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The Old and the New: Evaluating Existing and Proposed Dams in California

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THE OLD AND THE NEW: EVALUATING EXISTING AND PROPOSED DAMS IN CALIFORNIA

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I. INTRODUCTION

Dams have been a major part of California's water infrastructure for over 150 years. Over 1200 dams are under the safety jurisdiction of the California Department of Water Resources ("DWR").[1] The federal government owns scores of others.[2] As dams overseen by state and federal authorities age, some are being considered for removal due to environmental impacts, safety concerns, or other reasons. Over the past decade there have been proposals for constructing five new large dams.[3] In addition, smaller reservoirs continue to be constructed for local use.

This article suggests criteria for determining when existing dams should be removed and for evaluating proposals for new dams. Section II

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[1] *See* CAL. DEP'T OF WATER RES., DIV. OF SAFETY OF DAMS, DAMS WITHIN THE JURISDICTION OF THE STATE OF CALIFORNIA (2007), *available at* http://www.water.ca.gov/damsafety/damlisting/index.cfm (follow "California Jurisdictional Dams" hyperlink).

[2] *See* CAL. DEP'T OF WATER RES., DIV. OF SAFETY OF DAMS, DAMS OWNED AND OPERATED BY FEDERAL AGENCIES (2007), *available at* http://www.water.ca.gov/damsafety/damlisting/index.cfm (follow "Dams Owned and Operated by Federal Agencies" hyperlink).

[3] *See* Colin Sullivan, *New Dam Proposals Restart 1970s-Era Fights*, CLIMATEWIRE, May 7, 2008, http://www.eenews.net/public/climatewire/2008/05/07/1 ("The state's Department of Water Resources is studying five multibillion-dollar projects . . . .").

offers a historical overview of dam building in California. Section III discusses current issues concerning evaluation of removal, repair, and expansion proposals for existing dams in the state. Section IV outlines issues, including funding and impacts, related to recent proposals for the construction of additional dams and reservoirs.

II. CALIFORNIA'S DAM BUILDING HISTORY

Some of the first significant dams in California, such as Daguerre Point Dam on the Yuba River (built in 1906) and Clementine Dam on the North Fork American River (built in 1939), were constructed on rivers in the Sierra Nevada foothills to hold back sediment loosened at higher elevations by hydraulic mining.[4] Powerful jets of water washed away entire hillsides to create access to gold.[5] Huge quantities of the resulting sediment actually raised the beds of the downstream rivers,[6] worsening flooding of farmland and downstream cities such as Marysville, Yuba City, and Sacramento.[7] The only purpose for these dams was to trap the mining sediment, thereby preventing it from going downstream—but the dams' unintended effects were expansive and continuous.[8]

In addition, many Californians now live on floodplains below reservoirs constructed in part to protect the settlements from winter and spring river floods.[9] Major dams such as Shasta Dam on the Sacramento River,[10] Folsom Dam on the American River,[11] and Seven Oaks Dam on the Santa Ana River[12] now provide some measure of flood protection to millions of Californians.

In some areas of California, topography and geology present a different form of flood risk. Alluvial fan floodplains are formed over time as rocks, gravel, and silt are eroded and carried out of higher elevations by precipitation; severe rainfall can dramatically accelerate the

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[4] *See* ROBERT KELLEY, BATTLING THE INLAND SEA 204 (1998).

[5] JEFFREY F. MOUNT, CALIFORNIA RIVERS AND STREAMS: THE CONFLICT BETWEEN FLUVIAL PROCESS AND LAND USE 204 (1995).

[6] KELLEY, *supra* note 4, at 72, 104, 181.

[7] MOUNT, *supra* note 5, at 207.

[8] *See* KELLEY, *supra* note 4, at 204.

[9] *Cf. id.* at xiii (stating, for example, that "most Sacramento Valley urban and agricultural development is in the historical floodplain").

[10] *Id.* at 308.

[11] *Id.*

[12] U.S. ARMY CORPS OF ENG'RS, WATER CONTROL MANUAL: SEVEN OAKS DAM & RESERVOIR iii (2003), *available at* http://www.spl.usace.army.mil/resreg/htdocs/SevenOaks/SOAK_WCM_2003/SOAK_WCM_Scr.pdf.

accumulation of debris.[13] Fires, which play an integral role in many California ecosystems, can further exacerbate this extremely rapid erosion by eliminating vegetation.[14] The results can be sudden and unpredictable: rampaging mud and rock flows with particles the size of cars.[15] Where such areas have been developed, such as at the base of the San Gabriel Mountains in Southern California, dams and reservoirs called "debris basins" have been constructed to hold back these flows from downhill communities.[16] After major erosion events, these reservoirs are dug out to prepare for subsequent storms.[17]

