of the Colorado Desert ecosystem, whose annual precipitation rarely exceeds four inches. The meager rainfall supports such drought-tolerant vegetation as desert scrub, creosote bush, saltbush, and tamarisk; the area's streams and springs, which ultimately drain into the Salton Sea, support cottonwood, willow, and other plants found in freshwater marshes. Of course, the botanical landscape also includes acres of agricultural lands, with crops that owe their existence almost solely to water imported from the Colorado River to the east.

The Salton Sea is not the first body of water to occupy the Salton Basin. Historic evidence and geologic studies have shown that the Colorado River has spilled over into the Salton Basin on numerous occasions over the millennia, creating intermittent lakes. Evidence of an ancient shoreline suggests that Lake Cahuilla occupied the basin until about 300 years ago. From 1828 to 1904, Colorado River flows flooded the Salton Basin no fewer than eight times. For example, an 1840 flood created a salt lake three quarters of a mile long and half a mile wide, and in June 1891, another outpouring of Colorado River water created a lake 30 miles long, 10 miles wide, and six feet deep. So, how many times has Nature filled the basin with water over geologic time? There's no way we can know for sure, but humans have been responsible for inundating the basin only once.

In 1901 the California Development Company, seeking to exploit the Imperial Valley's potential for unlimited agricultural productivity, dug irrigation canals from the Colorado River. But heavy silt loads inhibited the flow, and new residents of the valley became worried, prompting the engineers to create a cut in the western bank of the Colorado, to allow more water to reach the valley. Unfortunately, water broke through the engineered canal and nearly all of the river's flow rushed into the valley. By the time the breech was closed, the present-day Salton Sea was created.

The Sea occupies the lowest portion of a structural basin called the Salton Trough, a seismically active valley that lies at the southern end of the San Andreas Fault and marks the northern extent of the Gulf of California Rift Zone. The northern end of the Salton Trough is bounded by the San Jacinto and Santa Rosa mountains to the west, the Orocopia Mountains to the north, and the Chocolate Mountains to the east. The area's highest mountain is Rabbit Peak, in the Santa Rosa Mountains, at 6,623 feet. The Salton Sea is longer than it is wide and stretches

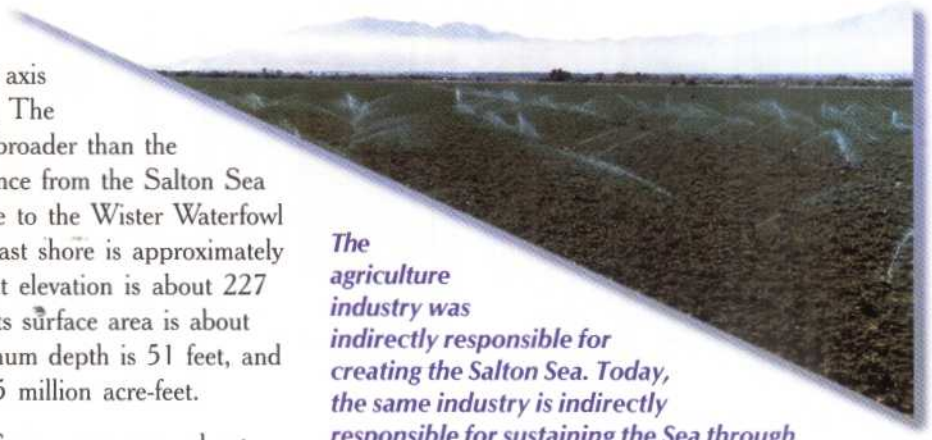
THE GEOGRAPHY OF THE SEA (PAGE 2)

along a northwest/southeast axis for approximately 35 miles. The southern half of the Sea is broader than the northern half, and the distance from the Salton Sea Test Base on the west shore to the Wister Waterfowl Management Unit on the east shore is approximately 15 miles. The Sea's current elevation is about 227 feet below mean sea level, its surface area is about 376 square miles, its maximum depth is 51 feet, and its total volume is about 7.5 million acre-feet.

The watershed of the Sea encompasses about 8,360 square miles and includes a small corner of San Bernardino County, some of Riverside County, most of Imperial County, the eastern portion of San Diego County, and part of the state of Baja California in the Republic of Mexico.

This salt flat near Bombay Beach is four to six inches thick. Water from the Sea periodically floods such low-lying areas, where it evaporates and leaves the salt behind. In the last century, entrepreneurs mined the area for salt, as the native people had done for generations.

Before the Salton Sea existed, the Salton Basin was well known to native people, explorers, and desert wanderers as a place with high concentrations of salt. You can still see portions of the trails walked by Native Americans of the Colorado River and the Pacific Coast on their long treks to bring salt from the Salton Basin to their villages. As early as 1815, ox-drawn carts were making the month-long expedition from Los Angeles to the Sea to supply new settlers



The agriculture industry was indirectly responsible for creating the Salton Sea. Today, the same industry is indirectly responsible for sustaining the Sea through runoff.

with the essential mineral, salt. In 1884, the economic value of salt was realized, and commercial mining began.

More recent economic activities in the area include the development of geothermal energy sources. Geothermal exploration began in 1957, and today several plants operate in Imperial County near Niland.

Ironically, the industry that played a supporting role in the Sea's creation—commercial agriculture—now has the lead in maintaining it, as the Sea is sustained primarily by agricultural drainage from the Imperial, Coachella, and Mexicali valleys (smaller contributions come from municipal effluent and stormwater runoff). Combined agricultural production in Imperial and Riverside counties amounts to well over $2 billion annually. In 1998, the top five agricultural products of Imperial County were cattle, alfalfa, head and leaf lettuce, and carrots[1]; in 1997, the top five agricultural products in Riverside County were milk, table grapes, eggs, nursery products, and hay.[2]

The Salton Sea offers many opportunities for recreation and is a popular destination for retirees seeking the serenity of the desert and the seemingly endless vistas of water, land, and sky—the Sea is so large that the distant shores are not visible in some areas due to Earth's curvature. The Salton Sea State Recreation Area occupies the northeast shoreline, while the Sonny Bono National Wildlife Refuge,

[1]Imperial County Farm Bureau

[2]Riverside County Farm Bureau

THE GEOGRAPHY OF THE SEA (PAGE 3)

operated by the US Fish and Wildlife Service, spans the southern shoreline.

Because its salt content (somewhat greater than the Pacific Ocean) causes vessels to be more buoyant, surface travel on the Sea is known to be the fastest in the nation. The Sea is so far below sea level, its high atmospheric density causes engines to perform much more powerfully than on other lakes. In fact, most of the world's aquatic speed records have been broken here.

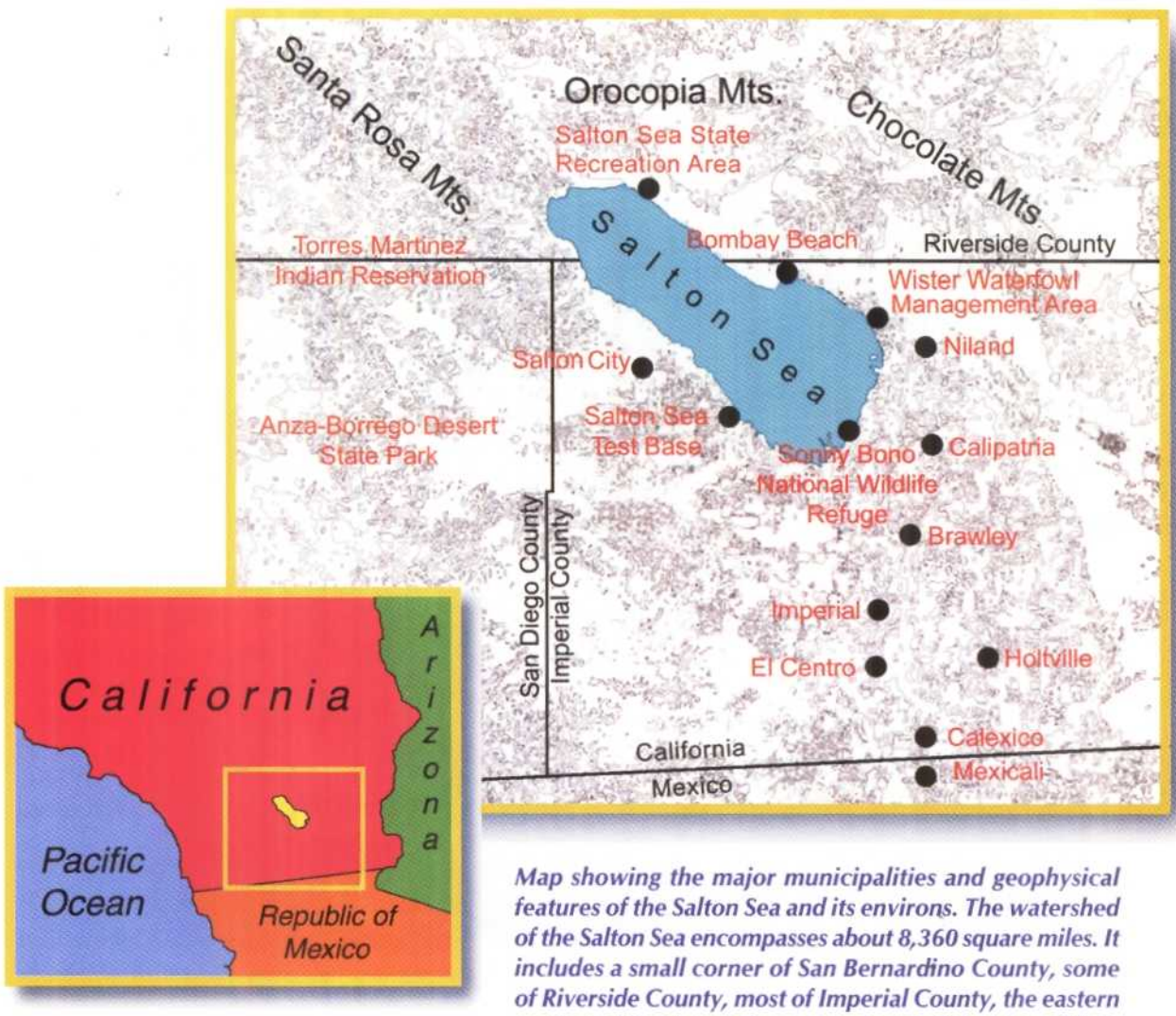
The popular sport fishery has been augmented over the years by numerous introductions of various fish species—striped bass in 1929, anchovy in 1948, halibut, croaker, bairdiella, mullet, and orangemouth corvina in 1950, grunion, flounder, sargo, and wrasse in 1951, threadfin shad in 1955, and tilapia in 1964. Such diversity has led to such fishing-oriented recreational developments as the Salton Bay Yacht Club, constructed in the 1950s, when the Sea was experiencing widespread popularity. In February

In this color-enhanced satellite photo, red represents mineral and rock types and green represents vegetation. The Salton Sea is in the center of the image, with the Orocopia Mountains to the northeast and the Santa Rosa Mountains to the northwest. The bright green area southeast of the Sea is the Imperial Valley, and the bright green to the northwest is the Coachella Valley. The diagonal strip to the southeast of the Salton Sea is the Algodones sand dunes. (Image processed by Lisa Heizer, San Diego State University, March 1994.)

THE GEOGRAPHY OF THE SEA (PAGE 4)

1955, the Salton Sea State Park, later to become the Salton Sea State Recreation Area, was dedicated. At the time, it was the second largest state park in California.

The Sea and the wetlands along its shoreline are a critical part of the Pacific Flyway, providing permanent habitat and seasonal refuge to millions of birds, representing hundreds of species. The Salton Sea is important to numerous migrating, wintering, and breeding bird species, particularly waterbirds. The Sea and adjacent wetlands, river systems, natural habitats, and agricultural fields also provide foraging and roosting opportunities. Typical mammals that inhabit the desert include bats and rodents, although most of the animals that flourish in this somewhat extreme environment are amphibians and reptiles.



Map showing the major municipalities and geophysical features of the Salton Sea and its environs. The watershed of the Salton Sea encompasses about 8,360 square miles. It includes a small corner of San Bernardino County, some of Riverside County, most of Imperial County, the eastern portion of San Diego County, and part of the state of Baja California in the Republic of Mexico. The Salton Sea occupies the lowest portion of a structural basin called the Salton Trough, a seismically active valley at the southern end of the San Andreas Fault.

FACTS ABOUT THE SEA

SALTON SEA Restoration Project

SEA FACTS

Our very own Salton Sea is unique for reasons that we sometimes take for granted. For that matter, even those who call the Salton Basin home may not know some of the interesting facts that make the Salton Sea one of the most unusual geographic features in the world. To learn more about California's largest landlocked body of water, read on.

The Salton Sea's surface area (376 square miles) as compared to other notable lakes: Mono Lake (60 square miles), Lake Tahoe (193 square miles), and the Great Salt Lake (1,700 square miles).

California's Dwindling Wetlands

1780: 5 million acres

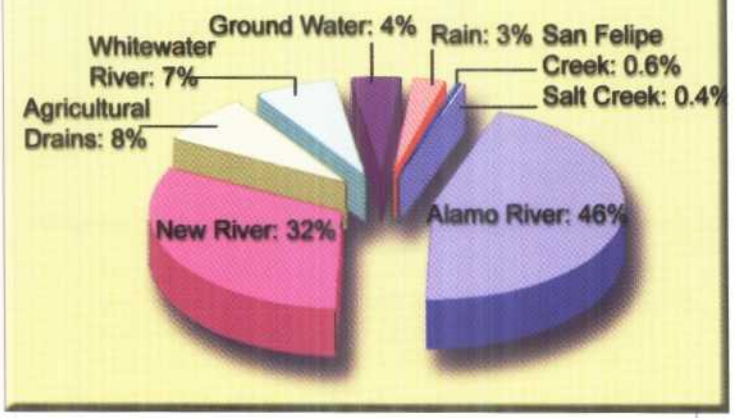
1954: 554,000 acres

1985: 454,000 acres

1999: 450,000 acres

As our wetlands decline, the importance of the Sea as habitat for wetland species increases. Since around 1780, 91 percent of California's wetlands have disappeared—more than from any other state in the US. The Sea's habitats support 40 percent of the entire US population of the threatened Yuma clapper rail, 80 to 90 percent of the American white pelican, and 90 percent of the eared grebe.

Sources of Inflow to the Salton Sea



Almost the entire inflow to the Sea (98 percent) is from agricultural runoff, which is transported to the Sea via rivers, creeks, and agricultural drains and by ground water infiltration.

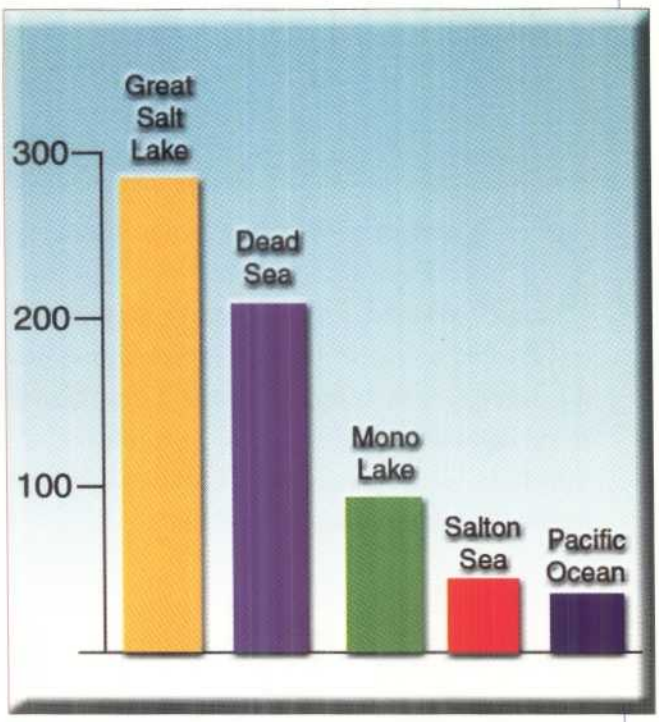
Recycled Paper

SALTON SEA RESTORATION PROJECT

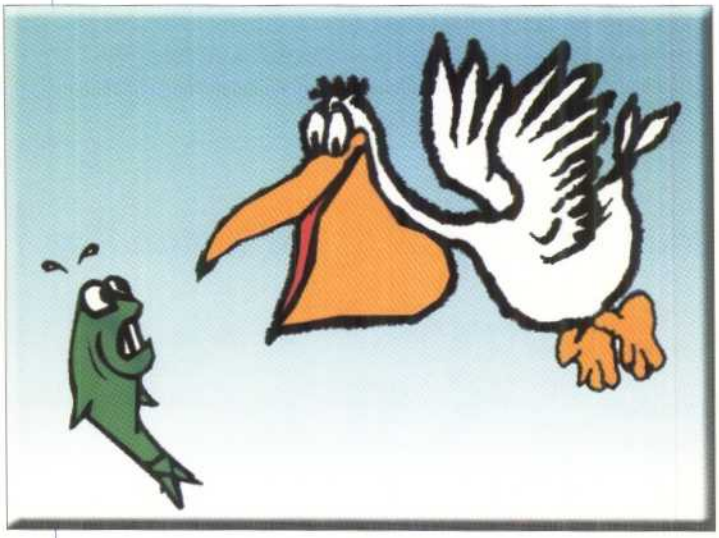
(760) 564-4888 or (702) 293-8129

Facts about the Sea (continued)

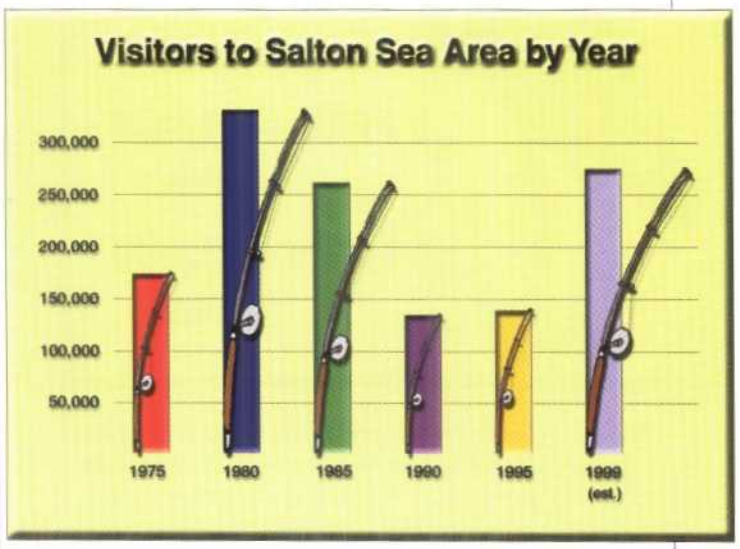
The level of selenium (Se, represented above in blue) recorded at Kesterson near Los Banos was approximately 80 parts per billion, before it was cleaned up; the US EPA's "level of concern" for selenium (represented in green) is five parts per billion. The selenium level at the Salton Sea? One part per billion (represented in red).



