THE TRAGEDY AT KESTERSON RESERVOIR: A CASE STUDY IN ENVIRONMENTAL HISTORY AND A LESSON IN ECOLOGICAL COMPLEXITY

BY
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I. INTRODUCTION

On July 23, 1970, the United States Bureau of Reclamation and the United States Fish & Wildlife Service ("USFWS" or "Service") signed an agreement to create the Kesterson National Wildlife Refuge in the heart of California's agricultural San Joaquin Valley, about eighty miles southeast of San Francisco. Nearly fifteen years later, on March 15, 1985, Secretary of Interior Donald Hodel ordered the immediate closure of the Refuge's Kesterson Reservoir, in large part

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because he feared that the federal government would be sued for killing wildlife in direct violation of the 1918 Migratory Bird Treaty Act.[1]

At the core of the apparent disjunction between these two events was the discovery by senior USFWS biologists, in June of 1983, of dozens of horribly deformed bird embryos at Kesterson. Some embryos had missing or deformed beaks, legs, or eyes; others had exposed brains. USFWS and U.S. Geological Survey ("USGS") scientists quickly identified selenium, a trace element, as the probable cause of the developmental defects. Selenium, an essential nutrient in small doses, had been leached from the soils of the San Joaquin Valley by irrigation water and deposited in Kesterson Reservoir at toxic levels. On September 21 of that year, this disturbing information reached the public when the *Fresno Bee* first covered the story.[2] The years of public outrage, political battles, and bureaucratic infighting that followed comprise part of the Kesterson story and have been well documented by journalists.[3] Less visible has been the research conducted by dedicated scientists. The amassing of scientific evidence in the face of bureaucratic inaction and outright hostility has been a driving force of change in environmental regulatory policy in the West in the years following the Kesterson tragedy.

Since the publication of Rachel Carson's *Silent Spring* in 1962, public awareness of the threat pesticides and herbicides pose, not only to human health, but also to entire ecosystems, has grown substantially. Yet, little published research exists on the dangers posed by naturally occurring trace elements, such as selenium, molybdenum, arsenic, and boron, when they are leached from the soil and thence into our water supplies. The literature that does exist appears prima-

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[1] 16 U.S.C. §§ 703-712 (1994). "Unless and except as permitted by regulations made as hereinafter provided, it shall be unlawful to hunt, take, capture, *kill*, *attempt to* take, capture or *kill*, possess, offer for sale, sell, offer to purchase, purchase, deliver for shipment, ship, cause to be shipped, deliver for transportation, transport, cause to be transported, carry or cause to be carried by any means whatever, receive for shipment, transportation or carriage, or export, *at any time or in any manner, any migratory bird,* [or] *any part, nest, or egg of any such bird* . . . included in the terms of the convention between the United States and Great Britain [acting on Canada's behalf] for the protection of migratory birds concluded August 16, 1916 . . . . " 16 U.S.C. § 703 (emphasis added).

[2] Deborah Blum, *Mineral is linked to bird deformities*, FRESNO BEE, Sept. 21, 1983, at A1.

[3] *See, e.g.*, TOM HARRIS, DEATH IN THE MARSH (1991) (examining Kesterson and general problem of selenium toxicity in American West); RUSSELL CLEMINGS, MIRAGE: THE FALSE PROMISE OF DESERT AGRICULTURE 51-76 (1996) (studying Kesterson and selenium toxicity, and generally examining fates of societies dependent on irrigation in world history).

rily in highly technical, scientific journals.[4] Shorter, popular accounts specifically about Kesterson appeared throughout the mid- and late-1980s in a number of periodicals. There was extensive newspaper coverage as well.[5]

Environmental historians have paid scant attention to this issue to date. In the few instances where Kesterson has appeared in a major work, it has generally been presented only briefly. Donald Worster deserves credit for giving it even the briefest mention in his provocative study of hydraulic society, *Rivers of Empire*.[6] Published in 1985, this book went to press as the Kesterson tragedy was still unfolding. Norris Hundley, Jr. devotes several pages to the selenium poisoning of Kesterson in his excellent volume, *The Great Thirst*, placing it within the context of the larger environmental crisis brought on by contemporary agricultural practices and water policies.[7] However, neither author addresses the critical role of the scientists who brought the Kesterson tragedy to the public's attention.

The danger posed to wildlife and human populations, not only by human-made pesticides and other chemicals, but also by naturally occurring trace elements leached from the soil, promises to be the next chapter in the history of irrigating the West. This paper integrates the history of irrigation projects, water policy, and water law, as they relate to Kesterson, with the history of ecological research that has been conducted on toxic drainwaters and their bioremediation.[8]

Kesterson invites this interdisciplinary approach. Its significance lies, in part, in the lessons it teaches about both the complexity of ecosystems and the fragility of those ecosystems in the face of human interference. As science has sought to understand what happened at Kesterson, it has become increasingly clear that the problem of toxic agricultural wastewater extends beyond Kesterson

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4 *See, e.g.*, Kenneth Tanji et al., *Selenium in the San Joaquin Valley*, ENVIRONMENT, July–Aug. 1986, at 6 (providing overview of California water history before Kesterson and highlighting options for disposal of San Joaquin Valley drainwaters).

5 For a sampling of periodicals covering the Kesterson story, *see*, AMICUS JOURNAL, Fall 1989; APF REPORTER, Jan. 1990; AUDUBON, Jan.-Feb. 1994; DEFENDERS, Nov.-Dec. 1984; GOLDEN STATE REPORT, Dec. 1989; SCIENCE OF FOOD AND AGRICULTURE, Mar. 1986; SPORTS ILLUSTRATED, Mar. 22, 1993; and UC DAVIS MAGAZINE, Summer 1986. Newspapers that extensively covered the developing story included the *Sacramento Bee*, the *Fresno Bee*, the *San Jose Mercury News*, the *San Francisco Chronicle*, and the *Los Angeles Times*.

6 DONALD WORSTER, RIVERS OF EMPIRE: WATER, ARIDITY, AND THE GROWTH OF THE AMERICAN WEST (1985).

7 NORRIS HUNDLEY, JR., THE GREAT THIRST: CALIFORNIANS AND WATER, 1770s–1990s (1992).

8 The integration of history, ecology, and law represents a promising direction for environmental history. One of the most ambitious and successful attempts to integrate these disciplines is ARTHUR F. MCEVOY, THE FISHERMAN'S PROBLEM: ECOLOGY AND LAW IN THE CALIFORNIA FISHERIES, 1850–1980 (1986).

and even beyond California, to threaten agriculture and public health throughout the American West. Therefore, Kesterson is a microcosm of much larger issues that will impact environmental policy in the United States for decades to come.[9]

The history of events leading to the creation and ultimate closure of Kesterson Reservoir dates back to the early years of this century when the Reclamation Act of June 17, 1902 created the Bureau of Reclamation. One of the Bureau's tasks was to provide irrigation water to arid lands with the intent of stimulating development of small family farms of 160 acres or less.[10] In 1937, Congress authorized California's Central Valley Project ("CVP") as a means for the Bureau to deliver irrigation water to valley farmers. Several decades later, in 1960, California voters approved the Burns-Porter Act to finance the new State Water Project, which led to construction of the California Aqueduct.[11] Circumventing the 160-acre limitation of the CVP, the State Water Project especially benefited corporate landowners who held vast tracts in the southern San Joaquin Valley.[12]

The CVP initiated, and the State Water Project extended, an era of dam and canal building that has permanently altered much of California's landscape while turning California into the leading agricultural producer in the nation. California accounts for about ten percent of the nation's total agricultural production. Half of California's production comes from the San Joaquin Valley, the southern

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[9] The Author's understanding of the interconnectedness of these larger issues was invaluably aided by extensive interviews with the following individuals: Harry Ohlendorf, formerly a research biologist with USFWS, and now Senior Environmental Scientist with the Sacramento, CA environmental consulting firm, CH2M Hill; Felix Smith, formerly a research biologist with USFWS; Jack Erickson, Brian Smith, and Des Hayes, engineers with the California Department of Water Resources, Fresno; Joseph Skorupa, avian biologist with USFWS; and Rick Higashi and Teresa Fan, environmental scientists at the University of California, Davis, Department of Land, Air, and Water Resources. Roger Hothem of USFWS, Davis Field Station, also deserves thanks for making available large quantities of source material.

[10] Originally known as the U.S. Reclamation Service, the Bureau of Reclamation took on its present appellation in 1923. There is a vast literature on the history of the Bureau and of federal water policy and politics in the American West. In addition to the works of Worster and Hundley previously cited, *see supra* notes 6-7, other works of broad scope include MARC REISNER, CADILLAC DESERT: THE AMERICAN WEST AND ITS DISAPPEARING WATER (1986), and NORRIS HUNDLEY, JR., WATER AND THE WEST: THE COLORADO RIVER COMPACT AND THE POLITICS OF WATER IN THE AMERICAN WEST (1975).

[11] *See* CAL. WATER CODE §§ 12930-44 (West 1992). California's Department of Water Resources had first reviewed and approved this Act, also known as the Water Resources Development Bond Act, in 1959.

[12] *See* HUNDLEY, *supra* note 7, at 273. California's large landowners won a victory in 1982 with the passage of the Reclamation Reform Act, codified as amended at 43 U.S.C. §§ 390aa to zz-1 (1994), which repealed the 160-acre limit for irrigation with water from federal projects in favor of a more generous 960-acre limit.

half of California's great Central Valley. The disaster at Kesterson Reservoir cannot be understood outside of agriculture's privileged position in California's economy, and the political strength of California's agribusiness industry.

II. Where Have All the Wetlands Gone?

For millennia before the first white settlers arrived, wetlands had been a dominant feature of the San Joaquin Valley. Over two hundred miles long, and forty to sixty miles wide, the Valley extends from the Sacramento-San Joaquin Delta in the north to Bakersfield in the south, and is bounded to the west by the Coast Ranges and to the east by the towering mountains of the Sierra Nevada. In its pristine state this alluvial valley had been a rich, diverse landscape that supported large populations of both resident and migratory species of fish and wildlife. Its freshwater lakes, marshes, riparian forests, and valley oak savanna provided habitat for tule elk and pronghorn antelope, grizzly bears that migrated annually from the foothills of the Sierra Nevada, and innumerable waterfowl. During the nineteenth century, an estimated 60 million waterfowl annually stopped over or nested in the Central Valley, which lies along the Pacific Flyway, a migratory route stretching from the arctic to the tropics. By the early 1990s, that number had declined to 2.5 million.[13]

The water for much of this habitat came from the San Joaquin River, which flows westward out of the Sierra Nevada, passes north of Fresno, and then turns northward and follows the valley floor to the Delta. Throughout the second half of the nineteenth and first half of the twentieth centuries much of this wetland habitat was drained — first by individual efforts and then by state-authorized irrigation districts — primarily to support agriculture. As early as the 1860s, the Miller-Lux Canal diverted water from the San Joaquin River to irrigate 400,000 acres of farmland. Beginning in the 1920s, with the invention of the turbine pump, groundwater sources were tapped to expand irrigated agriculture along the west side of the San Joaquin Valley. The water table dropped precipitously over the following decades, falling up to 200 feet in many areas between 1920 and 1950.[14] Most of the remaining wetlands disappeared. Today, due to conver-

[13] *See* Robert H. Boyle, *The Killing Fields*, Sports Illustrated, Mar. 22, 1993, at 62, 64.
[14] *See id.* at 29.