In California, the era of significant dam building began about 100 years ago. The O'Shaughnessy Dam, which inundated the Hetch Hetchy Valley, was authorized by the Raker Act in 1913[18] and completed in 1923.[19] Construction of the largest dams was concentrated in the period of the1950s through the 1970s. Although there were additional purposes, the large dams were constructed for three primary reasons: water supply, hydroelectric generation, and flood control. Constructed reservoirs would also solve some of the state's "problems of recreation, fish, and wildlife" by providing flat-water recreation opportunities (e.g., swimming, boating, and warm-water fishing) as well as water quality and downstream fishery benefits.[20] Nevertheless, water supply has always been a principal driving force. California's climate is considered Mediterranean; most precipitation occurs in the winter and early spring, with little to none for most areas in the summer and fall.[21] Unsurprisingly, water demands peak in the hot summer months.[22]

Initially, immigrants settling in California relied on nearby streams, springs, and shallow wells for water.[23] While these sources were adequate

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[13] *See* CAL. DEP'T OF WATER RES., CALIFORNIA FLOODPLAIN MANAGEMENT TASK FORCE 26 (2002) *available at* http://fpmtaskforce.water.ca.gov/docs/approved_report_Section1.pdf.

[14] *See generally* JACK AINSWORTH & TROY ALAN DOSS, NATURAL HISTORY OF FIRE & FLOOD CYCLES (2005), *available at* http://interwork.sdsu.edu/fire/resources/documents/NaturalHistoryofFire1995.pdf.

[15] NAT'L RES. COUNCIL, ALLUVIAL FAN FLOODING 40 (1996), *available at* http://books.nap.edu/openbook.php?record_id=5364&page=40.

[16] JOHN MCPHEE, THE CONTROL OF NATURE 183 (1989) ("They were quarries, in a sense, but exceedingly bizarre quarries, in that the rock was meant to come to them.").

[17] *Id.*

[18] NORRIS HUNDLEY, JR., THE GREAT THIRST 186 (2001).

[19] *See* DAVID CARLE, WATER AND THE CALIFORNIA DREAM 135 (2000).

[20] CAL. STATE DEP'T OF WATER RES., BULL. 3, THE CALIFORNIA WATER PLAN 21 (1957).

[21] MICHAEL BARBOUR ET AL., CALIFORNIA'S CHANGING LANDSCAPES 8 (1991).

[22] *See* BETTY BRICKSON ET AL., WATER EDUC. FOUND., LAYPERSON'S GUIDE TO CALIFORNIA WATER 2 (2000) ("The demand for water is highest during the dry summer months when there is little natural precipitation or snowmelt.").

[23] CAL. STATE WATER RES. BD., BULL. 1, WATER RESOURCES OF CALIFORNIA 18 (1951),

for the pre-European native inhabitants, they proved insufficient for growing municipalities. Beginning at the end of the 19th century, plans were being developed to dam distant rivers and convey the water to what had become burgeoning metropolises.[24]

In 1913, to serve its own expanding metropolis, the City of Los Angeles began importing water from the Owens Valley—more than 220 miles away.[25] Another of the large inter-basin transfer projects was the Hetch Hetchy project. William O'Shaughnessy, an engineer, conceived this ambitious scheme to dam the Tuolumne River in the Sierra Nevada (in what is now Yosemite National Park) and to build tunnels that would enable the water to flow by gravity over 150 miles to San Francisco.[26] John Muir, founder of the Sierra Club, led an epic nationwide struggle—one of the first in the U.S.—that nonetheless failed to prevent the dam's authorization in 1913.[27] In 1929, the East Bay Municipal Utility District constructed Pardee Dam on the Mokelumne River in the Sierra Nevada, once more to use gravity to move water to cities—this time on the east side of San Francisco Bay.[28]

However, as large as California's urban thirst for water has become, agriculture is by far the state's largest water user. On average, over 75% of California's developed water is applied to over nine million acres of farmland.[29] Originally, farmers would rely on streams adjacent to their property.[30] When surface sources became scarce during the drought of 1880, farmers and other settlers began to draw water from underground aquifers.[31] Over time, that lowered the groundwater table beyond the

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available at http://www.dpla2.water.ca.gov/publications/waterplan/DWR_Bulletin1.pdf.

[24] *See* BRICKSON ET AL., *supra* note 22, at 6-7.

[25] *See* GARY LIBECAP, OWENS VALLEY REVISITED: A REASSESSMENT OF THE WEST'S FIRST GREAT WATER TRANSFER 41 (2007).

[26] KEVIN STARR, ENDANGERED DREAMS: THE GREAT DEPRESSION IN CALIFORNIA 285 (1997).

[27] HUNDLEY, *supra* note 18, at 178; ROBERT W. RIGHTER, THE BATTLE OVER HETCH HETCHY 4 (2005).