The salinity level of the Salton Sea is 44 parts per thousand (ppt), compared to 280 ppt for Utah's Great Salt Lake (at Gunnison Bay), about 210 ppt for Israel's Dead Sea, 87 ppt for Mono Lake, and 35 ppt for the Pacific Ocean.



During the winter, the Salton Sea is host to about 30,000 pelicans. Each bird gobbles up about five pounds of fish daily, for a total of 150,000 pounds of fish every single day. But with an estimated 200,000,000 fish in the Salton Sea, there's plenty to go around.



The numbers of visitors to the Salton Sea area has fluctuated over the past few years. One of the attractions is the Salton Sea State Recreation Area, which has 1,400 campsites in five campgrounds, hundreds of picnic sites, trails, playgrounds, boat ramps, and a visitor center.

SALTON SEA RESTORATION PROJECT
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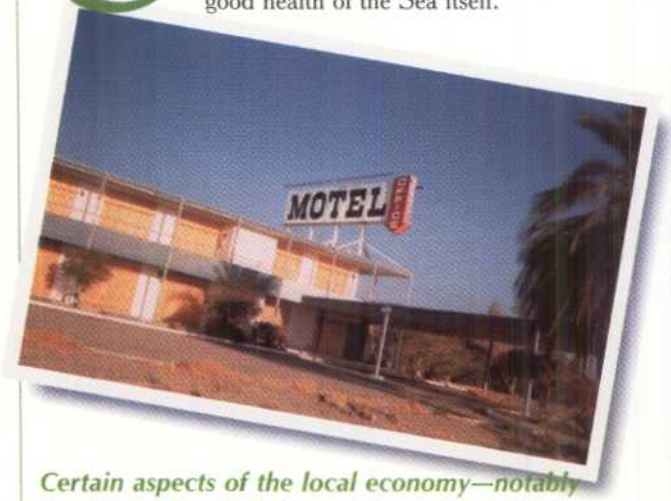
The Economy of the Sea

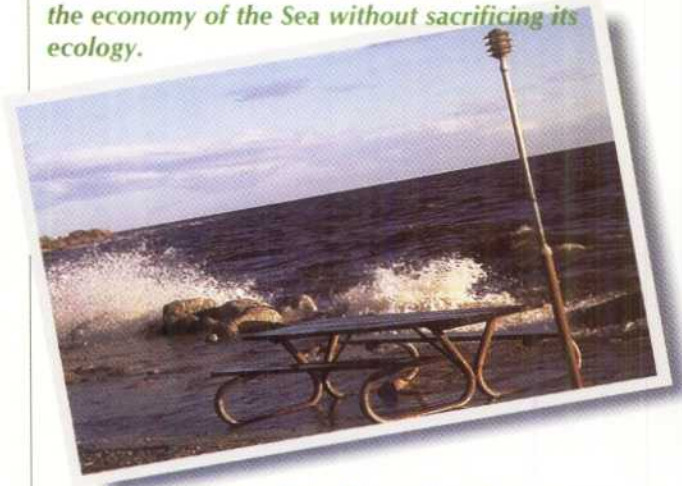
SALTON SEA Restoration Project

SEA FACTS

So many dire predictions have been made about the economic future of the Salton Sea and its environs that it's easy to believe that if the Sea's life systems die, the local economy will die too or that if the Sea is restored, it will rejuvenate all the industries connected with it—real estate, tourism, fisheries, geothermal, and agriculture. Of course the reality is far more complex than either of these scenarios, but an argument can be made that the economic well-being of the industries surrounding the Salton Sea is linked to the good health of the Sea itself.

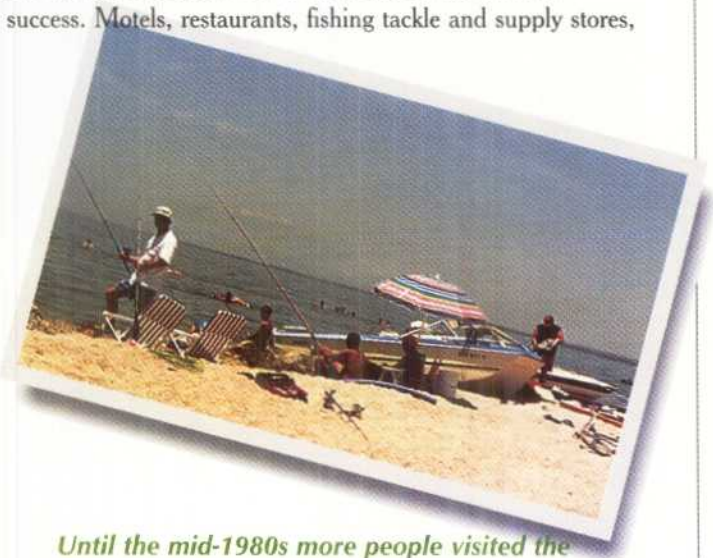


Certain aspects of the local economy—notably tourism and real estate—are in a slump. Rising water levels, unpleasant odors, and occasionally despoiled beaches are some of the factors that are affecting property values. The Salton Sea Restoration Project will address ways to improve the economy of the Sea without sacrificing its ecology.



The Salton Sea State Recreation Area at one time was the second most popular state park in California. In 1961, 400,000 boats were launched into the Salton Sea from this state park.

Economic activity in the Salton Sea area has been depressed for years. Residential lots laid out decades ago remain vacant. Many businesses have closed or are struggling because revenue is flat, and some commercial and residential buildings are unoccupied and in disrepair. Because many of the businesses depend on tourist dollars for survival, the decline in tourism has had a direct impact on business success. Motels, restaurants, fishing tackle and supply stores, recreational vehicle parks, and like businesses have suffered the brunt of this economic decline.



Until the mid-1980s more people visited the Salton Sea area than Yosemite National Park. In the future, when its water quality is improved, the Sea's beaches may all be as popular as Mecca Beach, shown above in a 1998 photo. (Photo courtesy of California State Parks, Salton Sea Sector.)

The Salton Sea—a literal oasis in the desert—has been attracting water-based recreation seekers almost since the beginning. Through the 1970s, locals and visitors alike enjoyed sunbathing, water-skiing, boating, fishing, swimming, camping, and picnicking. The Salton Sea State Recreation

THE ECONOMY OF THE SEA (CONTINUED)

Area was established along 20 miles of the northeastern shoreline to accommodate these visitors. But the Sea's attraction as a destination for outdoor enthusiasts has fluctuated in the last 20 years. The Sea's odor sometimes is unpleasant, its beaches periodically become littered with dead fish and birds, and its waters increasingly are clouded with blooms of algae, which are possible reasons why tourists are staying away. There is a perception that the Sea is a repository of toxic wastes from Mexico and that the numbers of fish have declined. Although these perceptions have no basis—in fact, fish catches at the Sea have never been more plentiful—they nevertheless may have had a negative effect on tourism.

The Sea's fishery in the past has been a significant resource, attracting anglers from all over the west. In 1989, the California Department of Fish and Game found the annual direct impact of the fishery to the local economy to be 50 to 65 million dollars. While the debate continues about how much salinity the Sea's fish will tolerate before they stop reproducing, it is generally accepted that the Sea's water is reaching the level at which some species will be adversely affected, and some fear that the fishery is on the verge of collapse.

The many geothermal plants south of the Sea, such as this one near Niland, generate an aggregate of 268 million watts of electricity and employ over 600 people.

From grapes to dates, agriculture has been a mainstay of the Salton Sea area economy for a hundred years. Today, the annual agricultural economy of Riverside and Imperial counties combined is two billion dollars. The Sea itself could not exist without its primary replenishment source—inflow from irrigation runoff—and the agriculture industry relies on the Sea as a repository of this runoff. Some area farmers have outfitted their fields with drip irrigation systems (below) to conserve water.

The region south of the Sea, between Heber and Niland, is called the Salton Sea Known Geothermal Resource Area for good reason—it supports 15 geothermal plants, employing approximately 600 people. The geothermal production wells tap into water reservoirs thousands of feet beneath the earth's surface, releasing superheated water, which drives turbines to generate electricity. The combined capacity of the geothermal plants in the Imperial Valley is approximately 268 megawatts.

The Salton Sea Restoration Project will address concerns about the Salton Sea area's economy and will try to balance the need to revive floundering industries with the need to preserve the Sea's ecology.

SALTON SEA SYMPOSIUM

DAY TWO PRESENTERS

Daniel W. Anderson
Professor, University of California, Davis--Areas of Expertise:
Ecotoxicology, Pollution/Wildlife Interactions, Avian Ecology, Seabirds, El Nino/La Nina studies.

My current research is in the Gulf of California and Colorado Delta, Southern California Bight and coastal California, Clear Lake, Eagle Lake, and the Klamath Basin. My involvement in the Salton Sea and Colorado Delta Area involves this: "my" major study species, brown and white pelicans both come through this area and spend a lot of time there; thus, just like them, I spend some time in this area, as well. I have spent time observing behavior of brown pelicans nesting and attempting to nest at the Salton Sea, observing their behavior and feeding interactions, measuring and examining carcasses, and I have been involved in aerial survey work of pelicans at the Salton Sea (with Ken Sturm). Our major study area for white pelicans (with Polo Moreno) has been in the Klamath Basin on the California/Oregon border; my major study area for brown pelicans is in the Gulf of California, where I have studied ecology and population dynamics of seabirds since 1971, emphasizing variations related to fishery activities, tourism, and natural environmental variability (El Nino phenonmenon, for example). Most of my current work with contaminants involves mercury and other elements/pesticides at Clear Lake, pesticides in the Klamath Basin, and heavy metals/pesticides in the Central Valley and Salton Sea involving coots, mallards, western grebes, more pelican work, and osprey as my major study species).

Education: BS (Zoology and Botany)--North Dakota State University, Fargo;
MS (Wildlife Ecology)--University of Wisconsin, Madison; PhD. (Wildlife
Ecology and Zoology)--University of Wisconsin, Madison. I studied under Joseph J. Hickey.

Previous affiliations: I started in 1971 as a Research Biologist with the US Fish and Wildlife Service, Denver Wildlife Reseach Center, in contaminant studies and I worked for a time under both James O. Keith and Milton Friend, who were my Section Chiefs, in that order. In 1976, I joined the University of California and have been there ever-since.

I currently teach classes in Ornithology, Ecotoxicology, and Field Biology at the University of California, Davis where I have been since 1976.

Douglas A. Barnum
Biologist, U.S. Geological Survey, Western Ecological Research Center

Research Interests include avian ecology, ecology of saline wetlands, ecology of arid lands endangered species, agricultural impacts on wildlife.

B.A. 1973 University of Missouri - Columbia
M.S. 1975 Washington State University
Ph.D. 1980 Brigham Young University

Nature of work at Salton Sea. Investigating general ecology, contaminant exposure, behaviors and movements of birds.

Richard W. Castenholz
Professor, Dept. of Biology
University of Oregon, Eugene, Oregon 97403

Expertise: Cyanbacterial systematics and ecology, ecology of hot springs and other extreme environments, effects of ultraviolet irradiation on cyanobacteria and microbial mats

Education - Ph.D. 1957, Washington State University, Pullman, Washington
Positions - University of Oregon, 1957 - present

Honors: Guggenhiem Fellow; Fullbright Scholar; Fellow of AAAS; Member, Bergey's Manual Trust, Fellow of American Academy of Microbiology

Christopher B. Cook,
Post-Graduate Research Engr. and Ph.D. Candidate, Univ. of Calif. Davis

Specialization: Mathematical modeling of surface water systems
Education: BS, 1991, Colorado State University; MS, 1991, and Ph.D., expected March 2000, Univ. of Calif. Davis
Previous Affiliations: Intern, Hydrologic Engineering Center, US Army Corps of Engineers; Undergraduate Researcher, Engineering Research Center, Colorado State University
Salton Sea activity: Project Manager; Field monitoring and hydrodynamic modeling of the Sea.

Barry A. Costa-Pierce,
Director, Mississippi-Alabama Sea Grant Consortium

Education

B.A. in Zoology (Honors)	1976	Drew University, Madison, NJ
M.S. in Zoology	1980	University of Vermont, Burlington, VT
Ph.D. in Oceanography	1984	University of Hawaii, Honolulu, HI

Other Education

Field Marine Science Course, Isle of Shoals Marine Laboratory, Cornell University, 1974
Honors Exchange Student in Marine Science, Spring Semester 1975. Rosenstiel School of Marine and Atmospheric Sciences, University of Miami, FL
Undergraduate Fellowship, Summer Semester 1975. Douglas Lake Biological Station, University of Michigan, Pellston, MI (Limnology, Phycology)
Undergraduate Scholarship, January 1976 Course in Marine Ecology, Marine Biological Lab, Woods Hole, MA (Completed with Honors)
Honors Student, 1976-77. Semester in Science, Ecosystems Center, Marine Biological Lab & the Woods Hole Oceanographic Institution, Woods Hole, MA (Completed Research on Salt Marsh Ecology and Global Climate Change at MBL. Completed Graduate Courses at WHOI/MIT in Antarctic Biology, Oceanic Zooplankton Ecology, Marine Physiological Ecology)

Current Professional Position

1998-date Director, Mississippi-Alabama Sea Grant Consortium and Professor of Coastal Sciences, University of Southern Mississippi, Ocean Springs, MS.

Research Interests

Ichthyology, fish population dynamics and fisheries management of perciform & sciaenid fishes; (2) Fisheries ecology, with emphasis on feeding ecology, digestive physiology, and food web trophodynamics; (3) Offshore cage aquaculture, with emphasis on bioengineering, systems ecology and environmental impacts. Ecosystems of principal interest are the Salton Sea and Gulf of California, the Gulf of Mexico, and the Great Lakes of Africa.

Salton Sea Experience

Worked on the ichthyology of the tilapias of southern California including the Salton Sea for Cal Fish & Game, 1995-97. Collected preliminary data on the fisheries ecology of Salton Sea while at Cal Poly, 1997-98. Principal investigator for Salton Sea fisheries population studies, 1999-present.

Joan Simpson Dainer

Current Affiliation, Title, and specialization: San Diego State University, Administrative Assistant for Center for Inland Waters and Salton Sea Project, Webmaster for Salton Basin-Colorado Delta Mothersite; specialization in limnology and computer wrestling

Education: The College of William and Mary, B.S. in Biology, 1967
San Diego State University, M.S. in Biology, 1999

Previous Affiliations:
1967-1990 High School Science and Mathematics Teacher in Missouri, Virginia, Texas and California
1988-1991 Instructor, Cerro Coso Community College, Bishop, California
1992-1999 Graduate Student and Teaching Assistant, San Diego State University; thesis research on horizontal distribution of lake plankton.

Work at the Salton Sea:
1996-present: Development of Salton Basin-Colorado Delta Mothersite, the primary internet source of information on the natural resources of the Salton Sea, its watershed, and the Colorado River delta region (see http://www.sci.sdsu.edu/salton/SaltonBasinHomePage.html)
1998-present: Assist coordination of SDSU Salton Sea Project, data analysis, computer graphics, and document preparation

Paul M. Detwiler

Center for Inland Waters and the Dept. of Biology, San Diego State University--Research Technician--Benthic Marine Invertebrates
Education: BA Marine Biology, BA Genetics (UC Berkeley, 1986)
MS Ecology, (San Diego State University, 1996)
Previous Affiliations: Lecturer, San Diego State, University of San Diego
Co-founder and Treasurer, Institute for Coral Reef Studies (non-profit organization founded in 1998)

Have worked as a science educator and researcher for the last ten years in Florida, Maine, Bermuda, and California, and as an Interpretive Naturalist for the National Park Service.
Nature of work at SS: collecting data on abundance and distribution of
benthic marine invertebrates in the field; detailing community composition and analyzing seasonal trends.
Misc: Other research interests include restoration ecology of vernal
pools and wetlands, management of commercially important echinoderm species, and development of multimedia to raise public awareness of marine conservation issues.