sion to agricultural and municipal uses, only 450,000 acres of an original five million acres of wetlands remain.[15]

The destruction of wetlands on such a grand scale reflects a national trend. More than half of the United States' original 215 million acres of wetlands have been destroyed since colonial times. Estimates place the current rate of loss between 300,000 and 450,000 acres per year.[16] While definitions of wetlands vary, there is consensus on key defining characteristics. The soils must be hydric — saturated, flooded, or ponded a majority of the time. Additionally, the land must support water-loving (hydrophytic) vegetation at least periodically. Wetlands are present in all fifty states. Their location, extent, and function depend upon topography, soil types, climate, proximate biological communities, ecological succession (the replacement of one biological community by another over time), water supply, geology, energy budgets and flows, and human impacts. In addition to economic benefits — which stem largely from fishing, hunting, and recreation — wetlands provide immense ecological benefits. Wetland ecosystems function as rechargers and dischargers of aquifers; they absorb and store floodwaters, providing flood flow alteration; they retain nutrients and transform wastes, including municipal wastes, into simpler organic and inorganic substances; and they provide habitats for millions of plants and animals.[17]

Kesterson and other national wildlife refuges were intended to remedy the net loss of wetlands. The National Wildlife Refuge (NWR) System, the world's largest collection of lands managed specifically as wildlife habitat, traces its roots to 1903, when President Theodore Roosevelt designated Florida's three-acre Pelican Island as a bird sanctuary. Now comprising well over 400 refuges, encompassing approximately 100 million acres, the NWR System is managed on behalf of the Department of Interior by USFWS. The overwhelming majority of the System's refuges have been created to protect migratory waterfowl, largely to insure compliance with international migratory bird treaties. Refuges conserve habitat for native plants and numerous species of mammals, reptiles, fish, amphibians, and insects — many of which are protected under the Endangered Species Act of 1973 as "threatened" or "endangered."[18] Nevertheless, because

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[15] SEE NATIONAL WILDLIFE FEDERATION, STATUS REPORT ON OUR NATION'S WETLANDS 24 (1987).
[16] *See id.* at 2.
[17] *See id.* at 6-15.
[18] 16 U.S.C. §§ 1531-44 (1994).

many refuges are located in areas that have been subject to agricultural, industrial, and municipal development, they are susceptible to contamination from pollutants.

III. THE RISE AND FALL OF KESTERSON RESERVOIR

Since 1944, water from the upper San Joaquin River has accumulated behind the Friant Dam. The Friant Dam was constructed to deliver irrigation water to the east side of the San Joaquin Valley via the Friant-Kern Canal, completed in 1949. To compensate for the resulting loss of downstream flows in the San Joaquin River, the Bureau of Reclamation constructed the 118-mile Delta-Mendota Canal. The Delta-Mendota Canal carries water southward from the Delta and delivers it to the western San Joaquin Valley.[19] Since the federal government highly subsidized the water, with farmers paying only a fraction of its true cost, the arrangement presented local growers with an economic incentive to bring additional acreage into production.

Unfortunately, much of this newly irrigated land suffers from severe drainage problems. It is here, in the western San Joaquin Valley, that this study of the connection between agricultural drainage and selenium toxicity begins. Most of the San Joaquin Valley is underlain by the Corcoran Formation, an impermeable clay layer, 20 to 200 feet thick, lying 10 to 40 feet below the Valley's surface. This geological feature — formed as a lake bed about 600,000 years ago — prevents water from percolating downward through the soil profile. As a result, irrigation water pools above it, saturating the soils near the surface and threatening to drown the roots of plants.

This situation is further compounded by the accumulation of salts in this water, which leaches from the Valley's alkali soils. The San Joaquin Valley receives an average of less than ten inches of precipitation per year; that figure declines to five inches at the valley's southern end. In arid regions, where evapo-

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[19] Today, 98% of the flow of the San Joaquin River is diverted for agricultural purposes, leaving the lower reaches of the river largely dependent on agricultural drainage for its flow. *See* Theresa S. Presser & David Z. Piper, *Mass Balance Approach to Selenium Cycling Through the San Joaquin Valley: From Source to River to Bay*, *in* ENVIRONMENTAL CHEMISTRY OF SELENIUM 153, 156 (W. T. Frankenberger & R.A. Engberg, eds., 1998). In effect, the San Joaquin River downstream of the city of Mendota is now a "de facto drain." In April 1997, the San Joaquin was named one of the most threatened rivers in the United States by the environmental organization, American Rivers. Interview with Felix Smith, former avian biologist, USFWS, in Carmichael, Cal. (Apr. 14, 1997).

ration exceeds precipitation in all but the wettest years, the net movement of salt is up toward the surface rather than down through the soil profile, resulting in a gradual increase in topsoil salinity. When irrigation water inundates these soils, it leaches their salts. But since the Corcoran clay prevents percolation downward, the trapped water becomes increasingly salinized over time, posing a grave danger to agriculture.

The scientific community understood such basic geohydrologic considerations by the late nineteenth century. Although the threat from selenium was not yet known, as early as 1957 a California Department of Water Resources ("DWR") report stated:

> At the present time, the most serious unsolved drainage problem in California is in the west side of the San Joaquin Valley. It is considered probable that full solution will require a master drainage channel extending from Buena Vista Lake in Kern County [at the southern end of the San Joaquin Valley] to Suisun Bay [in the Delta].
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> Drainage must be considered an integral and indispensable part of the development and utilization of water resources. Adequate provision must be made therefor in the total program.[20]

In 1960, representatives of the Westlands Water District ("Westlands") — which covers over 940 square miles, and is presently the largest and richest federally subsidized irrigation district in America — convinced Congress to authorize an expansion of the CVP.[21] With the creation of the San Luis Unit of the CVP, irrigation water became available to Westlands for the first time, ending the growers' reliance on diminishing groundwater supplies.[22] Part of the reason for this congressional action was the political clout of the corporate growers in the Westlands Water District. Southern Pacific and Standard Oil together control

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[20] California Department of Water Resources, Bulletin No. 3: The California Water Plan, at 21 (May, 1957). DWR was established in 1956, uniting dozens of formerly independent state agencies that had been responsible for water planning and development. DWR serves as both steward of water resources and water supplier for the state.

[21] *See* San Luis Act, Pub. L. No. 86-488, 74 Stat. 156 (1960).

[22] Westlands Water District was formed on September 8, 1952 by landowners of 400,000 acres along the west side of the San Joaquin Valley. At the time of Westland's formation, groundwater levels were dropping rapidly as a result of deep well irrigation. In 1965, Westlands annexed an additional 200,000 acres of land, the former Westplains Water Storage District. Most of this additional acreage was of poor quality and suffered from drainage problems. *See* BAY INSTITUTE OF SAN FRANCISCO, SELENIUM & AGRICULTURAL DRAINAGE: IMPLICATIONS FOR SAN FRANCISCO BAY AND THE CALIFORNIA ENVIRONMENT, at 6-7 (1986) [hereinafter SECOND SELENIUM SYMPOSIUM] (documenting proceedings of Second Selenium Symposium, Mar. 25, 1985, Berkeley, Cal.).

nearly 200,000 acres of the Westlands Water District. J.G. Boswell Company, the single largest agricultural entity in the world, controls 156,000 irrigated acres (240 square miles) in the Central Valley, of which 23,000 are in Westlands, with most of the remainder in the Tulare Lake District to the south.[23]

Today, Westlands holds two CVP contracts for 1,150,000 acre-feet of annual water supply.[24] Over the decade from contract water years 1989/1990 to 1998/1999, the average cost of this subsidized water has ranged from a low of $21.20 to a high of $54.76 per acre-foot.[25] Westlands growers supplement this CVP water by pumping approximately 200,000 acre-feet annually from groundwater supplies.[26] CVP water, supplemented by groundwater, presently allows the growers in Westlands to produce fifty different fiber, vegetable, seed, fruit, nut and grain crops. Nearly half of its acreage is devoted to cotton production.[27] Located almost exclusively in Fresno County, Westlands produces almost twenty-five percent of the county's $3 billion agricultural output. Statewide, Westlands agribusiness produces about sixty-four percent of California's garlic, twenty-eight percent of its tomatoes, and more than fourteen percent of its lettuce.

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[23] J.G. Boswell, Co. is perhaps best known for its role in defeating the construction of the Peripheral Canal. The Peripheral Canal would have brought irrigation water from the Sacramento River to the San Joaquin Valley via the California Aqueduct and the Delta-Mendota Canal, while bypassing the Delta. The Peripheral Canal also would have eliminated the problem of reverse flows, or saltwater intrusions, into the Delta and the San Joaquin River caused by pumping an excess of freshwater out of the Delta and into the California Aqueduct and the Delta-Mendota Canal. Boswell contributed $1.2 million to environmentalists who were waging a campaign against the Canal. The issue was defeated in a statewide referendum in June 1982. Boswell was not opposed to the acquisition of additional subsidized water that the canal would have provided. It was opposed, however, to the environmental protections that would have been provided for north-coast rivers and the Delta under Proposition 8 (a citizen-sponsored initiative). Proposition 8 would only take effect if the Peripheral Canal gained voter approval. *See* HUNDLEY, *supra* note 7, at 309-30; Eric Schine, *A Cotton-Pickin' Mess in California*, BUSINESS WEEK, Apr. 29, 1991, at 95, 98.

Saltwater intrusions into the Delta caused by reverse flows are the concern of CALFED, an interagency organization authorized by the Bay-Delta Accord of 1994. *See* PRINCIPLES FOR AGREEMENT ON BAY-DELTA STANDARDS BETWEEN THE STATE OF CALIFORNIA AND THE FEDERAL GOVERNMENT (Dec. 15, 1994). CALFED's participating California agencies are the California Resources Agency, California Department of Water Resources, California Department of Fish and Game, California Environmental Protection Agency, and the State Water Resources Control Board. CALFED's federal agencies are the Department of Interior, Bureau of Reclamation, Fish and Wildlife Service, Environmental Protection Agency, and the National Marine Fisheries Service.

[24] One acre-foot equals 325,900 gallons. Westlands has not always received 100% of its allotment, especially during the drought years of the early 1990s, when deliveries were significantly curtailed.

[25] *See* WESTLANDS WATER DISTRICT, UNTITLED PAMPHLET (1998) [hereinafter WESTLANDS PAMPHLET] (on file with Author).

[26] *See* WESTLANDS WATER DISTRICT, UNTITLED MAP AND PAMPHLET (1998) (on file with Author).

[27] This figure was 263,264 acres in 1997. *See* WESTLANDS PAMPHLET, *supra* note 25.

Onions, beans, almonds, cantaloupes, alfalfa hay and seed, and wheat are also significant crops.[28]

The authorization of the San Luis Project required drainage to be provided to Westlands through a combined federal and state effort. In the mid-1960s, the Bureau of Reclamation and DWR developed plans to construct a 280-mile master drain from Bakersfield to the Delta. But in November of 1966, Ronald Reagan defeated the reelection bid of Pat Brown, California's Democratic governor. Reagan was far less supportive of the project than his predecessor. Citing budget constraints and growers' unwillingness to help pay for the project, Reagan effectively ended California's participation. In 1967, DWR announced to the Bureau that it would not help build the drain. Despite the missing drain, the Bureau began water deliveries to Westlands in 1968.