[28] MARK TRASK, CAL. ENERGY COMM'N: ENVTL. OFFICE SYS. ASSESSMENT & FACILITIES SITING DIV., WATER-ENERGY RELATIONSHIP: IN SUPPORT OF THE 2005 INTEGRATED ENERGY POLICY REPORT 93 (2005), *available at* http://www.fypower.org/pdf/CEC_water-energy.pdf.

[29] *See* CAL. DEP'T OF WATER RES., BULL. 160-05, 1 CAL. WATER PLAN UPDATE 2005: A FRAMEWORK FOR ACTION 3-9 (2005), *available at* http://www.waterplan.water.ca.gov/docs/cwpu2005/vol1/v1ch03.pdf (describing the amount of California's developed water resources that is used for agriculture); CAL. DEP'T OF WATER RES., BULL. 160-05, 2 CAL. WATER PLAN UPDATE 2005: A FRAMEWORK FOR ACTION 3-1 (2005), *available at* http://www.waterplan.water.ca.gov/docs/cwpu2005/vol2/v2ch03.pdf (describing the acreage of irrigated cropland).

[30] JIM MAYER, WATER EDUC. FOUND., LAYPERSON'S GUIDE TO GROUNDWATER 5 (1998).

[31] *Id.*

power of existing pumps to bring it to the surface.[32] In the 1920s, the invention of the more powerful turbine pump allowed farmers to continue chasing water to greater depths,[33] but the farmers realized that such pumping was not sustainable, either physically or financially.[34] Therefore, they began looking for more distant sources.[35]

The Federal Central Valley Project ("CVP") includes the Shasta, Folsom, Trinity, and New Melones dams. The CVP was conceived, in large part, to reclaim land for mass-scale agriculture in the San Joaquin and Sacramento River Valleys of California.[36] As an economic incentive, the authorization spread repayment over forty to fifty years with no requirement to pay interest[37]—this multi-billion dollar subsidy continues to this day. In recent years the CVP has delivered about seven million acre-feet of water per year,[38] mostly to agriculture.[39]

Then, in 1960, the State Water Project was authorized to bring water (largely from Oroville Dam on the Feather River in Northern California) via natural channels and over 662 miles of canals, tunnels, and pipelines to the San Joaquin Valley, to portions of the San Francisco Bay Area, and to Southern California.[40] Financed by the water users themselves, it has recently delivered over four million acre-feet of water in a year.[41]

Although much attention is given to the largest dams, there are thousands of very small diversion dams.[42] These structures often pose insurmountable barriers to fish passage, especially to anadromous fish[43]

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[32] *Id.*

[33] *Id.*

[34] *See* BRICKSON ET AL., *supra* note 22, at 6.

[35] *Id.*

[36] U.S. DEP'T OF INTERIOR, BUREAU OF RECLAMATION, THE CENTRAL VALLEY PROJECT (1994), http://www.usbr.gov/dataweb/html/cvpintro.html#Intro (describing, in the introduction, how the Sacramento Valley "suffers from floods, and floods and drought alternately afflict San Joaquin").

[37] RICHARD W. WAHL, MARKETS FOR FEDERAL WATER 52 (1989).

[38] *California CVP Carryover Down 2.8 MAF,* W. FARM PRESS, Oct. 4, 2007, *available at* http://westernfarmpress.com/environment/100407-cvp-water/.

[39] *See Assessing a Policy Grab Bag: Federal Water Policy Reform*, AM. J. OF AGRIC. ECON., Aug. 1, 2002, *available at* http://goliath.ecnext.com/coms2/gi_0199-1965809/Assessing-a-policy-grab-bag.html ("On average, 90% of CVP deliveries go to agricultural uses.").

[40] *See* TRASK, *supra* note 28, at 91.

[41] *See* CAL. DEP'T OF WATER RES., BULL. 132-05, MANAGEMENT OF THE CALIFORNIA STATE WATER PROJECT 131 (2006), *available at* http://wwwswpao.water.ca.gov/publications/bulletin/05/Bulletin132-05.pdf.

[42] *See* CAL. DEP'T OF WATER RES., BULL NO. 250-05, FISH PASSAGE IMPROVEMENT REPORT 2005, at pp. 1-1, 2-7 (2005), *available at* http://www.watershedrestoration.water.ca.gov/fishpassage/docs/b250/B250%20for%20web%20and%20CD/B250.newcombined.pdf.