Deborah M. Dexter

Current Affiliation, Title, and specialization: San Diego State University, Professor of Biology; specialization in marine ecology, benthic invertebrates of marine and saline lake ecosystems

Education: Stanford University, B.A. in Biology, 1960,
Stanford University, M.A. in Education, 1962
University of North Carolina, Ph.D. in Zoology, 1967

Previous Affiliations: at SDSU since 1967; Investigations of sandy-beach faunas at universities and research institutes in Panama, Costa Rica, Colombia, Chile, Egypt, Mexico, Australia, Israel, Portugal and Thailand.

Work at the Salton Sea:
1990-1997: Studies on salinity tolerances of Salton Sea invertebrates; advisor to project on Experimental studies of effects of salinity and tilapia grazing in Salton Sea microecosystems

1998-present: Principal Investigator, Reconnaissance of the Biological Limnology of the Salton Sea (SSA/EPA grant); Investigation of seasonal dynamics and spatial distribution of benthic organisms; Biotic inventory of macroinvertebrates

D. John Faulkner
Professor of Marine Chemistry
Scripps Institution of Oceanography
University of California at San Diego
La Jolla, CA 92093-0212

Education

Imperial College, London	B.Sc.	1962	Chemistry
Imperial College, London	Ph.D.	1965	Organic Chemistry
Harvard University	post-doc	1965-7	Organic Chemistry
Stanford University	post-doc	1967-8	Organic Chemistry

Employment

1968-74	Assistant Professor	Scripps Institution of Oceanography, UC San Diego
1974-80	Associate Professor	Scripps Institution of Oceanography, UC San Diego
1975	Visiting Researcher	Cambridge University, UK
1980-	Professor	Scripps Institution of Oceanography, UC San Diego
1981	Senior Queens Fellow	University of New South Wales, Australia
1989	Visiting Scholar	University of British Columbia, Canada
1996	Erskine Fellow	University of Canterbury, New Zealand

Research on the toxicity of algal blooms in the Salton Sea

Other Research Interests

Chemical ecology of marine invertebrates, particularly sponges and opisthobranch molluscs
The role of symbionts in the production of sponge metabolites
Chemotaxonomic relationships in sponges
Biomedical applications of marine natural products, particularly in the treatment of inflammation, cancer, and viral and microbial infections
Use of marine natural products as biological probes to study basic cellular processes.

J. Christian Franson

Current affiliation: USGS, National Wildlife Health Center, Madison, Wisconsin
title: Research Wildlife Biologist
specialization: Wildlife Health

Education: Iowa State University
B.S. 1970
M.S. 1972
DVM 1979

Previous Affiliation: Research Veterinarian, Patuxent Wildlife Research Center

Nature of work at Salton Sea: eared grebe mortality investigation

Glenn F. Gebler
Graduate Research Assistant
University of Maryland at College Park
Department of Biology
College Park, MD 20742

Specializations include Protistology, Ciliophorology, and Chesapeake Bay Biology

University of MD at College Park, B.S. 1997.

Nature of work is the study of the Phylum Ciliophora.

Gwen T Hauer

Nova Southeastern University Oceanographic Center, Dania Florida
Graduate Student, Microbial Ecology
Bachelor of Science, Cal State University Bakersfield, 1992
Teaching Credential, National University, San Diego, 1993

Nature of the work at the Salton Sea: Naked Amoebae of the Salton Sea

Highlights: Currently 45 morphotypes (or species) have been observed in culture. About 20% of the isolates are new to science. Amoebae are
abundant in the Salton Sea, many species occurring at most sites sampled. Their role as microconsumers of bacteria and algae deserves
furthur study. Nine species were observed ingesting algae and pennate
diatoms. About eight species were found to survive in the salinity range 160-180ppt salinity, also a newly undescribed phenomenon in hypersaline environments.

G. Chris Holdren

Current Affiliation: U.S. Bureau of Reclamation, Denver, CO

Title: Manager, Ecological Research and Investigations Group

Specialization: Lake and reservoir management

Education: Ph.D., Water Chemistry (Civil and Environmental Engineering).
University of Wisconsin. 1977.
M.S., Water Chemistry (Civil and Environmental Engineering).
University of Wisconsin. 1974.
B.S., Chemistry. University of Nebraska. 1971.

Previous Affiliations:
Consultant specializing in lake management, 1988-1997
Associate Professor, University of Louisville, 1984-1988
Assistant Professor, University of Louisville, 1978-1984

Work at Salton Sea: Principal Investigator, Physical/Chemical Limnological Assessment of the Salton Sea

Miscellaneous: Former President, North American Lake Management Society

David W. Huston

Current Affiliation: M.S. Candidate, March 2000, University
of California, Davis - Water Resources Engineering
Education: B.S. Biological Systems Engineering 1996,
University of California, Davis
Nature of work at Salton Sea: Wind field analysis, field
monitoring and hydrodynamic modeling

Joseph R. **Jehl, Jr**

Senior Research Biologist, Hubbs Sea World Research Institute, San Diego.
Ph. D. U Michigan.
Once upon a time: Curator of Birds and Mammals, San Diego Natural History Museum (67-77).
Areas of specialization: avian ecology, systematics, physiology,
migration, salt lakes.
Conducted research at salt lakes in many areas of world for > 2 decades, but principally in Great Basin (Mono Lake, Great Salt Lake, Abert Lake, Salton Sea). Over 160 refereed publications, of which 40 or so deal with salt lakes.

Boris I. Kuperman, Ph.D., D.Sci.
Adjunct Professor of Biology, San Diego State University
Center for Inland Waters and Department of Biology, San Diego, CA

Formal Education

- Master of Science in Veterianary Medicine, Leningrad Veterinary Institute, USSR
- Ph.D. in Zoology (Parasitology), Zoological Institute, Russian Academy of Sciences, Leningrad
- D.Sci. in Zoology, Leningrad State University

Scientific Expertise
Parasites of fish and invertebrates, parasitic diseases, host-parasite interaction, free-living invertebrates.

Major Scientific Accomplishments:
Boris led programs at the Institute for Biology of Inland Waters (IBIW) and Zoological Institute of the Russian Academy of Sciences. He is an expert in parasitic diseases of fish and humans. In 1986 he organized the Laboratory of Ecological Parasitology at the IBIW and led it up to 1996. He was a director of the Russian-Finnish Project "Biomonitoring of Pollution Using Parasite Communities in the Volga River System, Russia". Boris was a head of numerous expeditions to different areas of the former Soviet Union. His research was focused on the biology, ecology, functional morphology, and development of fish parasites from the Volga River System, Onega and Ladoga Lakes, Amur River, waterbodies from Kamchatka Peninsula, and the Black and White Sea. Boris currently works as Adjunct Professor at the Biology Department of SDSU and Co-Investigator and Coordinator of Biotic Inventory in the Salton Sea Limnology Project. Boris has published 4 books and more than 100 papers in human and fish parasitology, fisheries ecology, and water quality.

Carina B. Lange

Education

B.S. in Marine Biology	1980	Universidad de Buenos Aires, Argentina
Ph.D. in Biological Oceanography	1988	Universidad de Buenos Aires, Argentina

Positions

1997-Indef	Associate Res. Oceanographer, GRD, University of California, San Diego
1995-Indef	Associate Res. Oceanographer, MLR, University of California, San Diego
1991-1995	Associate Specialist, GRD, University of California, San Diego
1990-1991	Assistant Specialist, GRD, University of California, San Diego
1986-1989	Staff Research Associate, GRD, University of California, San Diego
1985-1986	Laboratory Assistant, University of California, San Diego
1982-1984	Research Fellow, Consejo Nacional de Investigaciones Cientificas y Tecnicas, Buenos Aires, Argentina
1974-1982	Scientific Assistant, Geology, Instituto Antartico Argentino, Buenos Aires, Argentina

Professional Memberships

American Geophysical Union
American Society of Limnology and Oceanography
International Society for Diatom Research
The Oceanography Society
Asociacion Argentina de Ficologia

Recent Professional Activities

Micropaleontologist ODP Leg 175 (Aug-Oct 1997)
Associate Editor Cryptogamie-Algologie (Feb 1998-present)
Lecturer "Advanced Phytoplankton Course, Taxonomy and Systematics" (May 1998)

Nature of work at Salton Sea

Inventory of diatom species encountered in the plankton and benthos of the Salton Sea, and preparation of a catalog of all diatom species.

Victoria E.Matey, Ph.D., D.Sci.
Adjunct Professor of Biology, San Diego State University
Biology Department and Center for Inland Waters, San Diego, CA

Formal Education:

- Master of in Animal Physiology, Kishinev State University, USSR
- Ph.D. in Fish Physiology and Aquatic Toxicology, Leningrad State University, USSR
- D.Sci. in Fish Physiology and Cytology, Leningrad State University, Russia

Scientific Expertise:

Environmental physiology of fish, fish pathology, fish-parasite relationship

Major Scientific Accomplishments:
Victoria worked in several research programs at the Institute for Biology of Inland Waters (IBIW) and Institute of Evolutionary Physiology and Biochemistry of the Russian Academy of Sciences. She investigated the effects of water pollution on fish physiology and functional morphology. Victoria has been an active participated in the American-Soviet (Russian) Research Project "Water Acidification and Its Effect upon Aquatic Organisms: sponsored by the EPA. She worked as a visiting professor at the University of Maine, Orono, studying the effect of heavy metals on fish with special documentation by electron microscopy. Victoria was a leader of some international expeditions to contaminated waterbodies in Northern Russia. Now she is working as Adjunct Professor at the Biology Department of SDSU teaching the course in Parasitology and conducting parasitological and pathomorphological studies of fish from the Salton Sea at the Center for Inland Waters SDSU. Victoria published a book and more than 80 papers in physiology and functional morphology of fish, fish-parasite relationship, and aquatic toxicology.

Michael P. McCoy

Current Affiliation, Title, and specialization:
Scripps Institution of Oceanography, Graduate Student, Marine Natural Products Chemistry

Universities, Degrees, and years:
California State University Fullerton, Chemistry, 1997

Previous Affiliations and Titles:
Undergraduate Researcher, Rosenstiel School of Marine and Atmospheric Chemistry, 1996
Undergraduate Researcher, California State University of Fullerton, 1995-1997

Nature of work at Salton Sea:
Algal Toxins

David M. Miller, Ph.D.
Research Geologist
USGS, Menlo Park Research Center

Formal Education:

Bachelor of Science in Geology, Binghamton University
Ph.D. in Geology, University of California, Los Angeles

Scientific Expertise:

Surficial geology, active faulting, ecosystem geology

Major Scientific Accomplishments:

David has directed research programs in many parts of the Western U.S. and published on his wide spectrum of geologic studies. He has studied Great Salt Lake and its precursor, Lake Bonneville, for over 15 years, including their chemical evolution under changing climatic regimes. Since 1995 David has led USGS on the application of geology to understanding the susceptibility of the Mojave Desert ecosystem to a variety of impacts. Much of this work centers on recognizing the biologic communities that are specific to sediment deposits of certain ages and soil development, as a tool for extrapolating across the ecosystem. In 1997, David attended the workshop "Saving Salton Sea" and helped draft workplans for physical science studies crucial for providing scientific knowledge for that ecosystem, and he later contributed to the USGS "Tiger Team" that wrote a prospectus for long-term scientific study of the Salton Sea. David currently is the USGS Geologic Division lead on Salton Sea issues, and has responsibility for coordinating geochemical, surficial geology, seismic hazard, and bottom sediment studies.

Scott Miller

Current Position, NRC Postdoctoral Fellow
Ph.D.,Univ. of Oregon, 1999
Area of expertise: Cyanobacterial evolution,
particularly in extreme environments

Andrew M. Montano,
Aquatic Biologist

Affiliation: U.S. Bureau of Reclamation, Ecological Research and Investigations Group.
Education: Bachelors in General Studies, New Mexico Institute of Mining and Technology, Socorro, New Mexico - May 1994
Nature of work at Salton Sea: Chemistry of the Salton Sea

William H. Orem

Affiliation: U.S. Geological Survey, Reston, VA

Education:

B.S. in Chemistry, 1974, Lehigh University, Bethlehem, PA
M.S. in Oceanography, 1977, University of Delaware, Newark, DE
Ph.D. in Chemistry/Geochemistry, 1982, University of New Hampshire, Durham, NH

Experience: After completing his dissertation, Dr. Orem received a National Research Council Postdoctoral Associateship (1982-1984) with the U.S. Geological Survey to work on early diagenesis of organic matter in aquatic sediments. He joined the U.S. Geological Survey as a full time, permanent research scientist in 1984. Dr. Orem was also an adjunct faculty member at the University of Maryland, College Park, MD from

1983-1991. Dr. Orem's research work at the U.S. Geological Survey has included studies of biogeochemical processes in wetlands and marine sediments, organic geochemical studies of coal, application of organic geochemical methods in studies of ancient climates, and environmental geochemistry. His current research projects include studies of nutrient cycling in the Florida Everglades, the relation between sulfur contamination and mercury methylation in south Florida, and toxic organic substances from coal in relation to human health. Dr. Orem has been collaborating with Dr. Roy Schroeder (U.S. Geological Survey, San Diego, CA) on studies of nutrient accumulation and recycling in sediments and sediment porewater from sites in the Salton Sea.

Gerald T. Orlob,
Professor Emeritus, University of California at Davis

Specialization: Mathematical modeling of surface water systems
Education: BS and MS, 1948-49, University of Washington; PhD, 1959, Stanford University
Previous Affiliations: Univ. of Calif. Berkeley, Professor of Civil Engineering; Water Resources Engineers, Inc. CEO; Resource Management Associates, Inc. Principal
Salton Sea activity: Principal Investigator; Hydrodynamic Modeling of the Sea

Kristen M. Reifel
San Diego State University, Graduate Student, Research Assistant
University of California at Santa Barbara, 1992-1996, B. S.

Algal Toxins Survey researcher

Andrew Rogerson
Professor and Director of Graduate Programs at the Oceanographic Center Of Nova Southeastern University, Florida

Specialization - ecology and taxonomy of amoeboid protozoa
Education - PhD University of Stirling Scotland 1978
Previous Affiliations (summary from past to most recent) – University of Toronto (assistant prof); National Research Council Canada, Halifax (research associate); Culture Collection Algae and Protozoa, England (research scientist); University of California at Santa Barbara (research associate); University of London, England (senior lecturer).

Nature of work at Salton Sea - identification of naked amoebae (protozoa)

Roy A. Schroeder,
Research Hydrologist in Water-Quality

Affiliation: U.S. Geological Survey, San Diego, CA
Education: B.S. in Chemistry, 1964, Bethel College, No. Newton, KS
M.S. in Chemistry, 1966, Univ. of California, Berkeley
Ph.D. in Oceanography, 1974, Univ. of California, San Diego

Experience: After graduating from the Scripps Institution of Oceanography, Dr. Schroeder continued research into the biogeochemistry of amino acids while teaching in the Departments of Geology and Geophysics at Yale University and the University of Utah. He joined the USGS in Albany, NY, in 1978 and has been with the USGS in San Diego since 1985. Since 1996, his primary technical interest has been on the augmentation of ground water recharge with treated municipal wastewater for potable reuse in the Los Angeles area. Dr. Schroeder also has worked at various times since 1986 in the Salton Basin, where he has investigated contaminants in agricultural drainage, anthropogenic toxicants in the New River, and chemical concentrations on soils and sediments.

Jim Setmire
Hydrologist

U.S. Geological Survey currently on detail to the U.S. Bureau of Reclamation (30 years of federal government service)
Focus of work is on selenium in water, sediment and biota in the Salton Sea area
Bachelor of Science in 1968 from the University of Southern California with major in bacteriology and minor in chemistry.
Formerly Chief Western Lake Michigan Drainages Study Unit for the National Water Quality Assessment Program in Madison, Wisconsin.
Speaker at Salton Sea Symposium I and II

W. David Shuford

Current Affiliation, Title, and specialization: Point Reyes Bird Observatory (1975-present), Wetland Program Senior Scientist. Areas of primary interest are the biogeography and ecology of wetland birds in California and western North America. Major projects: Reconnaissance survey of the avifauna of the Salton Sea, Pacific Flyway (shorebird) Project, surveys of inland-breeding seabirds in California, ecology of California Gulls at Mono Lake.
Education: B.A., Colby College, 1971; M.S., Univ. California, Davis, 1973.
Previous Affiliations and Titles: not really applicable as have been affiliated with PRBO since 1975.
Nature of work at Salton Sea: documentation of the distribution, abundance, phenology, and habitat associations of birds using the Salton Sea and adjacent habitats.

Eugene B. Small
Associate Professor
University of Maryland at College Park
Department of Biology
College Park, MD 20742

Specializations include Protistology, Ciliophorology, Chesapeake Bay Biology

Wayne State University, B.A. 1953
Wayne State University, M.S. 1958
UCLA, Ph.D. 1964

Assistant Professor, U. of IL, Champaign
1965-1970

Associate Professor, U. of MD, College Park
1970-present

Nature of work is the study of the Phylum Cilophora.