Acting alone, between 1968 and 1975 the Bureau completed an 85-mile segment of a more modest 188-mile drain. The drain began in the south near Five Points in the Westlands Water District; its northern terminus was Kesterson, which was originally designed to be a flow-regulating reservoir. Federal budget constraints and effective political opposition, galvanized by the environmental threat of agricultural drainage water pouring into San Francisco Bay, prevented completion of the 103-mile lower segment from Kesterson to the Delta. As a result, the Bureau changed Kesterson's status from a regulating reservoir to a terminal holding reservoir which would store and concentrate drainage water.[29]

In 1968 the Bureau also acquired a 5900-acre tract of partially grassland habitat at the Kesterson Reservoir site. By 1970, the Bureau had constructed twelve evaporation/seepage ponds, averaging four feet deep, and covering 1280 acres. The cost was $10 million. That same year a cooperative agreement between the Bureau and USFWS made the area into a unit of the Service, to be managed for wildlife benefit.[30] The authors of this agreement willfully ignored years of research concerning the environmental dangers of agricultural wastewater.

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[28] *See id.*

[29] During parts of the year when river flows were considered sufficiently high to dilute contaminants present in the drainwater, water from Kesterson was to be discharged back into the San Joaquin River for transport to the Delta. *See* Harry M. Ohlendorf, *Bioaccumulation and Effects of Selenium in Wildlife*, in SELENIUM IN AGRICULTURE AND THE ENVIRONMENT, SOIL SCIENCE SOCIETY OF AMERICA SPECIAL PUBLICATION NO. 23, at 133, 153 (1989).

[30] *See* United States Department of Interior & California Department of Fish & Game, General Plan For Use of Project Land and Waters For Wildlife Conservation and Management, Kesterson Reservoir, Cal. (Apr. 4, 1969).

Beginning in 1957, state and federal agencies and the University of California assessed the environmental impact of pollutants in agricultural drainwaters. The initial focus was on salinity and boron, followed by nitrates and, later, pesticide residues.[31] In December 1960, a DWR report warned that drainage from the Panoche Fan area of the Westlands Water District was "unusable for beneficial purposes."[32] Subsequent state and federal reports repeated this warning. In 1962, USFWS warned the Bureau of Reclamation about the possibility of bioaccumulation of toxins in organisms exposed to agricultural drainage.[33] The following year, the Service warned against the use of agricultural drainage to enhance waterfowl habitat.[34]

Both the Bureau and the Service ignored these warnings, and in 1971 surface agricultural drainage water, supplemented by large quantities of irrigation-quality water, began flowing into Kesterson. During its first few years of operation, Kesterson Reservoir provided high quality wetland habitat, including breeding habitat, for migratory waterfowl and other waterbirds. The new wetland attracted tens of thousands of birds. Together with the San Luis Drain, Kesterson supported numerous species of fish. The new National Wildlife Refuge appeared to be a success, but the success proved ephemeral.

Beginning in 1976, the Bureau constructed the Westlands Drainage Collector System, a network of tile-lined drains lying six to eight feet below the surface, to serve 42,000 acres of Westlands in the northwest corner of the district. The purpose of the tile-lined drains was to remove irrigation water accumulating above the impenetrable Corcoran clay layer. In 1978, subsurface agricultural drainage water from these drains first began to flow into Kesterson. By 1981 inflow to Kesterson Reservoir consisted almost entirely of subsurface water. From an ecological point of view, the significant difference between surface and subsurface drainage water is that subsurface drainage is often heavily laced with trace elements and salts leached from the soil.

Unfortunately, these 42,000 acres of Westlands gave rise to the most selenium-contaminated shallow groundwater collected as subsurface drainage and

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[31] Reflecting the understanding gained in the wake of the disaster at Kesterson in the 1980s, present studies are focusing on selenium and other toxic trace elements.

[32] *See* SECOND SELENIUM SYMPOSIUM, *supra* note 22, at 5.

[33] "Bioaccumulation" is the accumulation of an element or compound in the tissues of an organism to concentrations that are significantly higher than those in the environment where the organism lives.

[34] *See* SECOND SELENIUM SYMPOSIUM, *supra* note 22, at 5.

delivered to Kesterson NWR. These lands are located just downslope of the Panoche alluvial fan — the area from which DWR had warned that drainage could serve no beneficial purpose. The sources of this selenium are the Moreno Shale and Kreyenhagen Shale formations in the drainage basin to this area.[35] Geologists believe that the selenium originated from extensive volcanic eruptions during the Cretaceous Period, from 146 to 65 million years ago. The selenium was deposited in sediments of a great inland sea that once covered the Central Valley and has since been uplifted and exposed to weathering and erosion.[36]

While these developments were unfolding at Kesterson, the idea of completing a master drain to the Delta remained alive. In 1975, the Bureau of Reclamation, DWR, and the California State Water Resources Control Board ("SWRCB" or "Board") formed the San Joaquin Valley Interagency Drainage Program ("IDP") to develop and evaluate options for in-valley and out-of-valley disposal of agricultural drain waters.[37] The final report of the IDP, issued in 1979, summarizes the urgency of the study:

> High, brackish water tables now underlying about 400,000 acres (160,000 hectares) of irrigated farmland in the San Joaquin Valley pose an increasingly serious threat to productivity. Ultimately, more than a million acres will be similarly affected. Loss of the productive capacity of these lands would be a serious loss to the people who farm them, to the economic community of the San Joaquin Valley, to

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[35] Soils of the Panoche Fan reach a maximum selenium concentration of 4.5 μg/g (micrograms per gram), with a median of 1.8 μg/g. The Moreno and Kreyenhagen formations, which give rise to this soil, reach a maximum concentration of 45 ppm (parts per million), with medians of 6.5 and 8.7 ppm, respectively. *See* Theresa S. Presser, *Geologic Origin and Pathways of Selenium from the California Coast Ranges to the West-Central San Joaquin Valley*, *in* SELENIUM IN THE ENVIRONMENT 139, 145 (W.T. Frankenberger, Jr. & Sally Benson, eds., 1994). In comparison, the average selenium concentration in the Earth's crust as a whole is only between 0.03 and 0.08 ppm. *See* CHARLES G. WILBER, SELENIUM: A POTENTIAL ENVIRONMENTAL POISON AND A NECESSARY FOOD CONSTITUENT 4 (1983).

[36] *See* Presser, *supra* note 35, at 141, 151-52.

[37] The SWRCB and the Regional Water Quality Control Boards it oversees are responsible for the allocation of water rights and the protection of water resources for the people of California. The Regional Boards develop water-quality standards which consist of "beneficial-use" designations and "water-quality objectives" which are established to protect the beneficial uses. *See* United States Department of Interior & California Resources Agency, A Management Plan for Agricultural Subsurface Drainage and Related Problems on the Westside San Joaquin Valley: Final Report of the San Joaquin Drainage Program, at 67 (Sept. 1990). Since it is also the responsibility of the Regional Boards to issue permits for construction and operation of drainage-water evaporation ponds, there has been a considerable conflict between their mission and their actions.

> the State of California, and to the United States. To prevent this loss, a comprehensive system is required to manage and dispose of the saline effluent of on-farm subsurface drainage systems.[38]

The IDP recommended completion of the San Luis Drain to the Delta. Subsequently, in 1980 the Bureau requested a waste discharge permit for the drain from the SWRCB. In turn, in 1981 the Board required that the Bureau first submit an environmental impact report by 1984. The Bureau testified before the Board that there were no toxicity problems related to the proposed discharge, and it was not receptive to the kinds of studies that USFWS biologists Harry Ohlendorf and Michael Saiki proposed. Consequently, in 1983 the Service undertook studies with its own funds at Kesterson and the nearby Volta Wildlife Area, which was not receiving agricultural drainwater.[39] As a result of the findings of those studies, the disaster at Kesterson was publicized, initiating a fundamental reappraisal of federal water policy in the West.

By June 1981, the Bureau's scientists had discovered high levels of selenium at Kesterson. The Bureau did not reveal these findings to the public.[40] In 1982, Gary Zahm, manager of the San Luis National Wildlife Refuge Complex, of which the Kesterson National Wildlife Refuge was a part, reported that, in the four years since the introduction of subsurface drainage waters to the holding ponds, cattails were dying, algal blooms were occurring, fewer waterfowl were present, and all but one species of fish had been extirpated. Tests conducted in 1982 by USFWS scientists on the remaining mosquitofish indicated selenium concentrations higher than ever recorded in a living fish. Research fisheries biologist Michael Saiki found that these levels were nearly 100 times greater than those found in fish at the Volta Wildlife Area.[41]

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[38] San Joaquin Valley Interagency Drainage Program: U.S. Bureau of Reclamation, California Department of Water Resources, California State Water Resources Control Board, Agricultural Drainage and Salt Management in the San Joaquin Valley: Final Report Including Recommended Plan and First-Stage Environmental Impact Report, at 1-1 (June 1979). There is no question that the San Joaquin Valley suffers from a negative salt balance. Data from 1990 indicate that 1.9 million tons of salt per year enter the Valley's groundwater due to leaching by irrigation water. Of that amount, 1.4 million tons per year are not exported from the Valley. Manucher Alemi, Presentation at the Salinity/Drainage Program Annual Meeting, sponsored by the University of California Salinity/Drainage Task Force, Sacramento, CA (Mar. 26-27, 1997).

[39] Interview with Harry Ohlendorf, former research biologist, USFWS, in Davis, Cal. (Nov. 18, 1997).

[40] *See* SECOND SELENIUM SYMPOSIUM, *supra* note 22, at 7.

[41] Selenium levels were 26.0–31.0 mg/kg wet weight at Kesterson versus 0.30 mg/kg wet weight at Volta. *See* Michael Saiki, *Concentrations of Selenium in Aquatic Food-Chain Organisms and Fish Exposed to Agricultural Tile Drainage Water*, *in* SECOND SELENIUM SYMPOSIUM, *supra* note 22, at 27.

During the summer of 1983, the Service increased the scope of its studies at Kesterson. In June of that year, biologists Harry Ohlendorf and Felix Smith found the first of what would be hundreds of dead and horribly deformed bird embryos. Throughout the summer the Service monitored 468 nests on a weekly basis. The species surveyed included American coots, black-necked stilts, eared grebes, mallards, gadwalls, and cinnamon teal. One nest in ten contained one or more deformed chicks, a percentage of abnormalities far greater than normally expected in a population of wild birds.[42]

Research conducted by Harry Ohlendorf demonstrated close parallels between the deformities observed at Kesterson and those reported in chickens raised on the seleniferous soils of South Dakota in the 1930s.[43] Experiments conducted at the South Dakota Agricultural Experiment Station as early as 1937 demonstrated the occurrence of deformed embryos when chickens were fed rations containing as little as 3.5 parts per million (ppm) of selenium. Reports of selenium toxicity in livestock date back even further, to the nineteenth century, when thousands of cattle and horses died throughout the western states. Chronic poisoning can occur when animals consume vegetation or feed with selenium levels as low as 5 ppm. This chronic poisoning is known as "alkali disease," reflecting the nineteenth century belief that it was caused by drinking alkaline waters.[44] Early in the twentieth century, researchers found that selenium, not salt-laden water, caused "alkali disease." Symptoms of the disease include lack of vitality, loss of hair, growth retardation, and hoof deformities. Death results from anemia and general wasting away of the body.[45]

Although the biochemical pathways of its transmission were not thoroughly understood, selenium had been known to be toxic to animals for many years. Early studies involved terrestrial ecosystems — the movement of selenium from the soil, to plants that bioaccumulated it, and thence into the diet of animals. Before 1982 little was known about the movement of selenium through aquatic

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[42] Harry Ohlendorf, et. al, United States Department of Interior, Fish & Wildlife Service, Fact Sheet: Deformed Waterfowl Observed at Kesterson Reservoir, at 1-2 (Sept. 21, 1983).