[43] *Id.* at p.2-7.

needing to go upstream to spawn or downstream for the remainder of their lifecycles.[44]

Another major benefit of some dams is hydroelectric generation. In an average year, hydroelectric energy produced in California satisfies almost one sixth of the state's demand.[45] That production generally increases in wet years and decreases during California's recurrent droughts.[46] In addition, hydroelectric generation creates few greenhouse gases or other air pollutants and does not require importing oil from politically volatile regions.[47]

With many dam projects, those who benefit from the water supply also enjoy the advantages of the electricity. San Francisco's famous cable car receives energy from the same Hetch Hetchy system that provides the city's water.[48] Similarly, customers of the federal Central Valley Project receive subsidized energy to accompany their subsidized water.[49] State Water Project customers use electricity generated at Oroville Reservoir to offset some, but not all, of the energy used to pump water as far as Southern California.[50]

III. THE OLD: EVALUATING EXISTING DAMS

Undoubtedly, dams have enabled California to become what it is today. Without the water supply and flood control that dams provide, the state would not have created one of the world's leading agricultural economies nor would it be one of the world's most desirable places to live. However, after over a hundred years of experience, we have also learned that a small number of these dams now have liabilities that exceed their current benefits.

It is important to note that only a very small number of dams are currently potential candidates for removal. For instance, Folsom Dam,

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[44] *Id.* at p.1-1.

[45] Cal. Energy Comm'n, Hydroelectric Power in California (2001), http://www.energy.ca.gov/hydroelectric/index.html.

[46] INT'L. ENERGY AGENCY, VARIABILITY OF WIND POWER AND OTHER RENEWABLES: MANAGEMENT OPTIONS AND STRATEGIES 10 (2005), *available at* http://www.iea.org/Textbase/Papers/2005/variability.pdf.

[47] *See* Philip J. Deutch, *Think Again: Energy Independence*, FOREIGN POL'Y (Nov.-Dec. 2005).

[48] HUNDLEY, *supra* note 18, at 191-93.

[49] *See* RENEE SHARP & BILL WALKER, ENVTL. WORKING GROUP, POWER DRAIN: BIG AG'S $100 MILLION ENERGY SUBSIDY (2007), *available at* http://www.ewg.org/reports/powersubsidies.

[50] FED. ENERGY REGULATORY COMM'N, FINAL ENVIRONMENTAL IMPACT STATEMENT FOR THE OROVILLE FACILITIES PROJECT 41 (2007), *available at* http://orovillerelicensing.water.ca.gov/pdf_docs/FEIS%20-FERC%20Part%201.pdf.

which provides essential flood protection for over 300,000 downstream inhabitants, is in the process of being strengthened, not dismantled.[51] Major water-supply dams such as Shasta and Oroville, which will not fill with sediment for centuries, will also likely be part of the California landscape for hundreds of years.

At the same time, there are a variety of reasons to consider removal of both small and large dams. As discussed further below, these negative characteristics include unsafe conditions, sedimentation, and unacceptable environmental impacts.

A. SAFETY CONCERNS

After the catastrophic failure in 1929 of the City of Los Angeles' St. Francis Dam, the State of California established the first comprehensive dam safety program in the world.[52] The State's Division of Safety of Dams annually inspects over 1200 dams.[53] In addition, it periodically reviews the designs of existing dams within the context of new information on seismic risks and other potential failure mechanisms.[54]

In relatively few cases, the state has found that dams do not have adequate safety margins to withstand the forces of maximum credible earthquakes or probable maximum floods. In most of those situations, engineering remediation (e.g., buttressing or other reinforcement, or replacement) is conducted to make the dams safe. In a few cases, however, the defects are so significant that dam removal is required. Calaveras Reservoir, which is located to the east and upstream of the City of Fremont, is an example of remediation.[55] Completed in 1925, the impoundment was constructed with a technique known as hydraulic fill—essentially filling the center of a dam with mud.[56] We now know that such a structure will "liquefy" (think Jell-O) and fail during an

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[51] *See Dam Upgrades Will Double Flood Protection for Sacramento*, ENV'T NEWS SERV., Jan. 14, 2008, http://www.ens-newswire.com/ens/jan2008/2008-01-11-093.asp.

[52] MARGARET LESLIE DAVIS, RIVERS IN THE DESERT: WILLIAM MULHOLLAND AND THE INVENTING OF LOS ANGELES 179, 243 (1993) (describing the unimaginable horror of the devastation, which cost over 450 lives, as well as the ensuing public outcry and the State's response).

[53] Cal. Dep't of Water Res., Division of Safety of Dams, http://www.water.ca.gov/damsafety/aboutdamsafety/index.cfm (last visited Sept. 18, 2008).

[54] Cal. Dep't of Water Res., Frequently Asked Questions, http://www.water.ca.gov/damsafety/FAQAnswer/index.cfm (last visited Sept. 18, 2008).

[55] S.F. PUB. UTIL. COMM'N, CALAVERAS DAM REPLACEMENT PROJECT CONSTRUCTION FACT SHEET (2008), *available at* http://sfwater.org/Files/Meetings/Calaveras_Construction_FactSheet_April08.pdf.