Highlights include: Small, E.B. & Lynn, D.H. 1985 The Ciliophora in An Illustrated Guide to the Protozoa. ed. Lee, J.J, Hutner, S.H. & Bovee, E.C. Society of Protozoologists. pp 393-575.

Ron Sutton

Affiliation: U.S. Bureau of Reclamation in Denver, Colorado

Title: Fishery Biologist

Specialization: Evaluating effects of Reclamation's water projects on fishery resources.

Education: Master's degree in zoology from Southern Illinois University and a bachelor's degree in fishery biology from Colorado State University

Years of experience as a fishery biologist: over 20 years in the public and private sectors, including 5 years with the Bureau of Reclamation.

Nature of work at the Salton Sea: Studied movement behavior of the endangered desert pupfish among various habitats around the Salton Sea. This study was conducted during the hottest portion of the summer of 1999.

Brandon K. Swan

San Diego State University, Graduate Student, Research Assistant
Michigan Technological University, 1992-1997, B. S.
Biological Limnology researcher

Mary Ann Tiffany

Current Affiliation, Title, and specialization: San Diego State University, Research Assistant for Center for Inland Waters and Salton Sea Project, specializing in phycology and the plankton of the Salton Sea

Education: B. S. University of Michigan, 1966, M.S. University of Michigan 1968

Previous Affiliations: University of Michigan, studied water pollution of the Great Lakes. Docent at Scripps Institution of Oceanography Aquarium.

Work at the Salton Sea: Work has mostly been on the distribution of microscopic organisms in the lake, the phytoplankton and zooplankton. Began a project studying these in January 1997 which is continuing. Also worked on a project together with Carina Lange of Scripps Institution of Oceanography studying the planktonic, benthic and epiphytic diatoms of the Salton Sea. Side project studying a rare flagellate, *Hermesinum adriaticum*, which is present in the Salton Sea.

Charles C. Trees

Center for Hydro-Optics & Remote Sensing (CHORS), Research Professor
San Diego State University
Remote sensing ocean color, bio-optical properties and phytoplankton pigment physiology
B.A. in Biology - 1972 University of Kansas
M.S. in Oceanography - 1978 Florida Institute of Technology
Ph.D. in Oceanography - 1985 Texas A&M University

1989 - present	CHORS Deputy Director, Research Professor, Biology Department, SDSU.
1989 - 1990	Associate Research Biologist, Marine Resources Division, SIO, UCSD.
1987 - 1989	Assistant Research Biologist, Institute of Marine Resources, SIO, UCSD.
1985 - 1987	Assistant Research Biologist, Visibility Laboratory, SIO, UCSD.
1982 - 1985	Research Assistant, Department of Oceanography, Texas A&M University.
1982	Visiting Research Scientist, NASA/Goddard Space Flight Center.
1978 - 1982	Graduate Research Assistant, Department of Oceanography, Texas A&M.
1977 - 1978	Research Oceanographer, Coastal Ecosystems Mgt., Ft. Worth, Texas.

To perform HPLC analysis of algal pigments during various survey deployments.

Richard A. Vogl

LFR Levine Fricke, Senior Associate Hydrogeologist

CA State Univ. Los Angeles, BS Geology 1987, MS Geology 1990
University CA Irvine, Certificate in Environmental Site Assessment and Remediation, 1993

As an Environmental Consultant, has performed numerous sediment, soil, groundwater, and surface water contaminant investigations and remediations over the past 13 years, the last 9 with LFR.

Conducted Environmental Reconnaissance Investigation of the Salton Sea Sediment

Nils Warnock

Current Affiliation: Point Reyes Bird Observatory, Senior Scientist
Education: B.A., Psychology, University of Colorado, Boulder, 1983; Ph.D., Ecology, jointly awarded University of California, Davis and San Diego State University, 1994.
Previous Affiliations and Titles: 1994-1996, Postdoctoral Research Associate at University of Nevada, Reno and Simon Fraser University, Burnaby, Canada; 1997-1998, Statistician, US Forest Service and US Geological Survey, Corvallis, OR.
Nature of work at Salton Sea: Principal investigator of bird monitoring study.
Miscellaneous: Present research focuses on migration ecology, avian conservation, and management of birds along the Pacific Flyway.

Michelle Wood

Current Affiliation, Title, and specialization
Associate Professor, Dept. of Biology, University of Oregon, Eugene, Oregon 97403

Specialization: cyanobacterial diversity and adaptation,
biological oceanography, microbial ecology

Education: Universities, Degrees, and years.
Ph.D. 1980 University of Georgia (Ecology, Microbial Ecology)
Postdoctoral Fellow, Committee on Genetics,
University of Chicago (1980-82)
Postdoctoral Fellow, Committee on Evolutionary Biology
University of Chicago (1982-84)

Previous Affiliations and Titles:
Assistant Professor, Univ. of Oregon (1990-95)
Research Associate, University of Chicago (1984-1990)

SALTON SEA SYMPOSIUM

Day Two Oral and Poster presentations

STATE OF THE SALTON SEA—OPENING COMMENTS

Milton Friend, Salton Sea Science Subcommittee
8505 Research Way, Middleton, WI 53562

A basic perspective for viewing the Salton Sea is to recognize its uniqueness as a waterbody within the geographic area referred to as the Salton Trough. The dynamic past of periodic flooding within this area that formed large waterbodies such as ancient Lake Cahuilla is history. Some of those waterbodies rose to sea level and higher elevations before evaporating to dryness. Such events no longer occur because of control of the Colorado River through a series of dams and allocation of waters to meet the needs of human society. Unlike the transient waterbodies of the past, the Salton Sea is a permanent waterbody that is primarily sustained by agricultural wastewater. The Sea is also unique because, despite being highly saline, it has rich biodiversity. The fish and bird components of this biodiversity are fundamental values that underlie support for restoration of the Sea. There is limited information about large-scale ecosystems of this type and even less knowledge of how to manage such environments. Science has joined management in the Salton Sea restoration effort by pursuing the knowledge needed to better understand the dynamics of this ecosystem and by providing guidance for the implementation of that knowledge to achieve restoration goals.

This second day of the Salton Sea Symposium addresses, "New Scientific Information and Discoveries". An exciting array of information is provided that separates fact from fantasy and replaces myth and innuendo with factual information about the current "State of the Salton Sea". The presentations provided address the physical and biological environments of the Sea and the fish and bird species that are dependent upon and affected by those factors. Today's presentations are a milestone in our scientific understanding of this complex ecosystem. This milestone is "the end of the beginning", rather than an endpoint. This Symposium marks the end of an intensive 18-month effort to provide a foundation for decision processes that hopefully will result in actions for moving forward with restoration actions for the Salton Sea. The difficult task of evaluating the current "State of the Salton Sea" as a foundation for initiating such actions has been completed. The more difficult tasks lie ahead and, as for the task just completed, science has an important role in guiding the way to success. That role is described in the final presentation of this Symposium.

GEOLOGY AND SEISMICITY OF THE SALTON BASIN

David M. Miller, U.S. Geological Survey
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The geology of the Salton Sea basin provides a foundation for understanding the ecosystem of the Salton Sea and for making decisions on remediation facilities. Bottom sediments are important as substrates and nutrient sources for many of the Sea's organisms. Although the geology of the basin is exceedingly complex, the geology of most relevance to understanding the ecosystem distills into the characteristics of sediment near and under the Sea. Sediment characteristics are controlled by bedrock sources, topographic characteristics of the land across which sediment is transported, and by its final depositional site (lake, stream, or alluvial fan). The bedrock geology of the area can be classified into five primary types, each of which erodes to form distinct sediment. For instance, schist and mudstone are very different rocks, but they each create clay-rich sediment such as that along the west side of the Sea. Evaluating the geology of the basin by using appropriately classified bedrock can therefore help in placing bottom sediments into a basin-wide context.

Geology is also an important factor for engineering design for remediation facilities from levees to pipelines. Part of the geologic complexity of the basin stems from its position on the San Andreas fault system, along which two of the Earth's major tectonic plates, the North American and Pacific plates, move past one another. In addition, several parallel major faults in and near the basin, such as the Elsinore and San Jacinto faults, take up part of the plate motion, and all are seismically active. Earthquakes cause ground rupture and ground deformation that may damage and destroy engineered facilities located near the fault line; over wider areas earthquakes cause strong shaking that can cause damage far from an earthquake's epicenter.

Plans for remediation facilities in the Salton Sea basin are developed as general plans that will be followed by more specific, detailed, plans. Planning for earthquake-caused ground rupture and strong shaking must likewise consider different scales, or resolutions, of information. Initial planning for the entire basin has used two information sources developed by California Division of Mines and Geology to make decisions on locations for facilities that will minimize hazards from earthquake-induced ground rupture: (1) existing information for state-mandated zones along active faults (Alquist-Priolo zones), and (2) regional maps of active faults. However, many poorly understood faults that lie in the basin do not have defined Alquist-Priolo zones, so initial design may require later improvement as fault information is developed.

After remediation options are determined and as detailed design work for facilities begins, detailed scales of geologic map information can provide the necessary framework for evaluating earthquake ground-rupture hazards and susceptibility to strong shaking. For example, in the San Gorgonio Pass area where detailed studies are underway by the U.S. Geological Survey, the two main splays of the San Andreas fault shown on regional maps and defined by the Alquist-Priolo zones are now known to comprise a set of compressional (thrust) faults that complicate an otherwise straightforward interpretation of the San Andreas zone. Detailed geologic study of remediation facility locations will provide information appropriate for more informed decisions relating to many hazards other than earthquakes, such as landsliding and floods.

THREE DIMENSIONAL HYDRODYNAMIC MODELING OF THE SALTON SEA

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Proposals presented to the Salton Sea Authority to control water levels and reduce salinity include schemes to isolate portions of this shallow water body to form fill-and-draw evaporation ponds to concentrate brines for ultimate export from the basin. These ponds, formed by dikes, could enclose areas of 10 to 20 percent of the Sea's surface, primarily in the Southern Basin, and consequently significantly change natural wind-induced circulation. Under various proposed alternatives, the reconfigured Sea could ultimately be maintained at desired lower elevations to protect lands along the Sea's periphery, stabilized consistent with balanced inflows of agricultural drainage, precipitation, and surface runoff and losses through water surface evaporation and deliberate export. By exporting salts concentrated by evaporation, the salinity of the Sea, now at levels that threaten its delicate ecosystem, could be regulated to decline gradually towards concentrations near ocean levels, closer to native salinity levels of the introduced fish species.

Physical modification of the Sea's configuration and bathymetry, as envisioned in various alternative solutions of the water balance-salinity problem, is expected to change the distribution of wind shear stresses applied to the modified water surface and could hinder waters that circulate freely under present conditions. Possible consequences include increased scour and deposition of sediments, transport of nutrients and biota, and alteration of water quality levels that could be detrimental to the aquatic habitat. To assess quantitatively the potential consequences of physical changes in configuration and bathymetry, an established three-dimensional finite element hydrodynamic model has been modified and applied.

The numerical model, implemented on the computer, is comprised of a system of elements formed into a "grid" that represents the physical reality of the Sea, including the lower portions of three main tributaries that flow into the Sea. A set of equations that characterize fluid motions is solved in the model for a representative period of time to describe water motions, salinity, and temperature levels at all locations within the grid. When the model is provided with information on the direction and speed of winds over the Sea's surface, it creates a corresponding field of velocities in the water body. The model was calibrated and verified against time-series of field observations of water velocities and temperatures obtained during a year-long field campaign performed during 1997.

The model solution contains time-series records of water velocity, temperature and salinity at all locations within the grid. By comparing model solutions with and without the evaporation ponds, the model can be used to determine potential changes in the water quality (temperature and salinity) and locations where increases or decreases in water velocity occur. Preliminary management scenarios have been performed for several pond structures under both present and future water surface elevations.

CHEMICAL/PHYSICAL LIMNOLOGY OF THE SALTON SEA

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A one-year sampling program is being conducted to assess the current chemical and physical conditions in the Salton Sea. Analyses include general physical conditions and water quality parameters, nutrients, trophic state variables, major cations and anions, trace metals and organic compounds. Samples are collected from three locations in the main body of the lake and from the three major tributaries.

The Salton Sea was formed in 1905 when an accident caused the Colorado River to flow into the Salton Sink. The Salton Sea has a current water surface elevation of 227 feet below sea level and has no outlet other than evaporation. Salt concentrations have fluctuated over the years as the level of the Sea has changed, but levels have generally increased. The Salton Sea currently has a salinity of over 43 ppt, or about 30% greater than sea water. Proposed reductions in inflow volumes are expected to cause this level to increase.

Nutrient concentrations are high and lead to frequent algal blooms, which in turn contribute to low dissolved oxygen concentrations. The tributaries have a much lower salt content, but consist primarily of agricultural return flows with high nutrient levels. Concentrations of trace metals and organic compounds do not appear to be of major concern.

Once monitoring has been completed, data will be used to develop information on nutrient and suspended solids loading to the Salton Sea. The geochemical model, PHRQPITZ, will be used to evaluate potential chemical reactions limiting the solubility of selected water quality variables.

CHARACTERISTICS AND CONTAMINANTS OF THE SALTON SEA SEDIMENTS

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Douglas S. Lipton, Ph.D., LFR Levine-Fricke, Healdsburg, CA, USA

The study conducted by LFR Levine Fricke included collection of sediment samples from 73 separate locations within Salton Sea. The sediment sampling assessed and measured contaminant concentrations and evaluated particle size distribution in the bottom sediment of Salton Sea using both surface sediment grab samples and core sediment samples which provided information to sediment depths up to approximately 6 feet. This sampling effort encompassed the entire Sea plus approximately 1 mile up each of its three main tributaries: the Whitewater, the Alamo, and the New rivers.

Chemicals found at elevated concentrations and of potential ecological concern were cadmium, copper, molybdenum, nickel, zinc, and selenium. Selenium and molybdenum were found to be the most elevated inorganic constituents relative to background concentrations. Concentrations of selenium in general were elevated over much of the northern half of the Sea. The highest chemical concentrations (such as selenium, cadmium, and copper) were generally limited to the upper 1 foot of sediment.

The most common organic compounds found at the Sea included volatile organic compounds (acetone, 2-butanone, carbon disulfide) that appear to be associated with natural biological processes occurring within Salton Sea sediment. One of the most significant findings of this study was the number of organic chemicals commonly used in agriculture earlier this century that were not detected at elevated concentrations, such as DDT. Chemicals not detected above the laboratory detection limit in sediment samples include many semivolatile organic compounds, chlorinated pesticides and PCBs, organophosphate and nitrogen pesticides, and chlorinated herbicides.

CONTAMINANTS IN THE SALTON SEA
Jim Setmire, Hydrologist USGS/USBR

Contaminants of Concern: Selenium, Nutrients, DDE, Boron, Sediment

Dissolved solids or chloride as an indicator, Colorado River water = 750 mg/L TDS. Looking at agricultural processes that control dissolved solids. Possibly show DH/O18O16 plot that indicates that evaporation is the main process controlling dissolved solids concentrations in the subsurface drainwater of the Imperial Valley tile water = median. Tail water = similar to Colorado River water Surface Drains = median from 49 drain samples New and Alamo River's at outlet to Salton Sea = medians from detailed study. Salton Sea water = 44,000 mg/L and 15,000 mg/L chloride.

Selenium:

Colorado River water2 ug/L, Subsurface drainwater - In May 1988 measured subsurface drainwater at 119 sumps and gravity tiles had median 25 ug/L (1-360 ug/L).

In 1994-5 - sampled 820 sites within the Imperial Valley – Discharge and specific conductance were measured at all 820 sites. Laboratory analyses at 304 of the sites had Median selenium concentration of 28 ug/L ranging from 1-311 ug/L. Selenium in tile water increases by evaporative concentration in a similar manner to chloride or dissolved solids. Give Se/Cl ratios that demonstrate that highest selenium concentrations have similar ratio to Colorado River water and median subsurface drainwater and also Alamo River Tail water 2-3 ug/L. Surface Drains - August 1994 sampled 49 sites had median of 6 ug/L (2-52 ug/L). New and Alamo River's at outlet to Salton Sea median 4 ug/L and 8 ug/L.

Interface area – Alamo River 200 feet seaward of the end of the levee on the left bank - water 3 ft deep – at a depth of 1.3 feet sp cond 5,000 uS, DO 4.2 mg/L (56%) and Se 8ug/L. At 3 feet – sp cond 51,000 uS, DO 1.2 mg/L (18%) and Se1.0 ug/L. Special sample collected in June 1989 on river side of interface had total Se of 6.35 ug/L with 2.56 ug/L in the +4 selenite state and 3.79 in the +6 selenate oxidation state. At interface total Se 2.4 ug/L (<method specific reporting limit) with 1.79 ug/L at +4 selenite and <0.2 in the +6 selenate state. Salton Sea water 1 ug/L. None of selenium is in the highly oxidized +6 selenate state.