[43] *See, e.g.*, E.J. Thacker, *Effect of Selenium on Animals*, *in* U.S. DEPARTMENT OF AGRICULTURE, SELENIUM IN AGRICULTURE: AGRICULTURE HANDBOOK No. 200 (1960) [hereinafter SELENIUM IN AGRICULTURE], at 50 (displaying photo of selenized chick embryo almost identical in appearance to those found at Kesterson). Much of the early research on selenium was brought together in SELENIUM IN AGRICULTURE, *supra*.

[44] J.E. Oldfield, *Selenium: An Essential Poison*, SCI. FOOD & AGRIC., Mar. 1986, at 23.

[45] *See* WILBER, *supra* note 35, at 62.

ecosystems. The potential benefits of the earlier generation of terrestrial research were not tapped.

Realizing the implications of the selenium threat at Kesterson, Felix Smith provided a "Concern Alert" to the USFWS Regional Director Joseph Blum, on June 13, 1983. This report stressed the dangers of selenium-laced drainwater to fish and wildlife, and recommended setting aside funding for further studies.[46] Smith received no response from within the agency. On July 8 of that year, the Service notified the Bureau of Reclamation of the embryo findings and forwarded a copy of the "Concern Alert." The Bureau's response, under Regional Director David Houston, was to downplay the significance of the threat and to question the Service's ability to analyze for selenium. From the beginning, the directors of the two agencies that had collectively created Kesterson NWR were unwilling to acknowledge the nature or magnitude of the selenium threat.

In August of 1983, USGS geologist Ivan Barnes and chemist Teresa Presser conducted an independent analysis for selenium in Kesterson ponds, the San Luis Drain, tile-drainage effluents, and shallow groundwaters. Preliminary results of the analysis indicated dangerous levels of selenium. USGS released its final results in February of 1984. Presser and Barnes had found the average selenium concentration in Kesterson Reservoir and the San Luis Drain to be from 10 to over 100 times background, or naturally occurring, concentrations. Furthermore, their findings demonstrated levels of selenium significantly higher than the Bureau's figures. The USGS reported gross errors in the Bureau's laboratory and field techniques. USGS found that the Bureau had not used EPA-approved techniques nor techniques generally accepted by the scientific community.[47]

As a consequence of these findings, it became increasingly difficult for the Bureau to downplay the selenium threat. Meanwhile, there were growing suspicions among USFWS and California Department of Fish & Game ("CDFG") scientists that the selenium toxicity at Kesterson posed a danger not only to wildlife, but to human health as well. Humans were consuming waterfowl shot in the vicinity of Kesterson National Wildlife Refuge. Citing the results of tests on birds collected at Kesterson by the CDFG, in October 1984 the California

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[46] Memorandum from Felix Smith, avian biologist, USFWS to Joseph Blum, USFWS Regional Director, titled "Concern Alert: Contaminant Problems at Kesterson NWR, California — Selenium" (June 10, 1983).

[47] One USGS value for selenium — collected using approved techniques — was 7000% of the Bureau's comparable figure. *See* SECOND SELENIUM SYMPOSIUM, *supra* note 22, at 8.

Department of Health Services issued the first of what would prove to be numerous notices limiting waterfowl consumption from the area around Kesterson. USFWS closed Kesterson's ponds to public access.

IV. KESTERSON AND THE LAW

On April 27, 1984, two private citizens, James and Karen Claus, entered the Kesterson fray. The Clauses owned a combination duck hunting club and cattle ranch adjacent to Kesterson. They petitioned the Central Valley Regional Water Quality Control Board to take enforcement action against the Bureau of Reclamation, the Grasslands Water District, and other drainage entities which discharged agricultural drainage water into the area. They reported finding sick and deformed birds on their property, as well as the absence of once-numerous fish and frogs. When the Board declined to take action, the Clauses appealed to the SWRCB on May 18, 1984.

Meanwhile, media pressure intensified. In August 1984, UPI writers Lloyd Carter and Gregory Gordon prepared a five-part series on the Kesterson problem, which the *Fresno Bee* carried in its entirety.[48] That same month, Governor Deukmejian and Secretary of Interior William Clark established the San Joaquin Valley Drainage Program to investigate alternative solutions to the valley's salinity and toxicity problems.[49] In October, San Francisco's public television station, KQED, presented a powerful documentary piece on Kesterson, entitled "Down the Drain."

The SWRCB held two evidentiary hearings on the Claus petition in October and December 1984. On February 5, 1985, the Board adopted Cleanup and Abatement Order No. WQ 85-1, requiring the Department of Interior to resolve the problem at Kesterson. Specifically, by its authority under the Porter-Cologne Water Quality Control Act, the SWRCB cited the Toxic Pits Cleanup Act to find that the wastewater discharged into Kesterson constituted a hazardous waste. SWRCB ordered the Bureau of Reclamation to submit a cleanup and abatement plan within five months, and to implement the cleanup plan within three years. The tide of government resistance appeared to be turning.

[48] Gregory Gordon & Lloyd G. Carter, *Poison in the Valley*, FRESNO BEE, Aug. 13-17, 1984.

[49] The San Joaquin Valley Drainage Program, founded in 1984, is not to be confused with the San Joaquin Valley Interagency Drainage Program ("IDP"), founded in 1975.

In Order No. WQ 85-1, the Board acknowledged that there were four types of material within Kesterson Reservoir that were, or may have been, contaminated: surface water, ground water, vegetation, and sediment and shallow soils. The order also asserted that fifty to sixty percent of the inflow to Kesterson Reservoir was seeping into underlying groundwater, polluting an aquifer which was used extensively to supply drinking water. The Toxic Pits Cleanup Act of 1984 prohibited discharge of liquid hazardous wastes into any surface impoundment that lies within one-half mile upgradient from a potential source of drinking water, unless that impoundment is equipped with a double liner and a leachate collection system.[50] The Board found that Kesterson Reservoir contained hazardous waste and was located within the one-half mile limit from a drinking water source. Therefore, the Bureau was subject to the Act.

The Board's authority to act against the Bureau rests in the provisions of the Porter-Cologne Water Quality Control Act. The Porter-Cologne Act is California's basic law covering water quality and the setting of waste discharge requirements.[51] Dating from the late 1960s, this law created the state regional water quality control boards and vests them with the power to impose permit restrictions on dischargers to state waters.

It is no coincidence that action against the Bureau originated from a state regulatory board rather than from Congress. Agricultural runoff has been exempted from the Clean Water Act ("CWA"), the federal water protection law, since 1977, when it was defined as "non-point source pollution."[52] Because the CWA regulates only "point sources," western irrigated agriculture has been able to operate free of federal controls.

A month after the SWRCB ruling, the Kesterson story went nationwide. On March 10, 1985, CBS' "60 Minutes" featured the situation at the Reservoir.

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[50] A surface impoundment refers to part of a waste management unit which is designed to hold liquid hazardous wastes. Surface impoundments include holding, storage, settling, and aeration pits, evaporation, percolation, and other ponds, and lagoons. *See* CAL. HEALTH & SAFETY CODE § 25208.2(x) (West 1999).

[51] *See* CAL. WATER. CODE §§ 13000-14958 (West 1992).

[52] The official designation of the CWA is the Federal Water Pollution Control Act of 1972, 33 U.S.C. §§ 1251-1387 (1994). As amended, the CWA exempts as a point source "agricultural stormwater discharges and return flows from irrigated agriculture . . . ." 33 U.S.C. § 1362(14) (1994). On November 6, 1986, President Reagan pocket-vetoed the CWA, which was due for reauthorization. On February 3 and 4, 1987, the House and Senate, respectively, voted by wide margins to override Reagan's veto. *See* BAY INSTITUTE OF SAN FRANCISCO, SELENIUM & AGRICULTURAL DRAINAGE: IMPLICATIONS FOR SAN FRANCISCO BAY AND THE CALIFORNIA ENVIRONMENT, at 10-11 (1988) [hereinafter FOURTH SELENIUM SYMPOSIUM] (documenting proceedings of Fourth Selenium Symposium, Mar. 21, 1987, Berkeley, Cal.).

Five days later, Congressmember George Miller, the new chairman of the House Subcommittee on Water and Power Resources, called a congressional hearing in Los Banos, California. At that tumultuous meeting, the Department of Interior, fearing a lawsuit under the Migratory Bird Treaty Act, announced the immediate closure of Kesterson Reservoir and the San Luis Drain, and the termination of irrigation water deliveries to Westlands' 42,000 acres that drained into Kesterson.[53] The Department of Interior and Westlands reached an agreement the following month to continue delivery of irrigation water. Without this agreement, continued farming would have been all but impossible. Under the agreement, flows to the San Luis Drain and thence to Kesterson Reservoir were to be stopped by June 1986.[54] Even with this respite, the consequences to Westlands' growers were potentially catastrophic. With their subsurface drains plugged, growers were once again faced with the prospect of rising water tables and the need for on-site evaporation ponds.

The agreement between the Department of Interior and Westlands to halt the flow of effluents into the San Luis Drain and Kesterson Reservoir brought the first chapter of the Kesterson saga to a close. Without the San Luis Drain to remove subsurface wastewater and Kesterson to store and evaporate it, the growers of the western San Joaquin Valley would have to find new ways of grappling with the twin problems of salinity and selenium toxicity. The scientific research that has been conducted on these issues, as well as the ultimate fate of Kesterson itself, are the subjects of the next section of this paper. The outcomes of this research will likely shape the future directions of public policy on irrigation systems and wildlife management throughout much of the West.

V. THE SCIENCE AND THE SELENIUM

Throughout 1984 and 1985, nesting failures continued at Kesterson. USFWS continued to find adult birds dead of selenium toxicosis, resulting from the bioaccumulation of that element. Selenium bioaccumulates to a greater extent in aquatic than terrestrial ecosystems. In aquatic systems, bioaccumulation

[53] In a number of cases in the 1970s, there were criminal prosecutions of private individuals and businesses under the Migratory Bird Treaty Act. However, no suit had ever held the government liable, and there was considerable debate within the Department of Interior over whether the treaty permitted prosecution of the government. *See* Harrison C. Dunning, *Legal Aspects of the Kesterson Problem*, *in* SECOND SELENIUM SYMPOSIUM, *supra* note 22, at 118, 121.