[56] *See* ROBERT B. JANSEN, ADVANCED DAM ENGINEERING FOR DESIGN, CONSTRUCTION, AND REHABILITATION 363 (1988).

earthquake.[57] In such cases, the responsible parties must decide whether to replace an existing dam with one meeting current engineering standards. The dam owner at the Calaveras Reservoir concluded that the importance of the water supply justified spending hundreds of millions of dollars for a new structure.[58] At San Clemente Dam on the Carmel River near Monterey, California, a different decision is pending. The thin-arch concrete structure of this dam would likely fracture under the lateral shaking of an earthquake.[59] This danger, combined with sedimentation problems and impediments to fish passage, make it likely that the dam will be removed altogether.[60]

B. SEDIMENTATION

Although it is common knowledge that dams impound water, what is not so obvious is that they also trap sediment that comes down in runoff.[61] When swiftly moving water enters a reservoir, the velocity decreases, and the suspended particles settle to the bottom.[62] Very few dams have been constructed with any means to remove that sediment, so it gradually accumulates over time.[63] With the exception of the relatively small debris basins constructed specifically to trap sediment from alluvial fans and debris flows, there are rarely any cost-effective and practical methods for removing what can amount to millions of tons of material.[64]

Although all reservoirs accumulate sediment, the amount can vary significantly based on the geology of the watershed. Now that hydraulic mining has ceased, dams on rivers of the Sierra Nevada accumulate

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[57] *Id.* at 300.

[58] *See* SAN FRANCISCO PUB. UTIL. COMM'N, CALAVERAS DAM REPLACEMENT PROJECT: FINAL CONCEPTUAL ENGINEERING REPORT, DAM AND APPURTENANT STRUCTURES ES-1, ES-3 (2005), *available at* http://sfwater.org/Files/Reports/Calavr_CER005_%20cover_.pdf.

[59] Martin Wieland, *Stress Management*, INT'L WATER POWER & DAM CONSTRUCTION, Feb. 23, 2005, *available at* http://www.waterpowermagazine.com/story.asp?storyCode=2026953.

[60] Memorandum from Sam Schuchat, Exec. Dir. & Trish Chapman, Project Mgr. to Cal. Coastal Conservancy Members 2 (Jan.17, 2008) (available at http://www.scc.ca.gov/sccbb/0801bb/0801Board14a_EO_Rep_San_Clemente_Dam_Removal.pdf).

[61] *See* U.S. ARMY CORPS OF ENG'RS, ENGINEERING MANUAL EM 1110-2-1420, ch. 13 (1997) *available at* http://www.usace.army.mil/publications/eng-manuals/em1110-2-1420/c-13.pdf.

[62] *See generally* DAN G. BATUCA & JAN M. JORDAAN, SILTING AND DESILTING OF RESERVOIRS (2000).

[63] U.S. ARMY CORPS OF ENG'RS, *supra* note 61, at ch. 13.

[64] *See* GREGORY L. MORRIS & JIAHUA FAN, RESERVOIR SEDIMENTATION HANDBOOK: DESIGN AND MANAGEMENT OF DAMS 1.3 (1998) ("Whereas the twentieth century focused on the construction of new dams, the twenty-first century will necessarily focus on combating sedimentation to extend the life of existing infrastructure.").

relatively less sediment, because the geology is tectonically stable with lower erosion rates.[65] On the other extreme, watersheds in the coastal ranges are less tectonically stable[66] and subject to much higher rates of erosion.

Some reservoirs, such as the one impounded by Ringe Dam on Malibu Creek, have become entirely filled with sediment in just a few decades.[67] In addition to its dam safety problems, the Carmel River's San Clemente Reservoir (discussed above) is also almost entirely filled with sediment.[68]

C. FISH PASSAGE

One of the major impacts of dams is the barrier they pose to fish passage. Dams have blocked access to over 80% of the spawning areas for the state's salmon population.[69] These dams and their accompanying diversions of water from natural channels have been major factors in the collapse of anadromous fish populations.[70] Salmon returning to California's Central Valley in 2007 were at the second-lowest levels ever recorded,[71] and the spring run of salmon on the San Joaquin River has been entirely eliminated.[72] The San Clemente Dam on the Carmel River, in addition to its other problems, is also a major barrier to endangered steelhead.[73]

In addition to blocking fish passage, reservoirs impounded by dams can also increase the temperature of water released downstream.[74] This

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[65] *See* JOHN A. MOODY & DEBORAH A. MARTIN, WILDFIRE IMPACTS ON RESERVOIR SEDIMENTATION IN THE WESTERN UNITED STATES 1100 (2004) *available at* http://wwwbrr.cr.usgs.gov/projects/Burned_Watersheds/Files/fire_reservoir_sedimentation.pdf.