Selenium in sediments:

Colorado River if available. Soils from fields in Imperial Valley (270 soil cores representing 15 fields have median concentration of 0.2 ppm selenium ranging from <0.1 to 1.3 ppm. Bottom sediment from 48 surface drains in Imperial Valley have median concentration of 0.5 ppm ranging from 0.1 to 1.7 ppm. Bottom sediment in Salton Sea 11 sites have median concentration of 2.7 ppm with range from 0.58 to 11 ppm. Compare to particle size distribution table and contour plot – Very fine sediment <0.002 mm in deepest parts of Salton Sea have highest selenium concentrations. Composed of highly organic matter, low density detritus.

Selenium in biota:

Invertebrates from Salton Sea had Se concentrations ranging from 0.8 to 12.1 ug/g dry weight – critical dietary threshold is 5 ug/g – only pileworms had concentrations exceeding the threshold – very limited sampling in numbers and area. Fish in the Sea had higher concentrations than fish in the freshwater drain/river system.

NIWQP focus has been on selenium concentration in food chain of both fresh water system and in the Salton Sea. Bioaccumulation and biomagnification of selenium.

Nitrogen –	Nitrate plus nitrite	Ammonia
East Highline	0.22 mg/L	0.03 mg/L
Subsurface drainwater	12.0 mg/L	0.07 mg/L
Surface drainwater	4.95 mg/L	0.19 mg/L
Salton Sea	0.1 mg/L	1.41 mg/L

Organic nitrogen at 2.95 mg/L and Organic carbon 42 mg/L

OVERVIEW OF THE LITTLE CRITTERS

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In the Salton Sea, as in many aquatic ecosystems, the small organisms rule. They drive the system. They carry out most of the photosynthesis and most of the decomposition. Their metabolic and biogeochemical activities are a major determinant of water chemistry and water quality. They serve as the base of the foodweb that sustains the fish and bird populations at the Sea. Not much happens without their involvement. Some are pathogens or toxic. In this session, we will hear talks by specialists on seven different aspects of the biology of these little critters. Each speaker will give both general background information plus their recent findings. There are also six posters on different aspects of the little critters available for your viewing. The present talk aims to provide an introduction and context for these oral and poster presentations.

The Salton Sea's biology has received little serious study despite its relevance to the lake's value to man and wildlife. In the 1950s a small group of scientists from UCLA and the California Department of Fish and Game carried out a two-year survey of the lakes's limnology and fish following the successful stocking of the lake with marine fish, invertebrates and algae during the previous decade. In 1968-69 the Federal Water Pollution Quality Control Administration carried out a study of nutrient inputs to the lake and phytoplankton populations. Other biological investigations at the lake have been of a very sporadic and limited nature. The work reported in this session represents the most thorough study of the Sea's little critters ever carried out. The work is still in progress. It is being done primarily by scientists and graduate students at six different institutions around the country with funding from the Environmental Protection Agency, Salton Sea Authority, and other sources.

Two general types of studies will be reported, systematic and ecological. The systematic studies represent the attempt by some of the nation's top specialists in different taxonomic groups of organisms to determine what species are in the Salton Sea, a task more difficult than it may sound. Small organisms are hard to identify and classify and non-specialists often err when they attempt this. Five groups with large numbers of species were selected for special attention: cyanobacteria, diatoms, dinoflagellates, ciliates, and amebas. We also enlisted, on an ad hoc basis, specialists to identify new species found in less species-rich groups - the rotifers, roundworms, flatworms, segmented worms, and crustaceans. Altogether, as a result of this biotic inventory, the number of cyanobacterial, algal, protozoan, and invertebrate species known from the Sea has gone this year from about 70 to about 360 and is still climbing. At least a couple of dozen of these species are completely new to science, not just to the Salton Sea.

Four studies predominantly ecological in character are reported. The benthos and plankton have been sampled at regular intervals over a year or more to document their seasonal dynamics and spatial variability. These are the food supply for the rest of the system, and a number of important interactions with the physical-chemical environment have been documented. Ectoparasites of fish have also been monitored since 1997; they often cover baby fish so densely as to suggest their effects on juvenile mortality could drive fish population dynamics in the lake. Finally, the potential role of algal toxins in fish or wildlife mortality events has been assessed by extracting with organic solvents phytoplankton samples obtained from different blooms and testing them for toxicity to brine shrimp and mice.

THE DIATOM FLORA OF THE SALTON SEA, CALIFORNIA

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Diatoms are unicellular, eukaryotic (cells in which the nucleus is separated from the cytoplasm by a nuclear membrane; i.e. structurally more complex than prokaryotic bacteria), photosynthetic (i.e. they require light for the process of photosynthesis) microorganisms ranging from ca. 2 µm to ca. 2 mm in size. They are found just about anywhere there is light and moisture. They are far more diverse and abundant in freshwaters, where they are the most common organism and make up the base of many freshwater food pyramids. In the oceans, diatoms are most abundant in areas of upwelling (coastal and open ocean), where oceanic currents bring up the nutrients from deeper waters to the photic zone, and in polar latitudes. In these regions, they are the most important organisms at the base of the food chain.

Diatoms have a highly differentiated cell wall, which is impregnated with opaline silica, so that their growth is subject to the availability of silicon in the water. The diatom skeleton (frustule) is composed of two valves that fit together in a nested, overlapping fashion like a Petri dish. Diatom classification is based on the features of the skeleton.

Diatoms are important ecological indicators because they are sensitive to such factors as salinity, temperature, pH and pollution. In limnology, freshwater diatoms are the primary tool for reconstructing lake conditions, especially changes in pH and fertility. They play a key role in monitoring acid rain and the pollution of the world's freshwater. With the objective of documenting the diversity of diatoms in the Salton Sea and thus expanding the limited knowledge about these single-celled algae from this extreme environment we set out to identify and photograph all diatom species encountered in the phytoplankton and the phytobenthos of the Salton Sea (see poster). A catalogue of the diatom assemblages is being prepared which will serve as a guideline to the diatom flora of the Sea for use by future students and researchers.

In the Salton Sea there are four general categories of diatoms. Those that live in the plankton float freely about with the water currents. Some diatoms live on the bottom mud or in the algal mats, these are the benthic diatoms. Others, the epiphytic diatoms, attach to the macroscopic green algae which grow on the rocks and other hard surfaces near the shore. Also present in the Sea are diatoms that get washed in by the rivers and other inflows. Many of these probably don't live long in the high salinity but their valves are found infrequently in the water or sediments.

We have found a great diversity of diatoms; 92 taxa were distinguished on their basis of their morphological features at the light- and electron microscope level. These were found after examining samples collected at 19 different sites (including shore and open water samples). Whenever possible, taxa were identified to the level of species using published literature. Some of these are new to science. In addition, a few taxa showed peculiar morphological features, probably as a response to adaptation to the extreme environment of the Salton Sea, and are documented as "morphotypes" in need of further taxonomic work. The most abundant diatoms are marine planktonic species which is not surprising given the salinity and history of the lake. They dominate the phytoplankton assemblage in the summer and fall with densities of about 10^6 cells per liter. Other common species are mostly found in salt lakes or are usually found in fresh or brackish water.

It is clear that diatoms are a major component of the microorganisms in the Salton Sea. Preliminary studies on the sediments reveal a rich flora preserved in the sediments which holds clues to the past history of the Salton Sea.

CILIATE DIVERSITY IN THE SALTON SEA, CALIFORNIA

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Ciliates are unicellular microorganisms that make up the Phylum Ciliophora in the Kingdom Protista. They are eukaryotic with dimorphic nuclei. They usually have proteinaceous projections, termed cilia, that cover portions of the cell and function primarily in locomotion and food-gathering. Another distinguishing characteristic for this group of protists is the presence of complex structures known as kinetids. All ciliates display some form of heterotrophic nutrition. In aquatic environments ciliates are important as grazers of bacteria, algae, and other protozoans, and in turn serve as food for small invertebrates and fish. When abundant in the Salton Sea plankton they can give the water a grayish color.

The major objective of the present study was to begin an inventory of the ciliate species found in the Salton Sea. Prior to this study, no ciliates from the Salton Sea had ever been identified. Two one-week sampling trips (in January and June 1999) were made to the Sea for collection purposes, and some additional samples were sent by SDSU biologists. Specimens were collected, observed live, catalogued, preserved with a fixative, stained, observed with standard light microscopy and identified to genera and, where possible, species. Approximately 664 microscope slide preparations were made and analyzed. Representatives from eight separate classes in the phylum Ciliophora were identified, on the basis of kinetid morphology and nuclear number and arrangements.

A total of 140+ different species of ciliates have been found in bottom sediment, algal mat and plankton samples from our twelve collecting sites. Of these, there are 40+ new to science, i.e. have never been found anywhere before. Of major interest was the finding in June of 35 species not found in January, even though the very same sites were sampled on both occasions. Factors that varied between the two trips included water temperature and dense blooms of planktonic dinoflagellates in January. Diatoms and bacteria, but not dinoflagellates, could be seen in the food vacuoles of some ciliates. Ciliates are clearly one of the most species-rich groups of organisms in the Salton Sea. To fully analyze and catalog this diversity will require great deal of work, as will the deciphering of the influence ciliates exert on the rest of this ecosystem.

NAKED AMOEBOID PROTOZOA OF THE SALTON SEA, CALIFORNIA

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Protozoa are unicellular microorganisms that include amoeboid, flagellated and ciliated organisms. They all display heterotrophic nutrition, that is, they consume organic material usually in the form of other microbes such as bacteria, other protozoa and unicellular algae. Because they are generally considered to be the major micro-consumers in ecosystems, it is important to understand the nature of the different protozoan groups within the microscopic community.

Amoebae without an obvious cell covering are termed "naked amoebae" and are different from other amoeba that live within a walled cell with openings for food ingestion. They are united by the fact that they are all eukaryotic (i.e. structurally more complex than prokaryotic bacteria) single cells that produce pseudopodia (literally 'false feet') of one form or another which they use forlocomotion and feeding. Naked amoebae are often small (less than 20 thousands of a mm), transparent and attached to particles making them difficult to see in freshly collected samples. Their constantly changing shape also makes them difficult to identify since they have few rigid diagnostic features for identification purposes. In 1979, the marine microbiologist Sieburth commented that investigators who examine planktonic or benthic samples seem to shy away from amoebae. Today, some 20 years later, little has changed and amoebae remain an understudied group despite the fact that they often number several thousand per liter in marine waters.

The objective of the present study was to document the diversity of naked amoebae in the Salton Sea and to provide a first estimate of their numerical importance. Since they are virtually invisible in fresh samples, they had to be cultivated in the laboratory to make them conspicuous in the collected samples. Of course, this enrichment procedure only worked for those amoebae amenable to laboratory cultivation and the results must be considered underestimates of the true biodiversity.

A total of 45 different types of amoebae were distinguished on the basis of their morphological features at the light microscope level. These were found after examining water collected at 19 different sites (15 shore samples and 4 open water samples). Wherever possible, these 'morphotypes' (presumed to be different species) were identified to the level of species or genus using published keys. However, because amoebae are an understudied group and because the Salton Sea is species-rich, we estimate that around 18 of the isolates (that's 40%) are new to Science. A diversity of 45 species can be put into perspective if we consider that a recent review of all the literature on naked amoebae from European marine waters yielded just 74 species (Rogerson & Goodkov, 1999 unpublished). In other words, more than half the biodiversity of amoebae in European waters can be found in the Salton Sea. Preliminary counts, also based on enrichment cultivation methods, showed that amoebae in the water column ranged from 14,560 to 237,120 cells per liter. These densities, also underestimates, are far higher than for any previously examined marine water sample.

It is clear that the Salton Sea is rich in microbial life and that naked amoebae constitute a significant part of the microbial assemblage. The ecological importance of high numbers and high diversity of amoebae is unknown. But it should be noted that amoebae are unique amongst micrograzers in that they prey on tightly associated microbes (those attached to the surface of particles). As such amoebae may be important in the cycling of carbon and nutrients in the Salton Sea. The view that amoebae may be important consumers *in situ* deserves further consideration.

CYANOBACTERIA OF THE SALTON SEA

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Aquatic environments like the Salton Sea represent extreme environments that mimic, in some ways, the extreme environments present in the early earth. The high concentrations of sulfur, for example, are toxic to many photosynthetic micro-organisms but can be tolerated by cyanobacteria. Cyanobacteria are among the most primitive oxygen-evolving photosynthetic organisms; they are more closely related to heterotrophic bacteria than higher plants. As a group, they are extremely diverse in the Salton Sea with most genera of common marine cyanobacteria represented by at least one species. We have been able to create pure cultures of many of these forms and have focused special attention on those which form long filaments. This type of cyanobacteria is found in large, slimy, visible mats along the shoreline at certain times of year; our observations suggest that these mats form near the bottom, in layers where hydrogen sulfide concentrations are high.

THE BENTHIC INVERTEBRATES OF THE SALTON SEA: DISTRIBUTION AND SEASONAL DYNAMICS

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Objectives:

This study focuses on the distribution and seasonal abundance of the benthic (bottom-dwelling) invertebrate species which serve as a major food source for fish and many types of birds in the Salton Sea. Its purpose is to document the diversity of species and their abundance within three major habitats: the sea bottom at depths of 2–12 m, the shoreline barnacle shell sand, and on rocky shorelines.

Methods:

We surveyed each habitat bimonthly throughout 1999. We sampled the offshore sediments using a grab off of our research boat. The grab removes a 225 cm2 sample of the sea floor, which is rinsed through a screen. Animals retained on the screen are preserved for later sorting and enumeration back in the lab. We sampled the Sea bottom along 3 transects, each containing 6 stations at depths of 2, 4, 6, 8, 10, and 12 m, collecting a total of 320 samples. We sampled the shoreline sand at 3 locations on the east side of the Sea using a coring device which removed the top 10 cm of a .01 m2 area for a total of 54 samples. Finally, we scraped off all the living material from within 60 10 x 10 cm squares on both barnacle- and algae-covered rocks to determine the abundance of invertebrate species in this habitat.

Important Results:

Ours is the first scientific survey of the invertebrate life in the Salton Sea since 1956, and we have discovered 4 species of worms new to the Sea. The macroinvertebrate community now consists of 5 worms, 2 amphipod crustaceans, and 1 barnacle. The pileworm *Neanthes succinea* is the key food chain organism for fish and birds, and is the dominant species on the sea bottom between depths of 2-12 m. However, its abundance varies greatly over the year, due to the seasonally decreasing oxygen levels in the water column. In spring, the pileworm was abundant at all depths and locations sampled, but disappeared by September from all sediments deeper than 2 m, and from the shoreline sand habitat. In contrast, densities of all invertebrate species increased throughout the year on the rocky shoreline, which harbors the highest numbers of organisms. In this habitat, *Neanthes* was present in densities of up to 85,540/m2, and the crustacean *Gammarus mucronatus* was seen at densities of up to 125,780/m2. This demonstrates the importance of the rocky shoreline both as a refuge for *Neanthes*, and as a habitat that should be maintained to ensure the availability of these food organisms for fish and birds.

PLANKTON AND ZOOPLANKTON DYNAMICS IN THE SALTON SEA

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The plankton of a lake ecosystem is very important to its functioning. Photosynthetic algae in the plankton form the base of the food web, directly providing food to the zooplankton and planktivorous fish such as the tilapia. Algae also produce dissolved organic matter (DOM). Bacteria and heterotrophic flagellates use the DOM and then are fed upon by planktonic ciliates which in turn can be fed upon by larger zooplankters and fish.

The concentration of chlorophyll in the water provides a good index of phytoplankton abundance. Chlorophyll concentration was highest in late winter, declined to a minimum in late summer, and then increased throughout the fall mixing period. Phytoplankton decline during the warm season probably is a consequence of reduced nutrient levels in surface waters. This would be caused by the limited mixing of bottom and surface waters as a result of the thermal stratification present during most of this season. In early fall when the lake first starts to cool and mix from top to bottom daily, the nutrients nitrogen and phosphorus are brought up from below and stimulate the winter blooms of dinoflagellates that color the water dark brown. Chlorophyll levels were usually highest in the surface water stratum, reflecting the ability of some phytoplankters to swim toward the light. Secchi disk readings ranging mostly from 0.5 to 1.5 m suggest self-shading may often limit growth of phytoplankton.

The dominant species present in the phytoplankton have changed since the 1950s, but most of the major groups (dinoflagellates, diatoms, chlorophytes, euglenoids, and cryptomonads) are the same. One exception is an alga in the raphidophyte group, which may be toxic to fish and has not been reported previously from the lake (see poster on *Chattonella marina*). The prominent dinoflagellates in the 1950s were *Prorocentrum* spp. and *Heterocapsa niei*. Now *Gyrodinium uncatenum*, several *Gymnodinium* spp., and a *Scrippsiella* sp. dominate, along with the *Heterocapsa*. The dominant diatoms in the 1950s were *Cylindrotheca closterium* and an unidentified *Cyclotella*. We now find *Thalassionema nitzschioides*, *Pleurosigma ambrosianum* and a very small *Cyclotella* to be the dominant ones (see the diatom poster).