[54] Westlands completed plugging their subsurface drains on the 42,000 affected acres on May 16, 1986.

occurs by direct adsorption (the assimilation of gas, vapor, or dissolved matter by surface tissue), or by ingestion of contaminated foods or water. In a terrestrial environment, bioaccumulation is largely by ingestion only, since uptake from air is less than from water.[55]

The chemist Berzelius discovered selenium in 1817. Selenium has both metallic and nonmetallic properties, and its atomic structure and chemical properties are most similar to sulfur. Several biochemical reactions do not discriminate between selenium and sulfur. Therefore, in the presence of excess selenium, organisms bind it, rather than sulfur, into proteins. In embryos, selenium interferes with the ability to utilize oxygen, resulting in deformities. In adults, it damages internal organs and the respiratory system.[56] Selenium exists in four states of biological significance: selenide (Se^{2-}), elemental selenium (Se^{0}), selenite (Se^{4+}), and selenate (Se^{6+}). Selenate, the most oxidized form, is the predominant mobile inorganic form in semiarid areas such as the San Joaquin Valley that possess alkaline (basic) soils. Elemental selenium from igneous and sedimentary rocks is generally insoluble and therefore unavailable for plant uptake. Through chemical weathering, and possibly microbial action, oxidation in alkaline soils produces soluble selenate which is readily available.[57]

In recent years, scientists have discovered that sediments act as a sink (collecting medium) for selenium present in water. Selenium concentrations in surface waters average 0.2–0.4 micrograms per liter (μg/L). Yet, concentrations up to 4200 μg/L have been found in subsurface irrigation drainage water in the San Joaquin Valley.[58] Selenium concentrations in subsurface irrigation drainwater entering Kesterson during 1983–1985 averaged approximately 300 μg/L, about 1000 times background levels. Recent research findings have persuasively shown that the toxicity threshold for waterborne selenium is less than or equal to 5 μg/L.[59]

From sediments and water, selenium enters the aquatic food chain as it is accumulated by phytoplankton, algae, rooted vegetation, and aquatic inverte-

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[55] *See* Ohlendorf, *supra* note 29, at 134-135.

[56] *See* Deborah Blum, *Kesterson Refuge: No Safe Harbor*, DEFENDERS, Nov.-Dec. 1984, at 30, 34 (citing selenium expert and South Dakota physician, Dr. Arthur Kilness).

[57] *See* Ohlendorf, *supra* note 29, at 139.

[58] *See id.* at 138.

[59] *See* Joseph P. Skorupa, *Selenium Poisoning of Fish and Wildlife in Nature: Lessons from Twelve Real-World Examples*, *in* ENVIRONMENTAL CHEMISTRY OF SELENIUM 315, 341 (W.T. Frankenberger & R.A. Engberg, eds., 1998).

brates. Eventually it moves to higher trophic levels (categories of consumers), including birds and terrestrial predators, where it accumulates in organs or tissues.[60] Elevated selenium concentrations in the diet of animals cause "acute toxicity, impaired reproduction (including developmental abnormalities, embryo mortality, and reduced growth or survival of young), pathological changes in tissues, and chronic poisoning of adult animals."[61] It is the bioavailability of selenium, rather than its concentration *per se*, that determines the expected level of teratogenesis (embryonic malformation). Selenium enters the food chain almost entirely through plants. However, selenium's metabolic pathways — which determine bioavailability — are not well known. Furthermore, it is apparent that the relationship between soluble selenium concentrations in soils and selenium concentrations found in plants depends upon a variety of biotic and abiotic factors, "including plant species, rainfall, temperature, soil pH and sulfate concentrations, plant growth rates, root depth, and distribution of selenium in the soil profile."[62]

The effects of water contaminated with selenium on plant and animal communities were essentially unknown before USFWS conducted studies at Kesterson from 1983 to 1985. The main focus of these studies was aquatic birds. However, the Service also studied mosquitofish, bullfrogs, gopher snakes, and small mammals such as mice and voles to assess selenium's impact on fish, amphibian, reptile, and mammal populations.[63] Chosen for their differing food habits and abundance during the nesting season, the species of aquatic birds studied included the American coot, mallard, cinnamon teal, gadwall, northern pintail, black-necked stilt, American avocet, killdeer, pied-billed grebe, and eared grebe.[64] In 1983, the Service found dead and deformed embryos; during 1984 and 1985, it discovered dead adult birds as well. Developmental abnormalities in embryos included missing or abnormal eyes, beaks, wings, legs, and feet, as well as exencephaly (brain protruding through eye sockets) and hydrocephaly (excess fluid within the skull resulting in compression of the brain). Of the 578 nests monitored between 1983 and 1985, no less than thirty-nine percent contained

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[60] *See* Ohlendorf, *supra* note 29, at 137-138.
[61] *Id.* at 149-150.
[62] Harry M. Ohlendorf & Gary M. Santolo, *Kesterson Reservoir — Past, Present, and Future: An Ecological Risk Assessment*, *in* SELENIUM IN THE ENVIRONMENT, *supra* note 35, at 69, 73.
[63] For a detailed reading on the effects of selenium on non-avian populations, *see* the extensive list of references in Ohlendorf, *supra* note 29, at 168-177.
[64] *See id.* at 155.

at least one dead or deformed embryo or chick.[65] These figures are particularly revealing when compared with observations from the Volta Wildlife Area, 10 km to the southwest of Kesterson. The Service used Volta as its reference site; Volta receives only fresh irrigation water from the Sacramento-San Joaquin River Delta via the Delta-Mendota Canal. During the three years of the study, the Service found only four dead embryos, and none with deformities, in 339 eggs (one percent) at Volta. By contrast, the Service identified 604 dead or deformed embryos and chicks in 2689 eggs (twenty-two percent) at Kesterson.[66] Furthermore, there were no signs of survival at Kesterson among the nearly 440 stilt and avocet chicks that hatched in 1984 and 1985.[67]

Clearly, selenium toxicity was taking a toll at Kesterson. Based on these and other observations, Harry Ohlendorf estimates that at least 1000 migratory birds, including adults, embryos, and chicks, died at Kesterson during 1983–1985. The probable cause of death was selenium toxicosis caused by the bioaccumulation of selenium resulting from feeding on plants, invertebrates, and fish with average selenium concentrations from 12 to 120 times normal levels.[68]

VI. POLITICS, POLITICS, POLITICS

On December 3, 1983, the Department of Conservation and Resource Studies at the University of California, Berkeley, represented by Professor Arnold Schultz, sponsored the first of four public symposia on the environmental implications of the crisis at Kesterson for California and the San Francisco Bay Area.[69] By the time that the third symposium took place in March 1986 — one year after the SWRCB's order to close Kesterson — a dominant concern had become the suppression of scientific information under what appeared to be federal "gag orders" and the apparent retribution against government scientists who were calling attention to pollution problems at Kesterson. Congressmember

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[65] *See id.* at 159.
[66] *See id.* at 163.
[67] *See id.* at 165.
[68] *See id.*
[69] These symposia, entitled *Selenium and Agricultural Drainage: Implications for San Francisco Bay and the California Environment*, are generally referred to as Selenium I, II, II, and IV. Selenium II was held on March 23, 1985; Selenium III on March 15, 1986; and Selenium IV on March 21, 1987. Selenium II, III, and IV were co-sponsored by the San Francisco Bay Institute; Selenium II was also co-sponsored by USFWS.

George Miller had warned against censorship of scientific information by government agencies as early as the first symposium.[70]

Felix Smith, the author of the Service's 1983 "Concern Alert," had faced the abolition of his position with USFWS in Sacramento and an imminent transfer to Portland, Oregon. Louis Clark, Executive Director of the private, non-profit Government Accountability Project, Inc. volunteered to represent Smith. Clark won a court order enjoining the Service from transferring or harassing Smith. Clark also wrote to the Department of Interior about the government's treatment of its scientists.

An excerpt from a letter dated February 26, 1986 from Congressmember George Miller to Louis Clark, requesting Clark's help in investigating allegations of a federal cover-up, is illuminating.

> We are advised continually by press accounts and by government scientists that agency officials have sometimes gone to extraordinary lengths to prevent public disclosure of the severity of some of these contamination problems. For example, employees have been forbidden to talk with the press, and others have been prevented from attending or delivering professional papers at scientific conferences. Instances also exist where employees have been given new assignments, and one employee of the Fish and Wildlife Service has been advised that his job has been eliminated. Finally, agencies have used heavy-handed techniques to silence employees and frustrate their efforts to document the extent of the contamination problems.[71]

Considerable additional evidence supports the thrust of Miller's contentions. Orders from David L. Trauger, Director of the Service's Patuxent Wildlife Research Center, prevented Ohlendorf from discussing the implications of his

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[70] As a representative of Contra Costa County — whose waters between the San Francisco Bay and the Delta were the proposed terminus of the San Luis Drain — Miller has had a long-standing interest in California water issues. He carried legislation to halt completion of the Drain, to reduce subsidies in the federal water program, and to provide the first federal water quality protections for the Delta. In 1985 he became chairman of the Water and Power Resources Subcommittee, which oversees federal irrigation and reclamation programs throughout the western states, and groundwater and water research programs nationally. *See* FOURTH SELENIUM SYMPOSIUM, *supra* note 52, at 10-11.

[71] Letter from Congressmember George Miller to Louis Clark, Executive Director, Government Accountability Project, Inc. (Feb. 26, 1986), *reprinted in* BAY INSTITUTE OF SAN FRANCISCO, SELENIUM & AGRICULTURAL DRAINAGE: IMPLICATIONS FOR SAN FRANCISCO BAY AND THE CALIFORNIA ENVIRONMENT, at x (1987) [hereinafter THIRD SELENIUM SYMPOSIUM] (documenting proceedings of Third Selenium Symposium, Mar. 15, 1986, Berkeley, Cal.).

1985 research findings at Kesterson.[72] Conference organizer Arnold Schultz wrote to Trauger two days after the conference to protest.[73] Trauger explained to Schultz that: " . . . 1985 observations constitute 'raw data' and were too tenuous to release for open forum."[74] Ohlendorf contends that he tried to present "solid data with a reasonable interpretation. There was not a proven cause and effect relationship necessarily, but there was circumstantial evidence that it [the cause] was selenium."[75]

Schultz also challenged Trauger's restriction that prevented Ohlendorf from discussing the failure of a hazing program at Kesterson, designed to frighten birds away from the Reservoir by firing blanks from shotguns and other firearms. Trauger responded that "there have been no studies conducted by our staff to evaluate the efficiency of this activity."[76] This statement was patently false; USFWS Regional Director Joseph Blum had testified before the SWRCB and sworn in a court affidavit that the hazing program had been monitored and that it was "largely unsuccessful in keeping American coots, water birds, and tricolored blackbirds [a candidate for the federal endangered species list] from using the reservoir during any season."[77]

Blum also testified that 1985 samples showed selenium concentrations from 10 to 1000 times higher than normal in small rodents captured near Kesterson.[78] This discovery implied that selenium was beginning to move up the terrestrial, as well as the aquatic, food chain. Elevated selenium levels in voles, mice, and shrews pose a potential threat to their predators — raccoons, coyotes, gray foxes, and endangered San Joaquin kit foxes. Despite the significance of the Service's findings, orders from Patuxent also prevented USFWS research scientist Donald Clark from discussing them at the symposium.

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[72] The Patuxent center in Laurel, Md. exercised supervisory authority over its research field station in California. Ohlendorf had been Assistant Director of Patuxent until he accepted a position with the new field station in 1980. Originally, the field station's studies were planned for Tulare Lake, but the focus shifted to Kesterson in 1982.

[73] *See* Letter from Arnold Schultz, Selenium Symposium Organizer to David L. Trauger, Director, USFWS Patuxent Wildlife Research Center (Mar. 17, 1986) (on file with Author).

[74] Reply Letter from David L. Trauger to Arnold Schultz (Mar. 31, 1986) (on file with Author).

[75] Interview with Harry Ohlendorf, former research biologist, USFWS, in Davis, Cal. (Apr. 9, 1997).

[76] Reply Letter from David L. Trauger to Arnold Schultz, *supra* note 74.