[66] *Id.*

[67] *See* U.S. ARMY CORPS OF ENG'RS, REGIONAL SEDIMENT MANAGEMENT DEMONSTRATION PROGRAM PROJECT BRIEF, ERDC/RSM-DB5, at 3 (2003) *available at* http://www.wes.army.mil/rsm/pubs/pdfs/rsm-db5.pdf.

[68] Plan. & Conservation League Found., Restoring Carmel River / San Clemente Dam, http://www.pclfoundation.org/projects/sanclementedam.html (last visited July 31, 2008).

[69] *See* CAL. DEP'T OF WATER RES., *supra* note 42, at p.1-3.

[70] *Id.*

[71] Eric Bailey, *Salmon Collapse Could Force Fishing Restrictions*, L.A. TIMES, Jan. 30, 2008, http://articles.latimes.com/2008/jan/30/local/me-salmon30.

[72] Press Release, Natural Res. Def. Council, Judge Tosses Biological Opinion for Salmon and Steelhead in California, http://www.nrdc.org/media/2008/080416a.asp (last visited Sept. 18, 2008).

[73] CAL. DEP'T OF WATER RES. & U.S. ARMY CORPS OF ENG'RS, SAN CLEMENTE DAM SEISMIC SAFETY PROJECT: FINAL ENVIRONMENTAL IMPACT REPORT / ENVIRONMENTAL IMPACT STATEMENT § 4.4, at 31 (2008).

[74] *See* David Harrison, Jeff Opperman & Brian Richter, *Can Hydro Power Be Sustainable?*, INT'L WATER POWER & DAM CONSTRUCTION, Sept. 17, 2007, *available at*

further stresses the fish, whose physiology requires cooler water temperatures.[75]

California Fish and Game Code section 5937 addresses fishery impacts of dams, requiring dam owners to keep downstream fish "in good condition."[76] A federal court has found that the federal Bureau of Reclamation is subject to California's requirement to keep downstream fish in good condition.[77] Similarly, the "public trust" doctrine,[78] which provides that certain natural resources are held in trust by the state for the benefit of the public, was invoked to reduce the impacts of dam diversions from tributaries feeding Mono Lake.[79] What remains to be seen is whether the California law, bolstered by further use of the "public trust" doctrine, will proactively operate to remove dams that have degraded the condition of fish populations.

D. NATURAL VALUES

In at least one case, the existence of a dam and the water it impounds deprives the public of the enjoyment of an outstanding natural resource. O'Shaughnessy Dam and the Hetch Hetchy Reservoir inundated a valley—Hetch Hetchy Valley—that had been comparable to its neighbor Yosemite Valley.[80] The Yosemite Valley's spectacular beauty rivals any of the natural wonders of the world.[81] As society's values evolve and better alternatives for energy generation and water supply are identified, some dams should be removed to restore a broad range of natural values.

E. CRITERIA FOR CONSIDERING DAM REMOVAL

The first question that should be asked is whether the original

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http://www.waterpowermagazine.com/story.asp?storyCode=2047075.

[75] U.C. Cooperative Extension, Fact Sheet No. 27, Fishery Habitat: Temperature Requirements, *available at* http://danr.ucop.edu/uccelr/h27.htm.

[76] CAL. FISH & GAME CODE § 5937 (Westlaw 2008).

[77] Natural Res. Def. Council v. Patterson, 791 F. Supp. 1425, 1431 (E.D. Cal. 1992).

[78] SOMACH, SIMMONS & DUNN, HETCH HETCHY WATER AND POWER ISSUES 24 (2004).

[79] JONES & STOKES ASSOCS., MONO BASIN ENVIRONMENTAL IMPACT REPORT, LEGAL HISTORY OF THE MONO LAKE CONTROVERSY App. R-5 (1993) *available at* www.monobasin research.org/images/mbeir/dappendix/app-r-text.pdf.

[80] Scott Michael Atkinson, *Paradise Drowned: New Studies Continue the Debate Over Hetch Hetchy Reservoir,* EJ MAGAZINE, Fall 2005, at 26.

[81] Editorial, *The Hetch Hetchy Steam Roller*, N.Y. TIMES, Oct. 2, 1913, *available at* http://query.nytimes.com/mem/archive-free/pdf?_r=1&res=9901EFD7163DE633A25751C0A9669D946296D6CF&oref=slogin.

purposes of a dam are still valid. For instance, Daguerre Point Dam was built on the Yuba River as a "debris dam" to trap sediment resulting from hydraulic mining.[82] In 1884, the California courts ruled that hydraulic mining was a public and private nuisance, and the practice was stopped.[83] Therefore, Daguerre Point Dam, as far as its original function is concerned, is obsolete, and so are others that were built for the same purpose. Some other dams that were built to manage water supplies or to provide other benefits are now so filled with sediment that they, too, are functionally obsolete. Matilija Dam, on the Ventura River in Southern California, is a prime example, and it is slated for removal.[84] Over the coming decades, additional dams will likely become similarly useless.