Summer has the highest total zooplankton density, mainly due to the high numbers of the copepod, *Apocyclops dengizicus*, and a rotifer, *Brachionus rotundiformis*. In late summer, there are sometimes abrupt decreases in zooplankton populations. In 1998 an especially dramatic decline in zooplankton occurred when hydrogen sulfide was found throughout the water column and oxygen levels fell to almost zero following a mixing event. This simultaneous scarcity of phytoplankton and zooplankton in late summer, together with low oxygen availability, may represent a time of serious stress to fish. Zooplankton species now dominant are the same as or similar to those found in the 1950s. Three species of rotifers alternate dominance during the year. These feed mostly on algae and other small organisms. One of them, *Brachionus rotundiformis*, may have been present in 1955. Two species of *Synchaeta*, a genus of rotifer not previously been reported from the Sea, are now very common in the winter. Larvae of the benthic barnacle (*Balanus amphitrite*) and polychaete worm (*Neanthes succinea*) are also found in the zooplankton. These larvae were scarcest in summer. This possibly was due to 1) summertime reduction of adult barnacles by a drop in lake level that left many 'high and dry' and 2) anoxia that rendered most of the lake bottom uninhabitable by adult polychaetes.

THE POSSIBLE IMPORTANCE OF ALGAL TOXINS: FINDINGS AND PROSPECTS

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Algal toxins have been known to cause disease and mortality in fish, birds, marine mammals, and even humans. Several algal groups contain species that are commonly known to produce toxins including Prymnesiophyceae, Dinophyceae and Raphidophyceae and Bacillariophyceae. Although algae in these groups have been found in the Salton Sea, no humans have been affected. One health hazard to humans in coastal areas is consumption of mollusks contaminated with algal toxins. Mollusks, however, are not found in the lake. Fish, birds, and invertebrates, however, could be susceptible to any toxins present. In response to the 1992 and 1994 unexplained bird mortality events, we surveyed for algal toxins in the Salton Sea. The goals of this survey were to determine if and when algal toxins are present in the lake and to document the phytoplankton community structure at those times.

Phytoplankton samples were taken from the water surface and from the top 50-100 cm of the water column using various methods, beginning in January 1999. One portion of each sample was extracted with organic solvents and screened for toxicity using a brine shrimp lethality assay. Samples that showed activity in the screening process were then analyzed using a mouse toxicity bioassay. A second subsample was preserved in Lugol's solution for identification and counting of types of algae present.

Several species of prymnesiophytes (*Prymnesium* sp., *Chrysochromulina* sp.) are occasionally found in the lake in low densities. In this same group, a coccolithophore (*Pleurochrysis pseudoroscoffensis*) was seen in very high densities in surface films during spring and summer 1999. Although samples taken from these films showed activity in the brine shrimp lethality assay, they showed no activity toward mice. Samples dominated by *Chattonella marina* (Raphidophyceae), a species known to cause fish kills in oceanic systems, were taken during summer and fall months. Several samples dominated by dinoflagellates (*Heterocapsa niei, Gyrodinium uncatenum, Gymnodinium* sp., *Scrippsiella* sp.) were also taken throughout the year. Samples dominated by *C. marina* and by dinoflagellates again showed moderate to high lethality in the brine shrimp assay but were negative in the mouse bioassay. No potentially toxic diatoms were observed. While some blooms at the Salton Sea show toxicity to invertebrates, those tested so far are inactive when tested in a vertebrate system (mice). This limited study is not sufficient, however, to rule out toxic algae as a factor in major mortality events in birds or fish at the Salton Sea.

SALTON SEA DESERT PUPFISH MOVEMENT STUDY

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Summary

During the summer of 1999, the Ecological Planning and Assessment Group of the U.S. Bureau of Reclamation (Reclamation) conducted a survey of the desert pupfish community within shoreline pools of the Salton Sea (Sea), agricultural drains that discharge directly into the Sea, and lower Salt Creek tributary for the Salton Sea Restoration Project (Project). The objectives of this study were to determine the movement of pupfish within and between various habitat types within one summer season and to address the purposes (i.e., feeding, breeding, dispersal, and avoidance of predators) for which pupfish were utilizing these areas. This information would help determine the importance of the Sea as a corridor to movements among various habitats and allow mixing of the gene pool. Information from this study could be used to determine how various proposed Salton Sea restoration actions might affect the desert pupfish, such as the construction of a desert pupfish channel around a series of concentration ponds to allow movements among habitats.

Methods

Irrigation drains, shoreline pools, and a tributary (Salt Creek) were sampled every two weeks from the end of June to the middle of September (6 sample trips) during the summer of 1999. Fish were captured using small minnow traps. Movements of pupfish were determined by a marking and recapturing technique. Collected pupfish were marked by injecting a small fluorescent plastic material just under the skin. Unique markings were used for each site. Feeding habits were determined by examining the stomach contents of 10 desert pupfish.

Conclusions

Movements of desert pupfish were documented between different, adjacent habitat types. Of the 3,239 desert pupfish captured during the study at all sites, 278 were recaptures, including 27 recaptures at areas different from where they were initially marked.

The best evidence of desert pupfish movements between habitats was observed in the southwestern area of the Sea between an irrigation drain and a connected shoreline pool. Of the 1,441 pupfish captured in the drain during the study, 214 were recaptures from this drain and 19 were recaptures from the shoreline pool. In the shoreline pool, 308 pupfish were collected, including 13 recaptures from this pool and 7 recaptures from the drain. Although some pupfish were moving between these habitats, a large proportion remained where they were initially marked. There was no clear explanation for this behavior. Since the shoreline pool was always open to the Sea, there is a good probability that some pupfish moved into other habitats via the Sea. However, no marked pupfish from this drain or shoreline pool were recaptured in other nearby habitats.

Movements of desert pupfish from lower Salt Creek into the shoreline pool south of Salt Creek were confirmed when one marked pupfish from Salt Creek was recaptured in the shoreline pool. Movements were also supported from the catch rate data which showed the densities of pupfish declining in Salt Creek while the numbers in the shoreline pool increased during the summer. The movements into the shoreline pool were probably a result of deteriorating habitat conditions in lower Salt Creek (e.g., drying channel and dying aquatic vegetation). Access from the shoreline pool to the Sea was blocked by a barnacle bar throughout the study.

The limited stomach analyses suggested a shift in diet from primarily plankton to small fish and fish eggs as the spawning season progressed.

Decreases in the size of isolated shoreline pools during the season were observed and may require maintenance of the connectivity between habitats to prevent pupfish from becoming stranded within habitats that cannot sustain them for prolonged periods.

THE IMPORTANCE OF THE SALTON SEA TO PACIFIC FLYWAY WATERBIRDS

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Great concern recently has been expressed about the fate of the Salton Sea ecosystem because of increasing salinity, contamination from agricultural and urban sources, disease outbreaks, and large die-offs of waterbirds. Particularly hard hit in the 1990s were the Eared Grebe (150,000 in 1992, unknown causes); American White Pelican (9,000 in 1996, botulism); Brown Pelican (1,200 in 1996, botulism); and waterfowl, shorebirds, and waders (>11,000 in 1998, avian cholera). Concern is heightened because connections with other important ecosystems in western North America link the health of populations of many species of waterbirds to that of the Salton Sea. Additionally, because of the loss or degradation of other major wetland systems in the Pacific Flyway, including the nearby Río Colorado Delta region, birds have become increasingly dependent on the Salton Sea.

As part of the Salton Sea Reconnaissance Survey, designed to gather primary data on the Salton Sea ecosystem, we synthesized prior bird data, and in 1999 initiated baseline studies of bird use of the Salton Sea and adjacent Imperial Valley. These studies used a suite of standardized methods to gather data on current population sizes, seasonal abundance patterns, and local distribution patterns and habitat associations of the key groups of birds in this area.

Prior and current data demonstrate that the Salton Sea supports large numbers and a great variety of avian species and is arguably one of the most important wetlands to birds in North America. The Salton Sea hosts hundreds of thousands, and at times low millions, of migratory, wintering, and breeding birds and is the destination for many post-breeding birds moving north from Mexico. Populations in the Salton Sea area of a number of species – Eared Grebe, American White Pelican, White-faced Ibis, Ruddy Duck, Mountain Plover, Black Tern, and Burrowing Owl – are of regional, continental, or worldwide importance. Colonial breeding species with significant populations at the Sea include the Double-crested Cormorant, Cattle Egret, Gull-billed Tern, Caspian Tern, and Black Skimmer. The Sea also supports notable populations of a number of additional taxa of conservation concern, such as the Fulvous Whistling-Duck, Least Bittern, Wood Stork, Yuma Clapper Rail, Black Rail, and Snowy Plover.

Although waterbirds are widely distributed in various habitats at the Salton Sea and Imperial Valley, studies in 1999 documented particularly large concentrations of waterbirds at both the north and south ends of the Sea. Isolated river deltas and islands were very important refugia for large flocks of roosting and colonial nesting birds.

Future research should continue to focus on diseases and contaminants; the reproductive success, ecology, diet, and habitat use of key species; and life history needs of species that move between the Sea and adjacent agricultural habitats or to and from distant wetlands. Ongoing research and monitoring is needed to understand seasonal and long-term population dynamics and to assess the effectiveness of any large scale projects implemented to resolve the Sea's ecological problems.

BOTH NORTH AMERICAN PELICAN SPECIES CO-OCCUPY HABITATS AND SHARE MANAGEMENT/CONSERVATION PROBLEMS OF THE COLORADO DELTA REGION

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The two North American pelican species, the brown pelican (*Pelecanus occidentalis*) and American white pelican (*P. erythrorhynchos*), both importantly occupy the Colorado Delta Region (the "Delta")(including the Salton Sea and extending into the northern Gulf of California) during major portions of their annual cycles. This is unusual in that the two species seldom ecologically overlap significantly in other parts of their ranges (other than as occasional mixed-species roosting groups or rare mixed-species feeding groups). Both species have historically bred or currently breed at the Salton Sea or in other parts of the Colorado Delta region, but major habitat utilization for both species comes during migration and post-breeding dispersal. American white pelicans that utilize the Delta region are comprised and dominated by individuals from the declining western population segment, so that events in the Delta will importantly affect the status of this entire population segment in other parts of western North America. The source of all Salton Sea brown pelicans are from much larger populations in the Gulf of California, and the Delta Region supports only a small proportion of "global" brown pelican population numbers. But the recent range expansion of this formerly endangered species as a breeder into the Salton Sea represents a developing ecological and behavioral phenomenon of seabird range expansion, a potentially important expansion into the United States, and the first inland occurrence of this species as a breeding bird. As a case-history, both species of North American pelicans then abundantly demonstrate what has been shown for other avifauna of the Delta region–that this area is a unique and valuable binational treasure that represents a vital element in the connectivity of the Pacific Flyway for pelicans and many other avian species.

SEASONAL VARIATION OF NUTRIENT, MAJOR ION, AND METAL CONCENTRATIONS IN THE SALTON SEA, 1999

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The Salton Sea was formed in 1905 when an accident caused the Colorado River to flow into the Salton Sink. The Salton Sea has a current water surface elevation of 227 feet below sea level and has no outlet other than evaporation. Salt concentrations have fluctuated over the years as the level of the Sea has changed, but levels have generally increased. The Salton Sea currently has a salinity of over 43 ppt, or about 30% greater than sea water. Proposed reductions in inflow volumes are expected to cause this level to increase.

A one-year sampling program was conducted to assess the current chemical and physical conditions in the Salton Sea. Analyses included general physical conditions and water quality parameters, nutrients, trophic state variables, major cations and anions, trace metals and organic compounds. Samples were collected from three locations in the main body of the lake and from the three major tributaries.

Nutrient concentrations are high in the Salton Sea and lead to frequent algal blooms, which in turn contribute to low dissolved oxygen concentrations. However, the tributaries have a much lower salt content, but consist primarily of agricultural return flows with high nutrient levels. Lastly, concentrations of trace metals and organic compounds do not appear to be of major concern in the water column.

THERMAL, MIXING, AND OXYGEN REGIMES OF THE SALTON SEA, 1997-1999

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Among the environmental factors having greatest impact on the organisms that live in and on the Salton Sea are water temperature, the mixing of surface and bottom waters, and concentration of dissolved oxygen. Here, we report the results of our 1997-1999 monitoring of the thermal, mixing, and oxygen regimes of the Sea, interpret them in relation to weather and climatic variables, and discuss the numerous ways in which these processes may be affecting plankton, benthos, fish, and aquatic birds of the Sea.

Temperature and dissolved oxygen were measured at three mid-lake stations at 2-5 week intervals from January 1997 to December 1999. Two additional near shore stations were added in January 1999. Measurements of conductivity were begun in July, 1998 and hydrogen sulfide measurements were made in July - September, 1999. Daily weather data was obtained from 4 meteorological stations surrounding the Salton Sea.

The lake has a warming period from early January to July-September, followed by a 4-5 month cooling period. Thermal stratification exists during most of the warming period but this is interrupted by periodic wind-driven mixing events, especially in early spring. Mixing events are less frequent in the summer, but when they occur they sometimes result in the entire water column becoming anoxic with measurable quantities of hydrogen sulfide in surface waters. These may be responsible for crashes in plankton populations often observed at these times. During stratification anoxia and high concentrations of hydrogen sulfide, up to 5 mg/L, are found in bottom waters. For a large part of the warming period, few fish are found in midlake and macroinvertebrates are absent over most of the lake bottom as a result of these conditions. By the end of the warming period mean water column temperature in midlake is 31-34°C. During the cooling period, convectional circulation in the water column supplements wind-generated turbulence and the whole water column mixes more or less daily. Oxygen levels during this period are almost always >3 mg/L at all depths. By the end of the cooling period mean midlake water column temperature is 13-15°C. Lake hydrodynamics are complex, influenced by freshwater inflows at the south end and a double-gyre current system. Dissolved oxygen profiles differed markedly with distance from shore. In general, during the warming period the well-oxygenated layer is thicker in nearshore areas than in midlake. Salinity gradients have been found in the southeastern sector of the lake, upcurrent from the New and Alamo River inflows. Such gradients will inhibit mixing of bottom and surface waters wherever they occur.

NUTRIENT DYNAMICS IN THE SALTON SEA—IMPLICATIONS FROM CALCIUM, URANIUM, MOLYBDENUM AND SELENIUM

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The Salton Sea has been accumulating chemical constituents delivered by its tributary streams for nearly 100 years because it has no outlet. The buildup of chemicals that are highly soluble and unreactive, such as chloride, has resulted in the development of a quasi-marine lake. In contrast, chemicals that react to form insoluble phases ultimately enter the sediment that accumulates on the floor of the Sea. Solubility properties are especially relevant for two important contaminants, selenium (Se) and nitrogen (N). The Se is contained in Colorado River water used for irrigation, and N is derived mostly from chemical fertilizer. Both are delivered to the Salton Sea as highly soluble oxyanions by the Alamo and New Rivers, which are relatively high in oxygen at their outlets to the Salton Sea, but are removed as reduced species in anoxic sediment on the Sea's floor. Without this removal mechanism, Se concentration would presently be about 400 parts per billion (ppb) and N would be 100 parts per million (ppm) in the Salton Sea's water, rather than the observed concentrations of only about 1 ppb and 5 ppm, respectively. Ironically, anoxic conditions responsible for producing the noxious odors and leading to periodic dieoffs of large numbers of fish in the Salton Sea have prevented aqueous Se and N from reaching levels that could indeed pose an extreme environmental hazard.

Does all the Se and N ever discharged to the Salton Sea still reside in its sediment, or has some been lost? It is well known that certain bacteria are capable of converting both elements into gases that can then be volatilized to the atmosphere. By comparing concentrations of Se and N with those of molybdenum and uranium, elements with similar geochemical properties, this study concluded that there is now little, if any, Se and N loss to the atmosphere. It is important that any engineering changes made to the Salton Sea do not result in reintroduction of these contaminants from sediment into the overlying water.

Dissolved N concentration in the Salton Sea is apparently several times higher today than it was in the mid-1950's; yet dissolved phosphorus (P) concentration has changed little, if at all. Why have P levels not increased? One possible explanation is that phosphate is efficiently removed from the water column by incorporation with calcium as apatite minerals--the material that composes bone. If so, attempts to slow or reverse excessive biological productivity (eutrophication) through large-scale harvesting of fish may not result in lowering the dissolved P concentration that would thereby improve the trophic status of the Salton Sea.

RECONSTRUCTION OF PREHISTORIC LAKE CAHUILLA AND EARLY AMERICAN SETTLEMENT PATTERNSIN THE SALTON SEA BASIN USING GIS

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During prehistoric times, the Colorado River occasionally meandered into and filled the Salton Sea Basin, creating several huge inland lakes, variously called Lake LeConte or Lake Cahuilla. Previous researchers have identified high stands of these ancient lakes using standard survey methods. The objective of this investigation was to further delineate the prehistoric shorelines using satellite imagery, global positioning system (GPS) and geographic information system (GIS) technologies. Using one-meter digital orthophotographs, points were selected in the laboratory and were located in the field using a GPS. Point data were integrated with a digital elevation model (DEM) and elevation contours were plotted on Landsat-TM images, generating a range of prehistoric shorelines. Contours were then correlated with archaeological site data, geomorphic features, and other factors to reconstruct Early American settlement patterns for Lake Cahuilla. The combined GIS coverages of ancient Lake Cahuilla and cultural resources may be used together as a cultural resources constraints model, identifying areas of high cultural resource sensitivity for evaluation of potential impacts as a result of implementation of Salton Sea restoration project alternatives.