[77] Affidavit of Joseph Blum, Regional Director, USFWS, at 2, City of Mendota v. Hodel, Civ. No. F-86-109-REC (E.D. Cal. 1986).

[78] *See id.* at 3.

Author John Terbough aptly describes the type of difficulties that confront scientists like Smith, Ohlendorf, and Clark. "When scientists obtain results that are contrary to the goals of a bureaucratic organization, their results may be suppressed, or buried deep in a report so thick and tedious that no one reads it."[79] In the deeply conservative atmosphere of the Reagan administration, government officials were not likely to jeopardize their careers by supporting scientists who championed wildlife at the expense of Bureau of Reclamation projects that benefited corporate agribusiness.

VII. CLOSING IT DOWN AND CLEANING IT UP

In October 1986, the Bureau, in cooperation with the Service and the U.S. Army Corps of Engineers, provided the SWRCB with its Final Environmental Impact Statement (EIS) for the clean-up of Kesterson Reservoir.[80] The Bureau examined five options in the EIS: a no-action alternative, a flexible response plan, an immobilization plan, a wetland restoration/onsite disposal plan, and an offsite disposal plan.

The Bureau proposed a phased approach, incorporating three of these remediation options, which would be implemented in succession if the previous option proved unsatisfactory. The first and least expensive option, the Bureau's preferred alternative, was the flexible-response plan. This so-called "wet-flex" option called for the harvesting, disking (plowing underground), or incinerating of onsite vegetation in order to eliminate a primary selenium exposure pathway, vegetation consumed by wildlife. The southernmost ponds, where selenium concentrations were highest, were to be flooded with fresh water from the CVP, while the northernmost ponds were to be dewatered, reverting to seasonal wetlands only.[81]

The immobilization plan was an extension of the flexible-response plan. Under this option, all the ponds of Kesterson Reservoir were to be flooded with fresh water. The theory behind these plans was that once the existing surface water (from irrigation drainage) infiltrated the bottom sediments and soils, the

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[79] JOHN TERBORGH, WHERE HAVE ALL THE BIRDS GONE? ESSAYS ON THE BIOLOGY AND CONSERVATION OF BIRDS THAT MIGRATE TO THE AMERICAN TROPICS 26-27 (1989).

[80] U.S. DEPARTMENT OF INTERIOR, FINAL ENVIRONMENTAL IMPACT STATEMENT, KESTERSON PROGRAM, MERCED AND FRESNO COUNTIES, CAL., (Oct. 1986) [hereinafter KESTERSON PROGRAM EIS] (2 volume set).

[81] *See* 2 KESTERSON PROGRAM EIS, at 3-16.

selenium would be converted from selenate to the less bioavailable selenite and selenide, and to insoluble elemental selenium.[82]

The third and most expensive option was the onsite disposal plan. Under this plan, the uppermost six inches of soil, with the existing vegetation, were to be excavated and disposed of in a lined and capped onsite landfill. After removal of the most contaminated soils, topsoil would be imported and wetland habitat would be reestablished at Kesterson, which would continue to function as part of the Kesterson National Wildlife Refuge.[83]

On December 1, 1986, the Department of Interior selected the phased approach as the clean-up action. To the Bureau's dismay, studies conducted by Alex Horne at the University of California at Berkeley and by USFWS demonstrated that although levels of selenium in the food chain decreased with freshwater inflow, the rate of decrease slowed at a level that was still too high. An insufficient amount of selenium was being withdrawn from circulation. These findings invalidated the "wet-flex" and immobilization options.[84] On March 19, 1987, the SWRCB rejected the phased approach and ordered the Bureau to clean up Kesterson Reservoir by August 19, 1988, using the onsite disposal plan.

New evidence soon became available, however, that suggested that even the onsite disposal plan would not be effective in cleaning up Kesterson. Researchers at Lawrence Berkeley Laboratory found that groundwater that had not percolated deep into the soil profile but remained near the surface had accumulated selenium to concentrations higher than water in the original ponds. These findings implied that if the Bureau excavated the ponds according to the onsite disposal plan, the contaminated groundwater would be released into the new ponds, making them more toxic than before and presenting a continuing threat to wildlife.[85]

Instead of allowing the excavation of the surface soils and then the rewatering of the Reservoir, as proposed under the onsite disposal plan, the SWRCB ordered the Bureau to fill all areas where it expected ephemeral pools to form and to fill all areas to six inches above the expected seasonal rise in groundwater level. The deadline was January 1, 1989.[86]

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[82] *See id.* at 3-22.

[83] *See id.* at 3-28.

[84] Interview with Harry Ohlendorf, former research biologist, USFWS, in Davis, Cal. (Apr. 9, 1997).

[85] *Id.*

[86] *See* SWRCB, Order No. WQ 88-7 (Jul. 5, 1988).

On December 16, 1988, Bureau contractors completed the filling and grading of Kesterson Reservoir. The low-lying areas of the Reservoir were filled with a total of 1,050,437 cubic yards of earth, at a cost of approximately $6.5 million.[87] Kesterson Reservoir had been buried.

But had it been killed? After Kesterson was dewatered, research continued there under the Kesterson Reservoir Biological Monitoring Program. The objectives of this program, developed by USFWS and the Central Valley Regional Water Quality Control Board, were to: assess the impact of Kesterson Reservoir on local and migratory wildlife; provide a basis for adjusting Kesterson Reservoir management; verify the effectiveness of cleanup actions at Kesterson; and provide a basis for modifying future biological monitoring.[88]

The researchers' main concern was that surface pools formed in low-lying areas during particularly wet years would still contain selenium concentrations high enough to pose a continued threat to wildlife. If pools formed during late winter or early spring and persisted during the nesting season, they might support selenium-laden plants and invertebrates upon which birds would then feed.

Subsequent studies revealed that surface water selenium concentrations in some pools exceeded the recommended safe levels of 5 μg/L; concentrations as high as 1600 μg/L have been recorded.[89] Studies in the Tulare Lake Basin, adjacent to the Kern National Wildlife Refuge, have shown that waterborne selenium concentrations of 10 μg/L have been associated with hatchability effects and concentrations of 10 to 20 μg/L with teratogenic effects.[90] Based on these figures, it is clear that persistent rainwater pools in Kesterson may still pose a threat, albeit a somewhat reduced one, to aquatic birds.

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[87] *See* Department of Interior, Effectiveness of Filling Ephemeral Pools at Kesterson Reservoir (Apr. 1, 1989), (included as part of Department of Interior's response to SWRCB Order No. WQ 88-7).

[88] *See* Ohlendorf and Santolo, *supra* note 62, at 73. Research areas consisted of grassland, filled, and open habitat. Grassland habitat includes the higher elevation, upland area that existed at the reservoir before it was dewatered. Filled habitat includes formerly low-lying areas that were filled with soil to prevent the formation of seasonal wetlands. Open habitat includes former cattail (marshy) areas that were not filled, but were disked to prevent use by tricolored blackbirds. These areas cover 30%, 60%, and 10% of the reservoir, respectively. *See id.* at 76.

[89] Interview with Joseph Skorupa, avian biologist, USFWS, in Davis, Cal. (Nov. 19, 1997).

[90] *See* Ohlendorf and Santolo, *supra* note 62, at 104.

VIII. BEYOND KESTERSON

Even if the continuing threat at Kesterson proves negligible, the problem of selenium toxicity is far from solved. The closing and ultimate filling-in of Kesterson Reservoir did not end this problem in the San Joaquin Valley. Kesterson lies in the heart of the Grasslands wetlands, which, at 160,000 acres, comprises one-third of the wetlands in the Central Valley. The Grasslands are visited by twenty percent of North America's migratory waterfowl annually.[91] Seventy percent of the Grasslands is privately owned and operated by duck hunting clubs. Studies conducted in the Grasslands during 1984 revealed elevated levels of selenium in bird and fish populations. These levels were high enough to assume reproductive problems.[92]

In the Tulare Basin, located in the southern San Joaquin Valley, about 160 km south of Kesterson, a 1987 study revealed embryonic malformations similar to those found at Kesterson.[93] The Tulare Lake Drainage District has been called by one research scientist the "skeleton in the closet" of the State Water Project.[94] To compensate for its lack of a natural drainage to the ocean, the Tulare Lake Drainage District constructed more than twenty shallow impoundments from 1972–1985 to provide for evaporation of saline irrigation drainage water. Although not intended to provide wildlife habitat, these ponds have attracted large numbers of waterbirds, including populations of nesting birds. The selenium content of drainage water entering these ponds ranges from less than 1 μg/L to greater than 1000 μg/L.[95]

In 1988, the Tulare Lake Drainage District applied to the SWRCB for a loan of $1 million to build additional evaporation ponds for agricultural drainwater.[96] The Democratically controlled state legislature required the SWRCB to

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[91] Gary Voet, *Kesterson comes back to life*, SACRAMENTO BEE, Jan. 8, 1997, at E6.

[92] *See* Ohlendorf, *supra* note 29, at 166. Today, the Grasslands Bypass Channel Project diverts drainage water away from the Grasslands wetlands that flank Kesterson. Under an agreement among agricultural, government, and environmental parties, in 1995 the Bureau of Reclamation reopened part of the San Luis Drain on an interim 5-year basis to transport drainage to Mud Slough and then to the San Joaquin River. While conditions have generally, but not universally, improved in the Grasslands, drainwater entering the San Joaquin River from Mud Slough remains heavily laden with selenium, the concentration of which is no longer diluted by wetland flows, losses to sediment, or bioaccumulation in organisms. *See* Presser and Piper, *supra* note 19, at 157-158.

[93] *See id.* at 167.

[94] Interview with Joseph Skorupa, avian biologist, USFWS, in Davis, Cal. (Apr. 24, 1997).

[95] *See* Skorupa, *supra* note 59, at 327.

[96] SWRCB meeting, Sacramento Cal. (Dec. 15, 1988).

submit new environmental impact statements before these evaporation ponds could be exempted from the Toxic Pits Cleanup Act. USFWS went before the Board and showed that avian embryonic deformity rates were higher at Tulare Lake than at Kesterson and were caused by selenium.[97] Incredibly, the Board, dominated by political appointees of Governor Deukmejian, ruled that these findings were "not relevant." Of the fifty-six scientific articles reviewed by the Board, only five were considered relevant.[98] The Board approved the loan request, subject only to new Waste Discharge Requirements to be issued by the Central Valley Regional Water Quality Control Board.[99]

This incident is yet another example of corporate and government stonewalling concerning drainwater issues. During his presidency, Ronald Reagan threatened to disband USFWS' research arm for publicly exposing problems with drainwater; a Democratic Congress prevented him from doing so. In October 1991, the Bush administration ended federal funding for drainwater studies. State agencies were willing to fund USFWS' continuing selenium research. However, Douglas Buffington, Director of Research for the Service's Region 8 — which includes the Patuxent Wildlife Research Center and its field stations — forbade scientists to seek non-federal funding for that research.[100] More recently, the Tulare Lake Drainage District (which for all practical purposes means the J.G. Boswell Co.) went to DWR in an attempt to revoke USFWS avian biologist Joseph Skorupa's research grant.[101] Failing that effort, the District tried to have Skorupa removed as principal investigator of avian deformities. To its credit, DWR refused.[102]

In June 1991, an external review of the Patuxent Wildlife Research Center severely criticized USFWS' leadership for politicizing the selenium issue through its malfeasance.