Nevertheless, most dams in California still fulfill at least a portion of their original purposes. In these cases, it is more difficult to weigh the advantages and disadvantages of removal.

There are many very small (i.e., twenty feet in height or less) dams that yield little benefit but cause disproportionate damage. For instance, several small dams on Butte Creek, a tributary to the Sacramento River, substantially blocked salmon migration.[85] In that case, providing an alternative water supply for local users and then removing the dams restored passage—almost instantaneously—for those fish to move upstream to spawn.[86]

Even some relatively large dams have benefits that are small in comparison to their detriments. In some cases, legal requirements require agencies to reassess these facilities. For instance, the Federal Power Act actually requires the Federal Energy Regulatory Commission to reweigh benefits and costs of hydroelectric projects when they come up for relicensing.[87] As part of the FERC relicensing process for the project on the Klamath River, FERC determined that the cost of retrofitting dams in that project to allow fish passage could be greater than the value of the relatively small amount of energy those dams generate.[88] This, in turn,

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[82] CAL. DEP'T OF WATER RES. & U.S. ARMY CORPS OF ENG'RS, DRAFT DAGUERRE POINT DAM FISH PASSAGE IMPROVEMENT PROJECT ALTERNATIVE CONCEPTS EVALUATION 1 (2003).

[83] COMM. ON FLOOD CONTROL ALTERNATIVES IN THE AM. RIVER BASIN ET AL., FLOOD RISK MANAGEMENT AND THE AMERICAN RIVER BASIN 21 (1995) (citing Woodruff v. N. Bloomfield Gravel Mining Co., 18 Fed. 753 (9th Cir. 1884)).

[84] Michael Collins, *Override of Water Bill Veto Aides Dam*, VENTURA COUNTY STAR, Nov. 7, 2007, *available at* http://www.venturacountystar.com/news/2007/nov/07/override-of-water-bill-veto-aids-dam/.

[85] PETER H. GLEICK, THE WORLD'S WATER 2000-2001, at 121-122 (2000).

[86] *Id.*

[87] *See* 16 U.S.C.A. § 797(e) (Westlaw 2008).

[88] *See* CAL. ENERGY COMM'N, ECONOMIC MODELING OF RELICENSING AND DECOMMISSIONING OPTIONS FOR THE KLAMATH BASIN HYDROELECTRIC PROJECT 1 (2006).

has spurred negotiations among the dams' owner, farmers, Indian tribes, the fishing industry, conservationists, and government agencies regarding potential removal of four Klamath River dams.[89]

It is also important to note that in most cases environmental review requirements apply to dam removal. Because removal of many dams requires work in the waters of the United States, a discretionary permit under Section 10 of the River and Harbor Act of 1899 and Section 404 of the Clean Water Act is required,[90] also triggering review under the National Environmental Policy Act.[91] For projects in California requiring any type of discretionary governmental approval, the California Environmental Quality Act applies.[92]

Another issue to consider is whether there are alternative means for achieving the benefits—if there are any benefits—that are provided by a dam under consideration for removal. In the case of Hetch Hetchy Reservoir behind the O'Shaughnessy Dam on the Tuolumne River, several groups—including Restore Hetch Hetchy, Environmental Defense, and the Tuolumne River Trust—have identified alternative water supply projects that could continue to meet San Francisco's needs.[93] The feasibility of supplying San Francisco with water without the O'Shaughnessy Dam has been confirmed by a subsequent study carried out by the University of California.[94] For replacing the San Clemente Dam on the Carmel River, a mix of water-supply alternatives has been identified.[95] These include water recycling, brackish water desalination, and improved water use efficiency.[96]

For dams that hold back accumulated sediment, an important

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[89] Jeff Barnard, *Klamath River Dam Removal Plan Ready*, CONTRA COSTA TIMES, Jan. 20, 2008.

[90] River and Harbor Act of 1899 § 10, 33 U.S.C.A. § 403 (Westlaw 2008); Clean Water Act § 404, 33 U.S.C.A. § 1344 (Westlaw 2008).

[91] National Environmental Policy Act of 1969, 42 U.S.C.A. §§ 4321-4347 (Westlaw 2008).

[92] California Environmental Quality Act, CAL. PUB. RES. CODE §§ 21000-177.

[93] *See generally* GERALD H. MERAL, RESTORE HETCH HETCHY, FINDING THE WAY BACK TO HETCH HETCHY VALLEY: FEASIBILITY STUDY (2005), *available at* http://www.hetchhetchy.org/pdf/restore_hh_full_report_sept_2005.pdf; *see also* SPRECK ROSEKRANS ET AL., ENVTL. DEF., PARADISE REGAINED: SOLUTIONS FOR RESTORING YOSEMITE'S HETCH HETCHY VALLEY (2004); *see also* Tuolumne River Trust, Stop the SFPUC Water Grab!, http://www.tuolumne.org/content/index.php?topic=programs_bayarea (last visited July 31, 2008).