EARTHQUAKES: PLANNING FOR GROUND RUPTURE HAZARDS

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The Salton Sea basin is criss-crossed by a mosaic of faults, many of which are active in the sense that they are considered capable of destructive earthquakes and associated ground rupture along the fault line. The faults of this basin are particularly complex because the basin contains the San Andreas fault system, along which two of the Earth's major tectonic plates, the North American and Pacific plates, move past one another. The San Andreas fault system in the basin undergoes a big jog or step. At the step, the basin is sinking and young volcanic materials are intruding into the sediment; this rapidly sinking part of the basin forms the southern Salton Sea. In addition, several parallel major faults in and near the basin, such as the Elsinore and San Jacinto faults, take up part of the plate motion.

Earthquakes cause ground rupture and ground deformation that may damage and destroy engineered facilities located near the fault line; over wider areas earthquakes cause strong shaking that can cause damage far from an earthquake's epicenter. Damage due to shaking is difficult to predict without extensive information on the earth materials on which a facility is built.

Planning for earthquake-caused ground rupture in the Salton Sea basin must consider different scales, or resolutions, of information. Initial planning for the entire basin can use the two information sources developed by California Division of Mines and Geology to make decisions on locations for facilities that will minimize hazards from earthquake-induced ground rupture: (1) existing information for state-mandated zones along active faults (Alquist-Priolo zones), and (2) regional maps of active faults. However, many poorly understood faults that lie in the basin do not have defined Alquist-Priolo zones, so initial design may require later improvement as fault information is developed.

After remediation options are determined and as design work for facilities begins, detailed scales of geologic map information can provide the necessary framework for evaluating earthquake ground-rupture hazards. For example, in the San Gorgonio Pass area where detailed studies are underway by the U.S. Geological Survey, the two main splays of the San Andreas fault shown on regional maps and defined by the Alquist-Priolo zones are now known to comprise a set of compressional (thrust) faults that complicate an otherwise straightforward interpretation of the San Andreas zone. Detailed study of remediation facility locations will provide information appropriate for more informed decisions relating to many hazards other than earthquakes, such as landsliding and floods.

ECTOPARASITES OF FISH AND INVERTEBRATES OF THE SALTON SEA

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Parasites of fish and invertebrates are integral parts of aquatic ecosystems. Especially in water bodies with poor environmental conditions they can exert a strong regulatory effect on populations. Environmental stresses can depress host immunity. Fish become more susceptible to infections and these can become more severe, even fatal. Sick and dead fish can become a source of disease for piscivorous birds and can present serious threats to their health.

For many decades, the Salton Sea has been the site of an unprecedented series of die-offs of fish and water birds. These mortality events have been associated with critical combinations of high temperature and salinity, low oxygen tension, and toxic algal blooms. Recently, bacterial and viral pathogens have been documented or suspected as a cause of some of the massive birds and fish kills. Until 1997 nothing was known about parasites and their roles in fish disease at the Salton Sea.

Parasitological monitoring was carried out in 1997-1999. A total of 1,512 fish were examined from 6 locations along the shoreline of the Salton Sea. The young of tilapia, croaker, and longjaw mudsucker were found infected by ectoparasites that is parasites that attach to the external body surfaces. Some permanent and persistent infestations of fish by such parasites were discovered around the perimeter of the Salton Sea at Varner Harbor, Bombay Beach, Red Hill Marina and Salton City. Invertebrates such as pile worms and copepods that represented the major food items for fish were also infected.

We found that fish from the Salton Sea are infected by three species of parasitic protozoans: the dinoflagellate *Amyloodinium ocellatum,* the ciliate *Ambiphrya ameiuri*; and the flagellate *Cryptobia branchialis*, and two species of parasitic flatworms, *Gyrodactylus olsoni* and *Gyrodactylus imperialis*. The protozoans range from 7.5 µm to 129 µm in length, the flatworm from 261µm to 312 µm. These parasites are dangerous and sometimes spread pathogens for fish in aquaculture facilities. In nature, however, infestations by these parasites are usually low. At the Salton Sea, parasitic protozoans infected fish from spring through fall with extremely high intensity. In summer months of 1997-1999, 100% of fish from 6 locations examined were infected by the dinoflagellate *A. ocellatum.* Hundreds of these dangerous and destructive parasites were attached to fish gills. In spring and autumn during 1997-1999, about 100% of fish fry from the same locations along the shoreline were heavily infected by the ciliate *A. ameiuri,* which completely covered fish skin, fins and, rarely, gills. In autumn 1997, an outbreak of fish infestation by *C. branchialis* was found at Bombay Beach. Parasites tightly covered the gill surface. Parasitic flatworms *G. olsoni* and *G. imperialis* infected gills longjaw mudsucker and tilapia in different seasons. Their numerous hooks penetrated deeply into epithelial tissue of gills, skin and fins, heavily damaging it.

All these ectoparasites affect fish gills and skin, which are the major respiratory organs for young fish. Both parasitic protozoans and flatworms changed the general structure of fish gills and skin and caused numerous lesions, local erosion, and severe irritation at sites of their attachment to epithelial tissues. These alterations of fish gills and skin may suppress respiratory functions and cause fish suffocation. The numerous sites of epithelial damage also represent portals of entry for bacterial, viral and fungal infections.

The pile worm, *Neanthes succinea,* was heavily infected by peritrich *Epistylis sp.*, individuals of which were attached to their body segments and locomotory organs. Another peritrich, *Rhabdostyla vernalis*, was distributed over the body surface of the copepod *Apocyclops dengizicus*. It is suggested that heavily infected invertebrates have decreased locomotor capabilities and become easy prey for predators.

Parasites appear to be an important stressor affecting fish populations in this unique water body. If they are a major cause of juvenile fish mortality, as seems likely, they may play a major role in determining fish population dynamics in the Salton Sea.

INVERTEBRATES OF THE SALTON SEA: A SCANNING ELECTRON MICROSCOPY PORTFOLIO

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The last detailed examination of the biota of the Salton Sea was carried out in the 1950s. A biotic inventory is currently being conducted by researchers at SDSU and other universities. As part of this, we are attempting to document all invertebrates in the Salton Sea with scanning electron microscopy (SEM) and light microscopy (LM). General morphology and ultrastructure of representatives of 11 major taxonomic groups of invertebrates are demonstrated in this portfolio of images and brief descriptions. Forms illustrated include different stages of their development of both planktonic and benthic organisms.

Planktonic invertebrates

1. Larvae of barnacle, *Balanus amphitrite saltonensis.* Found in greatest abundance in nearshore waters in January through April. Adult forms live attached to hard substrates. Extensive deposits of barnacle shell form major structural habitats for other invertebrates in the Sea.
2. Larvae of pile worm, *Neanthes succinea.* Most abundant in March, scarce in summer, increases starting in November. Prey for fish and birds feeding in water column.
3. Rotifer, *Brachionus rotundiformis.* Most numerous organism in the summer zooplankton. Plays an important role in nutrient cycling. Prey for copepods and fish.
4. Cyclopoid copepod, *Apocyclops dengizicus.* Dominates summer zooplankton. Prey for small fish. Feeds on algae, protozoans and rotifers.

Benthic invertebrates

5. Adult pile worm. Major item in diet of several fish and eared grebes. Most abundant in winter on mud at a depth of 5-8 m. Estimated biomass is up to 13 million kg for the entire Sea.
6. Polychaete worm, *Streblospio benedicti.* First found in the Salton Sea in January 1999.
7. Amphipod, *Gammarus mucronatus.* Lives in algal mats, among living barnacles, and on various other bottom substrates. Eaten by fish, eared grebes and other birds feeding in shallow water.
8. Amphipod, *Corophium sp.* Lives in small tubes on submerged rocks.
9. Harpacticoid copepod, *Cletocampus deitersi.* Abundant among algae and detritis on rocks and also present in the mud.
10. Ostracod, *Cyprideis beaconensis.* Lives in algal mats and in the sediments, but can swim up into the water column.
11. Flatworm (Turbellaria), an as yet unidentified species. Lives in the sediments. Probably feeds on bacteria, protozoans, and algae.
12. Roundworms (Nematoda). Several species have been found in sediments and are being identified.

POPULATION GROWTH AND THE SALTON SEA: THE MAJOR LONG-TERM ISSUE, OUT FROM UNDER THE RUG

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Current proposals for solving the problems of the Salton Sea all fall short of the mark. They are classic examples of the idea of a technological fix, the idea that scientists and engineers can provide the solution to what are fundamentally social and political problems. When called to the rescue, the scientists and engineers are happy to look for these technological fixes on behalf of the politicians, who usually need to claim "progress made" before the next election cycle. The scientists and engineers know the fixes will not help much in the long run, and may even delay attention to the real problems. But a "fix search" can provide a job, research funds, per diem for travel to interesting places and conferences, and other perks. So we are happy to oblige, to be 'good soldiers' and not question orders. To avoid offense, to maintain our positions, and to keep the funds flowing, we refrain from pointing out to the politicians the lack of vision and courage that keeps them from dealing with the important issues. This poster attempts to depart from these self-serving and myopic traditions.

The long-term health of the Salton Sea requires four things: removal of salts, continued large inflows of wastewaters, some additional freshwater inputs for dilution purposes, and removal of phosphorus from the Sea at a rate faster than it is coming in. However, the last three of these will be very difficult if not impossible given the high rate of population growth, especially in California, Arizona, and Baja California. Should large amounts be invested in the proposed technological fixes for the Sea if the politicians are not willing, at the same time, to deal with the social and political issue of population management so that the 'fixes' can bear real fruit? We suspect not.

In the U.S., population growth is driven primarily by immigration. The U.S. Census Bureau estimates that under current immigration policies, immigration will account for about 80 million of the 122 million increase in the U.S. population predicted for 2050. Increasing population and increasing environmental degradation go hand in hand. In a very real sense, immigration is the greatest controllable cause of environmental problems in the U.S., including those confronting the Salton Sea. Our high average standard of living (nice cars, nice homes, nice industries, nice agriculture, nice daily showers, etc.) is a bigger cause, of course, but even the 'greenest' individuals seem disinclined to give up much of this.

The poster presents a collage of information on problems of eutrophication and water supply at the Salton Sea, their relation to population growth and immigration, the failures of the executive and legislative branches of the U.S. government to deal effectively with immigration issues, and the smear tactics and cognitive dissonance with which some organizations attempt to suppress rational discussion of them.

An information packet with materials from different organizations on these issues will be available to symposium registrants. A resolution for forwarding to the President and Congress of the United States will also be available for signing by interested persons. This will present the Salton Sea as just one example of the collision between high rates of population growth and the need to reduce environmental degradation, and will ask for appropriate government action, so that expenditures on engineering projects at the Salton Sea, among other places, have a chance of purchasing more than white elephants.

CHATTONELLA MARINA, A POTENTIALLY TOXIC ALGA IN THE SALTON SEA, CALIFORNIA

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Chattonella marina, an alga in the raphidophyte group, was identified from the Salton Sea in 1997. Algae in this genus are known to be extremely toxic and produce brevetoxins and superoxide radicals, both of which may be lethal to fish. Massive fish kills, especially in aquaculture operations, have occurred world-wide due in part to this organism. Fish collected at the height of the *Chattonella* bloom showed damage to their gills similar to that caused by *Chattonella* in experimental studies. To our knowledge, this is the first recored of a species of *Chattonella* in a salt lake.

We report on high abundance of *Chattonella marina* in the phytoplankton of the Salton Sea from April to November in 1997. Maximum mean density was over 600 cells/ml mid-lake which exceeds the density known to kill fish in studies of this organism in Japan. It was not detected from January 1997 to March 1997 or in January and February 1998. We believe that this alga forms cysts and spends the cold months in the sediment.

STUDIES ON THE SKELETAL DEVELOPMENT OF *HERMESINUM ADRIATICUM*, A FLAGELLATE FROM THE SALTON SEA, CALIFORNIA

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Hermisinum adriaticum is a rare and unusual non-photosynthetic microscopic flagellate that has a skeleton made of silicon. Skeletons of *Hermesinum* have recently been found in large numbers in the surface of sediment of the Salton Sea and also infrequently in algal mat and the plankton. It has previously been reported as present in the Salton Sea. In fact, the greatest abundance of this organism ever seen anywhere was in the Salton Sea in the 1950's'(450 cells/ml).

This study adds to the knowledge of how this organism reproduces. In some samples of sediment, many newly forming skeletons were found in al stages of development. This allowed the study of the way the new daughter skeleton is formed as the cell gets ready for divisions. Scanning electron microscope images give a three dimensional view of each stage.

PLEUROCHRYSIS PSEUDOROSCOFFENSIS IN THE SALTON SEA, CALIFORNIA, USA

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The Salton Sea is a saline (46g/L), highly eutrophic lake in the southeast corner of California, USA. Small numbers of unidentified coccolithophores were seen in earlier (1955-1956) studies of the lake. Recently, we have identified this coccolithophore as *Pleurochrysis pseudoroscoffensis* (Prymnesiophyceae). To our knowledge, this is the first record of the presence of this species in any lake. This species was found only in small numbers in the water column and in surface sediment samples before 1999. In February, June, and July of this year, however, dense accumulations of *P. pseudoroscoffensis* on the surface film were seen at several locations around the Salton Sea. The community compositions of these blooms were analyzed and samples were taken for determination of possible toxicity.

Phytoplankton samples were taken from the water surface and from the top 50-100 cm of the water column using various methods. One portion of each sample was extracted with organic solvents and screened for toxicity using a brine shrimp lethality assay. Samples that showed activity in the screening process were then analyzed using a mouse toxicity bioassay. A second subsample was preserved in Lugol's solution for identification and counting of types of algae present.

Coccolithophorids are noted for producing blooms that are non-toxic. In a preliminary study, however, *P. pseudoroscoffensis* collected from a surface scum caused high mortality in a brine shrimp assay (100% lethality at 400 μg/mL). Several large samples have since been collected for toxicity analysis using both the brine shrimp lethality assay and standard mouse bioassay. Although all samples showed some level of activity in the brine shrimp assay, they were negative in the mouse bioassay. This evidence shows that blooms of *P. pseudoroscoffensis* are most likely not toxic to vertebrates and are not contributors to the various mortality events of birds and fish that occur in the Salton Sea.

SAMPLING THE BOTTOM-DWELLING ANIMALS OF THE SALTON SEA

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Benthic (bottom-dwelling) invertebrate animals form a major part of the diets of fish and many types of birds at the Salton Sea, and can be extremely numerous within different habitats. In fact, on submerged rocks, several thousand invertebrates can be collected from an area the size of a slice of bread! How are these animals collected from the different habitats? Our poster illustrates three techniques commonly used by ecologists for collecting animals: grab sampling, quadrat sampling, and sediment coring. In addition to depicting how we sampled the environments at the Salton Sea, we include images and natural history details of the animals collected by these methods.

POPULATION SURVEYS AND PRELIMINARY CONTAMINANT ANALYSIS OF BIRDS ON THE SALTON SEA.

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Funding for this project is entirely from USGS. The principal objectives originally indicated preliminary contaminant analyses and population surveys, but peer review comments noted that much of what we proposed for preliminary work had previously been done, or was being contracted for under the auspices of the Science Coordinating Committee. Furthermore, the peer reviewers commented that the available funding would not allow for any meaningful data collection beyond what was already known with respect to contaminants. We then decided to begin with population (nesting) surveys in a manner which would least likely conflict with other funded research activities.

Now in our second year of field work, we can expand our work into examining avian movements via satellite telemetry. Peer reviewers and other researchers view this avenue of research as the most productive use of limited resources and the type of research necessary to move beyond reconnaissance level science.

The study plan was completed and field work was initiated in April 1999. Consultations with Sonny Bono Salton Sea National Wildlife Refuge (SBSSNWR) staff, National Wildlife Health Research Center, Point Reyes Bird Observatory, and others led to the selection of a small colony of Great blue herons (GBH) and Great egrets (GREG) for intensive nest monitoring. Nesting structures at the Ibis Road colony were visited and inspected weekly between April and late July to ascertain egg numbers (presence or absence), number hatched, condition and number of young, stage of development, nest structure integrity, and hatchling status. Forty nests were established during this period, 27 GBH, 12 GREG, and 1 unknown. Only four GREG nest survived to the point of producing hatchlings, and no GREG nest survived to fledging. Seven GBH nests remained intact and produced fledglings. The Salton Sea routinely experiences severe wind storms during the spring and summer, and the particular area of the Ibis Road colony seems to be especially prone to severe, prolonged high wind events (SBSSNWR staff pers. comm.). These extreme winds rip apart fragile nesting structures and the nest themselves. A contract was issued for the development of a book on the historical status and distribution of birds of the Salton Sea and surrounding areas. This book is currently in development for publication during FY2000. Anticipated research for FY2000 includes a continuation of nest monitoring efforts at the Ibis Road Colony, publication of the Salton Sea book on birds, and satellite telemetry on Double-crested cormorants to document localized and long-range movements for a small number of birds. Information gained from this research effort should provide a thorough analysis of avian occurrence and distribution data, much of which has been sequestered in a variety of published journals, gray literature, and field notes. Moreover, this research will document movement patterns of Double-crested cormorants and provide insight into the potential for the dispersal of Newcastle disease.