> Where there is clear direction from upper management, such as the decision to discontinue drainwater work, this direction appears to be motivated by politics

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[97] *See* J.P. Skorupa & H.M. Ohlendorf, USFWS, Research Information Bulletin 88-49, Deformed Waterbird Embryos Found Near Agricultural Drainage Ponds in the Tulare Basin (1988).

[98] SWRCB, Draft Resolution No. 88-__ (unnumbered), titled "Satisfaction of requirement to review and consider the recommendations of any federal- or state-funded studies, reports, or research pertaining to agricultural drainage water management units" (responding to Assembly Bill No. 2875).

[99] SWRCB, Resolution No. 88-130.

[100] Interview with Joseph Skorupa, avian biologist, USFWS, in Davis, Cal., (Apr. 24, 1997).

[101] For a further description of the J.G. Boswell Co., *see supra* note 23.

[102] Interview with Joseph Skorupa, avian biologist, USFWS, in Davis, Cal., (Apr. 24, 1997).

> rather than by science or merit. ECRB [Environmental Contaminants Research Branch] scientists unanimously agreed that the drainwater issue is one of the most important issues facing American wildlife today. The PRRP [Patuxent Research Review Panel] noted a tangible feeling of frustration within the ECRB that this work is not allowed to proceed.[103]

The profound resistance encountered by those conducting research on drainage issues, including selenium toxicity, must be understood in light of California's multi-billion dollar agricultural industry. As scientific evidence has mounted against the dangers posed to animal and human health by contaminated irrigation drainwaters, the political climate has slowly begun to change. The greatest historical significance of Kesterson and of the agricultural drainage water issue may prove to be the reprioritizing of who gets — and who does not get — limited water resources. This fragile balance of power between agricultural interests, municipalities, and defenders of wildlife and the environment has been recognized from the start by the agribusiness community and explains their furious resistance toward anyone who has carried out research on drainwater issues.[104]

The reproducibility and consistency of scientific results is beginning to turn the tide against the political power of agricultural monied interests. This transition is taking place within the larger context of the California water wars. Alliances between metropolitan water districts, agribusiness, and environmentalists are shifting. Agriculture accounts for approximately eighty-five percent of California's water use. As metropolitan water districts find their demands on limited water supplies increasing, they may begin to realign in an "alliance of necessity, not an alliance of ideals" with grass-roots environmentalists.[105]

The issues raised by Kesterson clearly have ramifications that extend far beyond this single refuge in California. The problems uncovered at Kesterson raised public concerns about the health of other national refuges, while at the same time suggesting a link between federal irrigation projects and environmental contamination. This problem had not been unforeseen. In 1985, Ivan Barnes of the USGS predicted that the situation at Kesterson would be repeated "in dozens of places over thousands of square miles throughout the West."[106] USGS

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[103] Patuxent Wildlife Research Center, USFWS, Patuxent Research Review Panel Report, at 76 (June 1991).
[104] Interview with Joseph Skorupa, avian biologist, USFWS, in Davis, Cal., (Apr. 24, 1997).
[105] *Id.*
[106] Tom Harris, *The Kesterson Syndrome*, AMICUS J., Fall 1989, at 6.

and USFWS requested the Department of Interior to fund a study of potentially contaminated sites in fifteen western states. Secretary of Interior James Watt, a Reagan appointee, unceremoniously refused.[107] But it was too late to keep a lid on the selenium issue. In September 1985, the *Sacramento Bee* ran a series of articles concerning possible selenium contamination at 23 additional sites in the West.[108] That same year the Service began a survey to determine the extent of contamination problems at refuges throughout the nation.

On January 6, 1986, Congressmember John J. Dingall, the Chairman of the Subcommittee on Oversight and Investigations of the House Committee on Energy and Commerce, formally requested the United States General Accounting Office ("GAO") to review the status of cleanup activities at Kesterson. The GAO was also asked to determine the broader issues of whether the Department of Interior had assessed the extent of contamination at other national wildlife refuges, whether it had developed programs to deal with actual or potential contamination, and whether the Environmental Protection Agency was enforcing laws to prevent damage to the refuges. The GAO conducted its investigation from March 1986 to March 1987, and released its report in July 1987.[109] Of the 430 refuges extant in 1985, the GAO identified 85, or approximately twenty percent, as having contaminant problems. The GAO reported agricultural drainage as the contaminant source in forty of those refuges. Industrial waste was the contaminant source in twenty-one refuges, municipal waste in twelve, military activities in eight, and asbestos, cattle waste, and mosquito spraying in four.[110]

The combination of the Kesterson disaster and increased media and congressional attention to the problem of agricultural drainage has increased the Department of Interior's willingness to address agricultural drainage water's potentially harmful effects on wildlife and wildlife habitat. To this end, the Depart-

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[107] *See id.*

[108] Tom Harris & Jim Morris, *Selenium: Toxic trace element threatens the West*; *The Bee uncovers conspiracy of silence*, SACRAMENTO BEE, Sept. 8-10, 1985.

[109] UNITED STATES GENERAL ACCOUNTING OFFICE, GAO/RCED-87-128, WILDLIFE MANAGEMENT: NATIONAL REFUGE CONTAMINATION IS DIFFICULT TO CONFIRM AND CLEAN UP (Jul. 1987) [hereinafter GAO REPORT]. In its report, the GAO included the findings of the USFWS' 1985 survey. *See*, U.S. FISH & WILDLIFE SERVICE, PRELIMINARY SURVEY OF CONTAMINANT ISSUES OF CONCERN ON NATIONAL WILDLIFE REFUGES, (Apr. 1986).

[110] *See* GAO REPORT, *supra* note 109, at 32. Most of the refuge personnel based their judgments of the potential for contamination on a review of their records and on visual observations, rather than on-site testing. As a consequence, the final figures are not absolutely conclusive. If anything, they underestimate the problem; five additional refuge managers reported contamination problems shortly after the survey was completed. *See id.* at 34.

ment established the Irrigation Drainage Program in 1986, an interagency effort that includes USFWS, USGS, and the Bureaus of Reclamation, Land Management, and Indian Affairs. The Program's studies of water, sediment, plant, and animal samples began on May 30, 1986 at nine western locations.[111] The Program was subsequently renamed the National Irrigation Water Quality Program and expanded to include twenty-six sites in fourteen of the seventeen states where federal irrigation projects are located.[112] The Department confirmed that fourteen of the twenty-six study areas were contaminated by selenium above toxic thresholds. Three of them were as seriously poisoned as Kesterson.[113]

A brief look at one of these sites will prove instructive as to the magnitude of the problem and the difficulty of precisely assessing it. The Stillwater Wildlife Management Area comprises approximately 144,000 acres located 75 miles east of Reno, Nevada. Established in 1948 on public lands, Stillwater has historically been a major stopover for migratory waterfowl. Stillwater is watered by drainage from the Bureau of Reclamation's Newlands Project, which provides agricultural irrigation water to the lower Carson River area. The Service manages the 24,000-acre Stillwater NWR, which lies within the Wildlife Management Area. At the Stillwater NWR, USFWS found elevated levels of the trace elements selenium, arsenic, boron, mercury, and lithium. In 1985 and again in 1986, hundreds of thousands of fish died in the Carson River and Carson Sink, the area to the north of Stillwater where much of the drainwater empties. In 1987, the Carson Sink also witnessed a major bird die-off. The Service was not able to confirm the cause of the fish die-off and it officially attributed the bird deaths to avian cholera, a naturally occurring disease. The causal link, if any, between the fish and bird die-offs, high salinity content of the drainwater, and the presence of trace elements and other pollutants in the area has not been conclusively determined.[114]

An additional decade of research has not yet provided the answers. In the Salton Sea in southern California, unexplained massive die-offs of fish and the

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[111] These included the Lower Colorado-Gila River Valley area in Arizona and California; the Salton Sea area in southern California; the Tulare Lake area in the southern San Joaquin Valley; the Sun River Reclamation Project area, and the Milk River Reclamation Project area, both in Montana; the Stillwater Wildlife Management area in Nevada; the Lower Rio-Grande-Laguna Atascosa National Wildlife Refuge area in Texas; the Middle Green River Basin area in Utah; and the Kendrick Reclamation Project area in Wyoming. *See id.* at 60.

[112] Richard A. Engberg, et al., *Federal and State Perspectives on Regulation and Remediation of Irrigation-Induced Selenium Problems*, *in* ENVIRONMENTAL CHEMISTRY OF SELENIUM, *supra* note 19, at 4.

[113] Interview with Joseph Skorupa, avian biologist, USFWS, in Davis, Cal. (Nov. 11, 1997).

[114] *See* GAO REPORT, *supra* note 109, at 61-62.

deaths of thousands of comorants from avian cholera are recurrent. Like Stillwater, the Salton Sea is extremely saline and has high concentrations of trace elements, including selenium.

There are legal as well as scientific obstacles to responding to these environmental catastrophes. USFWS does not have authority to set enforceable water quality standards for fish, wildlife, or refuge habitat. That responsibility lies with the Environmental Protection Agency, under the provisions of the CWA. The EPA lowered the freshwater chronic criteria for selenium from 35 to 5 parts per billion (ppb) in 1987.[115] Yet, irrigation water — which is classified under the CWA as "non-point source pollution" — is not subject to this regulation. But even if EPA's more stringent standards were enforceable, recent scientific research has demonstrated that different organisms metabolize contaminants by different biochemical pathways. Some organisms can withstand high levels of toxins; others suffer deformities and death at levels currently considered acceptable by EPA standards. Furthermore, because selenium can enter the food chain from sediments, concentrations there, rather than in standing water, are at least as important in measuring toxic risk. Selenium that has been immobilized in sediments can be remobilized by oxidation if the sediments are disturbed or subject to drying.[116]

IX. PROSPECTS FOR THE FUTURE

Meanwhile, research continues on the disposal of contaminated drainwaters in the San Joaquin Valley. In September 1990, the San Joaquin Valley Drainage Program issued its final report, *A Management Plan for Agricultural Subsurface Drainage and Related Problems on the Westside San Joaquin Valley*.[117] Known as the "Rainbow Report," this study specifies the following eight recommendations for management of agricultural drainage from 1990 to 2040:

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[115] USEPA, OFFICE OF WATER REGULATION AND STANDARDS, AMBIENT WATER QUALITY CRITERIA FOR SELENIUM (1987). Many scientists presently believe that a standard of 2 ppb is necessary to properly protect the health of wildlife. Toxicity thresholds for fish and birds of less than 5 μg/L (ppb) of selenium have been established in at least six separate sites worldwide, indicating a uniformity of toxic thresholds. *See* Skorupa, *supra* note 59, at 341.

[116] Interview with Rick Higashi & Teresa Fan, Department of Land, Air, & Water Resources, University of California, Davis, in Davis, Cal. (Apr. 25, 1997).

[117] U.S. DEPARTMENT OF INTERIOR & CALIFORNIA RESOURCES AGENCY, MANAGEMENT PLAN FOR AGRICULTURAL SUBSURFACE DRAINAGE AND RELATED PROBLEMS ON THE WESTSIDE SAN JOAQUIN VALLEY: FINAL REPORT OF THE SAN JOAQUIN VALLEY DRAINAGE PROGRAM (Sept. 1990).

1. source control, consisting of on-farm improvements in the application of irrigation water;

2. drainage water reuse on progressively more salt-tolerant plants;

3. drainage water evaporation ponds, for water remaining after reuse on salt-tolerant plants, to be structured as temperature-gradient solar ponds that generate electricity from water containing very high salt and trace element concentrations;

4. land retirement, or the cessation of irrigation in areas with drainage problems and shallow groundwater containing elevated levels of selenium;

5. groundwater management, or planned pumping from the underlying aquifer, in areas where the water table may be lowered and the water pumped is of suitable quality for irrigation or wildlife habitat;

6. carefully regulated discharge of drainwater to the San Joaquin River, while still meeting water quality objectives;

7. protection, restoration, and provision of substitute water supplies for fish and wildlife habitat;

8. institutional change, including tiered water pricing, improved scheduling of water deliveries, water transfers, and marketing, and the formation of regional drainage management organizations.[118]

These recommendations have met with measurable, but limited, success. Westlands Water District has been active in implementing source control, in the form of drip, rather than furrow, irrigation. The District has also begun two experimental agroforestry projects. Drainage reuse by halophytes (salt-loving plants) such as pickleweed and eucalyptus is promising, but presents problems of its own. Mice eat pickleweed, and kestrals eat mice, so selenium present in saline drainwater still moves up the food chain.[119] Solar evaporation ponds proved effective at desalinization plants near Los Banos from 1985–1987, but they remain far too expensive to offer a practical solution.[120] Considering the high productive value of San Joaquin Valley land — including land with drainage

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[118] *Id.* at 1, 3.

[119] *See* Steve Grattan, Crop-production Water Relations of Eucalyptus for the Design of Drainage Water Reuse Systems, presented at the Salinity/Drainage Program Annual Meeting, sponsored by the University of California Salinity/Drainage Task Force, Sacramento, Cal. (Mar. 26-27, 1997) (on file with Author).

[120] Interview with Brian Smith, Engineer, DWR, in Fresno, Cal. (Apr. 18, 1997).

problems and high concentrations of selenium — it is not surprising that growers have not actively sought land retirement. Recently, however, Westlands has entered an agreement with the Bureau of Reclamation to retire up to 15,000 acres of land to address drainage and water supply issues.[121] Westlands has also implemented groundwater management programs, and has instituted programs for water transfers and marketing, and tiered pricing within the District.[122]

In 1994, Westlands brought a series of consolidated lawsuits against the Bureau of Reclamation, claiming that despite SWRCB Order No. 85-1, the United States is obligated to provide drainage service to Westlands, which has been without an outlet for its drainage waters since it plugged its drains in 1986. In 1995, in *Sumner Peck Ranch, Inc. v. United States*, the U.S. District Court ruled in Westlands' favor.[123] The court stated that the federal government has a legal obligation to provide drainage for the San Luis Unit of the CVP (Westlands Water District) and ordered the Bureau of Reclamation to seek a discharge permit from the SWRCB to build the rest of the San Luis Drain to the Delta. The issue has not been resolved to date. Meanwhile, no new restrictions have been placed on the 5400 acres of private evaporation ponds in the western San Joaquin Valley. Death and deformity rates in these private ponds rival or even exceed those at Kesterson. In 1996, the SWRCB found that six of fourteen evaporation pond complexes in the western San Joaquin Valley had levels of selenium so elevated that there was a high probability of reduced hatchability and embryonic deformities in bird populations.[124]

The decision in *Sumner Peck Ranch* parallels a recent emphasis by the state of California that the extension of an export drain may be the only "technically feasible solution" for the problem of agricultural drainwater in the San Joaquin Valley.[125] However, there is a third basis of state authority, in addition to the Toxic Pits and Porter-Cologne Acts that the SWRCB relied upon to order the closure of Kesterson Reservoir and the San Luis Drain, that may have the potential for regulating agricultural runoff.

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[121] Westlands Water District, CALFED Bay-Delta Program Position Statement, at 1 (Oct. 1998) (on file with Author).

[122] Telephone interview with Anthony Toto, Central Valley Water Resources Control Board, Fresno, Cal. (Aug. 26, 1997).

[123] 823 F. Supp. 715 (E.D. Cal. 1993).

[124] *See* Felix E. Smith, *The Kesterson Effect: Reasonable Use of Water and the Public Trust*, 6 SAN JOAQUIN AGRIC. L. REV. 45 (1996).

[125] Presser & Piper, *supra* note 19, at 158.

Under the Public Trust Doctrine, the government is the public guardian of "natural resources which are not capable of self-regeneration and for which substitutes cannot be made by man."[126] Its legal basis lies in the Ninth Amendment, by which the people retain unenumerated rights, which reasonably can be interpreted to include the right to protect common heritage resources from degradation or destruction.[127] The use of the Public Trust Doctrine in California dates back to the 1850s and has historically been applied in cases, such as hydraulic mining, concerning the control of fill in navigable waters. In *People v. Gold Run Ditch & Mining Co.*, the California Supreme Court held in 1884 that custom did not confer a right to landowners or mining companies to continue to dump their wastewater and debris into the navigable rivers of the State.[128] The practical effect of this ruling was to bring about an end to hydraulic mining in California.

More recently, the California Supreme Court has recognized that the Public Trust Doctrine also applies to the protection of a variety of natural resources and recreational activities.[129] In 1979, the National Audubon Society, the Mono Lake Committee, Friends of the Earth, and four Mono Basin landowners filed suit against the City of Los Angeles in an attempt to force the city to reduce its appropriations of the streams supplying Mono Lake. In the landmark 1983 decision, *National Audubon Society v. Superior Court*, the Court stated: "The principal values plaintiffs seek to protect . . . are recreational and ecological — the scenic views of the lake and its shore, the purity of the air and the use of the lake for nesting and feeding by birds . . . . it is clear that the protection of these values is among the values of the public trust."[130] In light of these precedents, the Public Trust Doctrine presents a third legal basis for challenging the continued irrigation of seleniferous soils in the San Joaquin Valley. The withdrawal of water from the San Joaquin River for irrigation and the subsequent replenishment of

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[126] Bernard Cohen, *The Constitution, The Public Trust Doctrine and the Environment*, 1970 UTAH L. REV. 388, 388 (1970).

[127] *See id.* at 393-394. "The enumeration in the Constitution of certain rights shall not be construed to deny or disparage others retained by the people." U.S. CONST., amend. IX.

[128] 66 Cal. 138, 4 P. 1152 (1884).

[129] For seminal articles on the legal foundations of the Public Trust Doctrine and its applicability to environmental law, *see* Cohen, *supra* note 126; Joseph Sax, *The Public Trust Doctrine in Natural Resource Law: Effective Judicial Intervention*, 68 MICH. L. REV. 471 (1970).

[130] 33 Cal. 3d 419, 189 Cal. Rptr. 346, *cert. denied*, 464 U.S. 97 (1983).

that river by selenium-laden agricultural drainwater will degrade the value of the river as a public trust resource.[131]

A court-mandated resolution of the drainwater issue is not likely to come quickly. Moreover, such a solution will not satisfy all parties, as it implicitly pits agricultural interests against those who would give greater priority to the environment. Furthermore, the choice between in-valley evaporation ponds or out-of-valley disposal to the Delta via either the San Joaquin River or a master San Luis Drain is dismal. Either avian deaths and deformities in and around the evaporation ponds will continue or the aquatic life of the Delta will be slowly poisoned. In each scenario, the threat to human health of contaminated drainwater seeping into underlying aquifers that supply drinking water will continue.

Perhaps the most effective solution to the past accumulation of selenium will lie not in the physical removal, or ponding and evaporation, of selenium-contaminated drainwater, but in the chemical alteration of selenium into non-threatening, and perhaps usable, forms. Scientists have conducted a great deal of research toward this end during the last two decades, the scope of which is impossible to recount fully here. In general, this research has followed two major approaches. First, selenium can be concentrated (by bacteria, for example) and subsequently removed. Alternatively, selenium can be volatilized by algae and aquatic plants and dispersed into the atmosphere.[132]

While these, and other, methods of bioremediation hold tremendous potential, such advances come slowly and often at tremendous cost. Their implementation, as well as their development, will require a huge commitment of resources. Therefore, society should not expect bioremediation techniques to provide a panacea or to give license to continued contamination. As the San Joaquin Valley Drainage Program report makes clear, the present need to reduce future inflows of selenium calls for significant changes in today's irrigation practices and agricultural water use.

[131] Felix Smith, retired since 1990 from the USFWS, is presently pursuing an alternative solution to a lawsuit. On November 14, 1995, he filed a complaint with the SWRCB, alleging that: "This irrigation use is unreasonable, is contrary to public trust protection, and is a nuisance." As of 1999, no action has yet been taken by the Board.

[132] There are hundreds of publications documenting recent research on selenium contamination and bioremediation. For useful collections of some of the more prominent research, *see generally* SELENIUM IN THE ENVIRONMENT, *supra* note 35; ENVIRONMENTAL CHEMISTRY OF SELENIUM, *supra* note 59.

X. KESTERSON TODAY AND TOMORROW

Although drainage and toxicity problems in the San Joaquin Valley as a whole remain daunting, the future of Kesterson and its environs looks bright. In late 1996, Congress officially renamed Kesterson NWR as the "San Luis National Wildlife Refuge, Kesterson Unit."[133] But much more has changed than Kesterson's name. The federal government has increased the size of the Refuge from 5900 to more than 10,000 acres. The Refuge now receives fresh water from the Delta for its wetlands and wildlife. As a consequence, the biological diversity of the area is increasing. Gary Zahm, manager of the Refuge, has told the media that as ground cover has recovered, songbirds such as gold finches and white crown sparrows are returning. Young cottonwoods and oaks are also coming up, portending more habitat for wood ducks and hawks.[134]

Ironically, the catastrophe at Kesterson may benefit the entire nation in the long run. Kesterson made clear the need for clean water in wetlands. Scientific evidence — made public in the face of terrific resistance from state and federal agencies — ultimately forced regulatory agencies to insure provision of clean water. In a larger sense, the work of the scores of scientists who have studied Kesterson have changed the political terrain of irrigation and drainage issues throughout the West, probably irreversibly.

In order for Kesterson's success story to be repeated elsewhere, vigilance from both the public and private sectors will be necessary. Scientists must be funded to continue bioremediation efforts and must be able to present substantiated evidence in an atmosphere free of repression stemming from political considerations. Politicians must look to the health of their constituents and the ecosystems in which they live. The intrinsic value of wildlife must be recognized and promoted above the short-term interests of agribusiness. Finally, if the public continues to register its will at the polls through elections and citizen initiatives, there may be a realistic chance of restoring the integrity of our wetlands and the wildlife they support.

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[133] The apparent intent behind this action was to downplay the name "Kesterson," which still carries negative connotations that affect federal funding, employee recruitment, and visitation. Gary Voet, *Kesterson comes back to life*, SACRAMENTO BEE, Jan. 8, 1997, at E6.
[134] *See id.*

XI. POSTSCRIPT

In June of 1999, the Sacramento consulting firm CH2M Hill released to the press the results of its most recent studies of mice and voles at Kesterson. The firm's report revealed that up to twenty-nine of eighty-seven house mice, deer mice, western harvest mice, and voles collected during 1998 were hermaphroditic. Individuals that appeared to be male also possessed female reproductive organs.

Because 1998 was a particularly wet year, water pooled for months at Kesterson, possibly remobilizing the selenium, returning it to the food chain, and causing these new cases of teratogenesis. Mice are often used as a laboratory model for humans; therefore, the implications of this latest turn of events are chilling. The saga of Kesterson appears to be far from over.