AVIAN DISEASE AT THE SALTON SEA

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Recent disease outbreaks at the Salton Sea have killed large numbers of birds. These events have resulted in a national focus on the Sea and issues associated with restoration actions. This presentation highlights the avian diseases occurring at the Sea, addresses their importance as a factor in the conservation of migratory birds and highlights what is being done to combat avian disease at the Sea. A review of existing information on disease occurrence at the Sea was conducted from historical records, National Wildlife Refuge Narrative Reports and the National Wildlife Health Center epizootic and diagnostic databases.

There has been a substantial increase since the late 1980s in the importance of disease as a cause of bird mortality at the Sea. Disease outbreaks have occurred since at least the 1920s. With the exception of 1932, annual outbreaks occurred during the period of 1925-1935, with each of those events killing a substantial number of birds. Type C botulism is the likely cause of those outbreaks. The frequency of outbreaks was much less during the period of 1936-1945 before increasing again since 1946. With few exceptions, the magnitude of bird deaths associated with individual disease outbreaks during the period of 1936-1987 has been low. Since 1987, the magnitude of losses from disease has increased substantially and there have been a number of catastrophic die-offs. During 1992, an estimated 155,000 birds died at the Sea, including an estimated 150,000 eared grebes. This was approximately 7 percent of the continental population of this species. The cause of this event and recurring grebe mortality at the Sea has not been determined despite extensive diagnostic evaluations. The 1996 outbreak of type C botulism was even more devastating regarding population impacts. That outbreak killed approximately 15-20 percent of the western population of white pelicans and killed more than 1,000 endangered California brown pelicans. During 1997 and again in 1998, all hatchlings from the double-crested cormorant colony on Mullet Island died from Newcastle disease. Avian cholera and salmonellosis are other important diseases that have appeared at the Salton Sea during recent years.

Environmental quality is a factor in many disease events. Therefore, the Salton Sea Restoration Project focus on improving the environmental quality of the Sea is a fundamental action required to reduce the probability for major losses from disease. Current actions taken include enhanced surveillance to provide early detection of disease occurrences and aggressive response to outbreaks that occur. In addition, studies have been initiated to gain a greater understanding of the ecology of disease at the Sea. Findings from those studies will be of considerable value in guiding management actions to achieve the Restoration Project Goal to:

"Provide a safe, productive environment at the Sea for resident and migratory birds and endangered species."

Achievement of this goal is important because more than 90 percent of inland wetland acreage that was part of the California landscape no longer exists. As a result, millions of migratory birds within the Pacific Flyway have become highly dependent upon the habitat provided by the Salton Sea.

A BACTERIAL PATHOGEN RECONNAISSANCE OF THE SALTON SEA

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OBJECTIVES

The Salton Sea has become an important resource for wildlife. Recent mortality of fish and birds at the Sea has prompted a high level of concern by many resource agencies. A more intensive survey to document the distribution of known and potential microbial pathogens in the Salton Sea ecosystem was needed to provide baseline information for those tasked to evaluate proposed engineering projects at the Sea. This study was to determine the prevalence of *Pasteurella multocida* (avian cholera), *Salmonella* spp., *Aeromonas* spp., *Vibrio* spp., *Yersinia* spp., *Erysipelothrix* spp. in the sediments and water of the Salton Sea ecosystem at various times of year. Isolates will be evaluated through molecular methods to determine potential epidemiological linkages and providing better insights into the their characterization and distributions.

METHODS

Water and sediment samples were collected monthly at the Sea, frozen, and shipped for analysis. Samples were collected at the inflows to the Sea on a monthly basis and from six other sites at the Sea on a quarterly basis. Primary isolation of selected bacterial pathogens included both direct plating and selective enrichment culturing. Enrichment media for the enhanced recovery of *Pasteurella*, *Yersinia,* and *Salmonella* spp. and selective/differential media for the isolation of *Aeromonas, Vibrio* spp.,and *Erysipelothrix* spp. were used. All bacterial colonies were screened based on typical colony morphology and biochemical reactions on selective or differential media. Isolates were biochemically characterized and identified using an appropriate system. Selected isolates are to be further analyzed by ribotyping, a method to compare the genetic material of the isolates to determine, not only the identification, but also relatedness of the isolates. Samples collected will also be screened by a polymerase chain reaction (PCR), a method to look for the genetic evidence of some of these pathogens.

RESULTS

The study is still on-going at this point. A full year of water collection has been completed but the analysis is still pending on some samples. At this point, the expected water-borne pathogens, *Aeromonas* and *Vibrio* spp. are present in many samples collected throughout the year. Although *Aeromonas* and *Vibrio* spp. are both occasionally pathogenic to wildlife and humans, the real threat from these organisms to both wildlife and human health has not yet been established. The identification and further characterization of these isolates is pending. The potential wildlife and human pathogen, *Salmonella*,spp. have been isolated from only two samples so far. The other pathogens of interest in this study have not been isolated yet. Screening of the samples using polymerase chain reaction (PCR) is pending.

AVIAN BOTULISM IN FISH-EATING BIRDS AT THE SALTON SEA

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During the summer of 1996, nearly 15,000 pelicans and other fish-eating birds died at the Salton Sea from type C avian botulism. This die-off was the largest documented loss of pelicans in the U.S., killing nearly 15% of the western white pelican (*Pelecanus erythrorhynchos*) population and many endangered California brown pelicans (*Pelecanus occidentalis californicus*), although a number of brown pelicans were treated and released. Since 1996, outbreaks of type C botulism have occurred in fish-eating birds every year at the Sea, however the losses have not been as extensive. These outbreaks are unusual for several reasons and may be unique to the Salton Sea. Type C botulism typically afflicts waterfowl and shorebirds, and although the disease has been previously documented in freshwater wetlands surrounding the Salton Sea, fish-eating birds were not involved and do not usually contract type C botulism. Also, it was apparent that sick and dying fish were the probable source of toxin for pelicans in these recent outbreaks, however, the role of fish is unclear. Some evidence suggests that fish may ingest toxin and contract the disease, making them easy prey for feeding pelicans and other birds. Other evidence suggests that fish become sick from other bacterial infections, allowing botulinum spores in their guts to germinate and produce toxin. A better understanding of the role that fish play in precipitating botulism outbreaks in birds and the contributing environmental conditions are necessary to evaluate how proposed engineering projects in the Sea may affect occurrence of this disease.

Currently the USGS/ National Wildlife Health Center, in conjunction with the USGS/Western Fisheries Research Center, Mississippi State University and others, are working to identify the key factors that initiate these unique die-offs on the Salton Sea. Research efforts will focus on determining the linkages between type C botulism outbreaks in pelicans and their predominant prey, tilapia (*Tilapia mossambicus*). Laboratory experiments will be conducted to evaluate the sensitivity of tilapia to type C botulism and the interactions between toxin production in fish and other bacterial infections. Field studies will also be conducted to evaluate patterns of botulism mortality in fish-eating birds in relation to water chemistry, sediment microbiology, fish kills, and the abundance of botulinum toxin and toxin-producing bacteria in fish.

In separate, but related studies, we are also determining the distribution of type C botulinum cells and spores in the Sea and its major tributaries, evaluating the risk of type C avian botulism in freshwater wetlands surrounding the Sea, and assessing the risk of type E botulism in fish in the Salton Sea. Last, we will evaluate the feasibility of vaccinating endangered brown pelicans brought in for rehabilitation purposes in order to prevent them from contracting the disease again upon their release.

EARED GREBE MORTALITY AT THE SALTON SEA IN THE 1990s: REVIEW OF FINDINGS AND NEW STUDIES

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Background: In late 1991 and early 1992, an undiagnosed disease occurred in eared grebes (*Podiceps nigricollis*) at the Salton Sea. Carcasses of 46,040 eared grebes were picked up and estimates of total mortality for this event were as high as 145,000. This was the largest eared grebe epizootic ever documented, resulting in the death of approximately 10% of the North American population of this species. Several significant mortality events have occurred in eared grebes at the Salton Sea since the 1991-1992 die-off. Affected grebes often exhibit unusual behaviors, such as coming out on shore and preening excessively, and congregating at freshwater drains where they drink water. The feathers of affected grebes frequently appear disheveled or wet. A total of 160 eared grebe carcasses from the Salton Sea have been necropsied at the National Wildlife Health Center since 1991, but the primary cause of these mortality events remains unknown. Avian cholera (caused by the bacterium, *Pasteurella multocida*) and avian botulism type C (caused by toxin produced by the bacterium, *Clostridium botulinum*) have been diagnosed in 21% and 4%, respectively, of eared grebes necropsied since 1991, but no other bacterial or viral pathogens were consistently isolated. No cause of death could be determined for 46% of the grebes examined. Pulmonary, hepatic, and skin lesions were observed during necropsies, but were not severe enough to account for the death of the birds. Exposure to salt and selected contaminants were investigated, but were ruled out as primary causes of mortality.

Future studies: Continued mass mortality of eared grebes at the Salton Sea is a potential threat to the population of this species. During fiscal year 2000, we initiated a 3-year study with the primary goal of identifying the cause(s) of undiagnosed eared grebe mortality at the Salton Sea. We will use field and laboratory studies to:

(1) Conduct epidemiological investigations of mortality events.

(2) Diagnose causes of mortality in eared grebes found dead at the Salton Sea, with particular emphasis on algal biotoxins (in collaboration with Wright State University), avian cholera, and avian botulism.

(3) Evaluate the significance of avian cholera in the mortality of eared grebes, comparing isolates of *Pasteurella multocida* with molecular methods to determine the role of this bacterium in grebe mortality.

(4) Investigate the role of feather disruption, with the resultant loss of the ability of grebes to maintain their body temperature and hydration, in grebe mortality.

(5) Measure serum chemistries of eared grebes to evaluate the physiologic alterations associated with illness.

VEGETATION MAPPING OF THE SALTON SEA BASIN

Dr. Timothy Krantz, Ms. Molly Ward
Salton Sea Database Program
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The Salton Sea Database Program has undertaken a project to identify and map the vegetation in the Salton Sea Restoration Project area. The objectives of this effort were to produce an accurate map of the dominant plant communities of the project area in order to facilitate Salton Sea restoration project planning efforts. Vegetation mapping for the project was produced at two levels of resolution: a low-resolution vegetation map for the entire watershed; and a high-resolution coverage for the immediate shore zone plant communities and adjacent wetlands.

The low-resolution vegetation map utilizes U.S.G.S. Landsat-TM images as the base map at a scale of 1:250,000. This coverage is based upon a modified Cal-GAP vegetation classification system developed by U.C. Santa Barbara. The vegetation map was clipped to the watershed boundary, including an area of approximately 8,300 square miles. This coverage identifies dominant plant communities within the entire basin.

A high-resolution, wetlands map has been produced on digital orthophotograph quarter-quadrangles (DOQQs). The DOQQs correspond to one-fourth of a 15-minute U.S.G.S. topographic quadrangle, at a scale of 1:12,000, with a resolution of approximately one-meter. The high-resolution vegetation mapping effort focussed on the immediate shore zone area and adjacent wetlands. Ground validation of the preliminary wetland map was accomplished during the Spring-Summer '99 season. The resultant map identifies dominant and associated species for the shoreline and adjacent wetlands, managed wetlands, and riparian wetlands, including the Whitewater River delta, Salt Creek, San Felipe Creek, and the New and Alamo Rivers to the Mexico border.

CHRISTMAS BIRD COUNTS AT THE SALTON SEA — PRESENTING 30 YEARS OF WINTERING BIRD DATA

Dr. Timothy Krantz, Mr. Shuzo Yoshihara andMr. Daniel Chambers,
Salton Sea Database Program, University of Redlands

Annual Christmas bird counts (CBCs) have been conducted at the Salton Sea since 1969. Two census areas have been established—one at the north end centered near the Whitewater River delta, and the other at the south end of the Sea centered near the National Wildlife Refuge. The counts are conducted on a designated day within a week or so of Christmas Day each year in a 7.5-mile radius circle at each location. All birds observed are tallied.

The CBCs represent the longest standing data set of winter bird use at the Salton Sea. Thirty-year trends have been calculated for each species, family, guilds (shorebirds, waterfowl, piscivorous birds, waders, etc.), individual census totals, and combined north-south census data.

SALTON SEA SCIENCE—WHERE DO WE GO FROM HERE?

Milton Friend,
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The oral and poster presentations of this Symposium clearly illustrate that we have learned a great deal about the Salton Sea that was previously unknown. In general, we now know that the biological complexity of the Sea is far greater relative to species diversity than was previously recognized and that there has been considerable adaptation by some of the species to allow them to thrive in this highly saline environment. We have also gained considerable insight relative to the biological importance different areas of the Sea provide for various species. One of the most important contributions of the science effort that has taken place is the "bridge" that has been built joining science and management in a collective and collaborative effort to improve the environmental quality of the Sea. Science has become a component of the restoration project that is issue driven rather than being an independent, exploratory activity.

The science displayed at this Symposium is a good beginning and needs to continue as a strongly integrated science effort that is relevant for the restoration project. Learning from pilot projects and adaptive management will be important aspects of the science activities from this point on. The establishment of baseline values against which change can be monitored and carrying out appropriate monitoring activities will be major scientific activities along with focused investigations to address specific information needs. A Strategic Science Plan has been developed as the conceptual framework for guiding this science effort.

The key component of the Strategic Science Plan is a Science Office dedicated to the restoration project. That Office would provide the link between scientists and managers but would not carry out scientific investigations. The basic roles would be science planning, coordination, evaluation, and contract awards and administration. The Office would be assisted in its efforts by two external bodies, a stakeholder advisory committee and a science advisory committee of technical specialists from various science disciplines. Another component of the Strategic Science Plan is a small common-use field facility at the Sea to facilitate field investigations undertaken as part of the restoration project.

The scientific and management challenges that lie ahead are formidable. However, failure is not an option. These are the types of challenges that must be overcome if we are to sustain global biodiversity and, by doing so, serve human values and needs through the benefits derived. These relations are expressed in the following quotation:

"The nation's biological resources are the basis of much of our current prosperity and an essential part of the wealth that we will pass on to future generations." (Pulliam 1995)

The Salton Sea Restoration Project and the science effort that is part of this undertaking is an opportunity to "make a difference". By doing so we will provide a lasting tribute to the memory of Congressman George Brown.

FISHERIES ECOLOGY OF THE SALTON SEA

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Beginning in 1929, large introductions of over 20 marine species were planted into the Salton Sea, CA from offshore San Felipe, Gulf of California. Of these, only the orangemouth corvina (*Cynoscion xanthulus*), bairdiella (*Bairdiella icistia*) and sargo (*Anisotremus davidsoni*) established and flourished in the Sea. In 1964-65, an aggressive exotic species from Africa, the tilapia (family Cichlidae), escaped to the Sea by two routes: (1) an aquarist fish farm near Niland, and (2) from irrigation ditches where it was stocked purposefully by California and Arizona fisheries agencies for the control of nuisance aquatic weed and insect species (Costa-Pierce and Doyle 1997). In the 1970's-80's, the tilapias quickly dominated the fish community of the Salton Sea as the salinity rose to hypersaline levels. We conducted a large, bimonthly fisheries sampling program of the Salton Sea Ecosystem (SSE) that set four, 50-m long multi-panel, multi-mesh gill nets overnight (two bottom and two surface nets at each station) at nine stations in the Sea. Our preliminary observations are: (1) eight species have been sampled, and their size and age distributions determined, (2) the Alamo and New Rivers are not refugia for any of the fish species in the Sea with the exception of threadfin shad, (3) highest catch per unit efforts (CPUEs) were in nearshore and estuarine stations, (4) a remnant threadfin shad population is present at southern stations, (5) tilapia CPUEs are higher than reported in tropical lakes worldwide, (6) there is a narrow population size-frequency distributions for bairdiella and tilapia, and many tilapia are 1.5-2.0 years old, (7) there is evidence for large scale seasonal in/offshore movements that result in a "bathtub ring"of fish in the summer, (8) there is no evidence of widespread deformities or external abnormalities in the corvina, sargo, tilapia, or croaker populations.

THE MIGRATION OF EARED GREBES THROUGH THE SALTON SEA

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From December through April, the Eared Grebes is probably the most numerous waterbird at the Salton Sea. Several tens of thousands winter there. In spring migration daily estimates have exceeded 1 million, and it appears that the majority of the entire North American population (about 4 million) passes through and stages there before moving to breeding grounds in the interior. Accordingly, the sea in its current condition represents one of the most important single localities for this species. At the same time, it is a potentially hazardous place, as indicated by occasional and still-unexplained dieoffs that have killed tens of thousands of birds.

From intensive studies at the major fall staging areas-- Mono Lake and Great Salt Lake-- over the past two decades, the biology and ecological requirements of the Eared Grebe are now well known. Accordingly, one can make reasonable predictions about how the grebes' status at the Salton Sea would be affected by changes in water level, salinity, and prey base.

In this paper I will review the species' history and status at The Salton Sea. I will also outline salient aspects of its biology in the nonbreeding season, its adaptations for exploiting the highly saline habitats that other grebes and waterbirds avoid, and the nature of its fall and spring migrations. Such information is essential for considering the potential causes of mass mortality. Even though the Salton Sea holds a larger fraction of the North American Eared Grebe population than any other single area, efforts to monitor the size and health of the population through local studies will be largely uninterpretable--and therefore futile—unless they are integrated with knowledge from the major fall staging areas.