[94] SARAH E. NULL & JAY R. LUND, REASSEMBLING HETCH HETCHY: WATER SUPPLY WITHOUT O'SHAUGHNESSY DAM, J. OF THE AM. WATER RES. ASS'N 406 (2006), *available at* http://hetchhetchy.water.ca.gov/docs/JAWRA_Null&Lund.pdf.

[95] *See generally* RMC, MONTEREY REGIONAL WATER SUPPLY PROGRAM: EIR PROJECT DESCRIPTION (2008), *available at* http://ciwr.ucsc.edu/monterey/ceqa/RegionalWaterSupplyProgram_04JUNE08.pdf.

[96] *See id.* at 1-1, 1-2.

question is what would happen to that material if the dam were removed. For Matilija Dam on the Ventura River, the plan is to gradually wash fine sediments downstream.[97] However, for San Clemente Dam, that is not a viable alternative—there are over 1000 structures in the downstream floodplain.[98] Allowing that much sediment to go downstream would raise the riverbed and exacerbate existing flood risks.[99] To remove San Clemente Dam, an innovative approach under consideration would permanently secure the sediment in places where it has already accumulated[100] and reroute a short section of the river around it—in essence creating an artificial ox-bow.[101]

Assumption of liability for dam removal is another question. After the dam is deconstructed, who is responsible if injurious amounts of accumulated sediment are released downstream?

Institutional issues must also be considered. These include asking what happens to the water rights if the dam is removed. Is the water available for other appropriators or is it dedicated to environmental purposes? Unless the dam and reservoir are on publicly owned lands (e.g., U.S. Forest Service land), who will hold title to the land after the dam is removed?

The next question is who would benefit and who would pay for dam removal. Usually those who own the dam are not the primary beneficiaries of removal, although they should bear responsibility for the current impacts.[102] In most cases of dam removal, funding is provided by both the dam owner and governmental and/or nongovernmental organizations. The mix depends on a variety of factors, including the financial capability of the dam owner, existing liability for impacts, and the magnitude of the public benefits of removing that dam. Developing the cost-sharing formula is much more an art than a science.

IV. THE NEW: EVALUATING PROPOSED DAMS

With a growing population and a future of climate change, there is a

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[97] NEAL FISHMAN & CAROL ARNOLD, CAL. OCEAN PROTECTION COUNCIL, MATILIJA DAM ECOSYSTEM RESTORATION PROGRAM ENGINEERING PLANS AND DESIGNS PROJECT 3 (2005).

[98] Plan. & Conservation League Found., Restoring the Carmel River, www.pclfoundation.org/projects/San-Clemente-Factsheet.pdf (last visited July 31, 2008).

[99] CAL. DEP'T OF WATER RES. & U.S. ARMY CORPS OF ENG'RS, *supra* note 73, § 3.1, at 9-10.

[100] *See id.* § 3.5, at 7-8, 11 (discussing sediment excavation, relocation, and placement).

[101] *Id.* § 3.5, at 1.

[102] *See* ASPEN INST., DAM REMOVAL: A NEW OPTION FOR A NEW CENTURY 22 (2002), *available at* http://www.aspeninstitute.org/atf/cf/%7BDEB6F227-659B-4EC8-8F84-8DF23CA704F5%7D/damremovaloption.pdf.

push to look at building some new dams to increase the state's water supply. In the year 2000, the Record of Decision was issued for a project known as CALFED.[103] That project included a commitment to build one or more new dams to increase surface water storage.

The Record of Decision specifically identified five potential dam and reservoir projects: enlarging Shasta Dam on the Sacramento River; building Sites Dam and Reservoir, a new off-stream dam and reservoir on the west side of the Sacramento Valley; the Delta Wetlands Project, which would use two, below-sea-level islands within the Sacramento San Joaquin Delta to store water; enlarging Los Vaqueros Reservoir in Contra Costa County; and building Temperance Flat Dam and Reservoir west of Fresno on the San Joaquin River just upstream of Friant Dam.[104] In the eight years since the CALFED Record of Decision was signed, $118 million in state and federal funds have been spent studying the proposed surface water storage projects.[105] Despite that large expenditure, the analyses of only two of the projects have been released to the public.

First, the U.S. Bureau of Reclamation ("USBR") looked at the cost-effectiveness of various levels of enlargement of Los Vaqueros Reservoir and concluded that a smaller expansion than the one envisioned in the CALFED Record of Decision would be cost-effective.[106]

Regarding the Delta Wetlands Project, the DWR found it problematic for two reasons. First, the project location within the Delta in an area already below sea level would require very expensive levee modifications to make the dam somewhat resistant to flooding. Projected sea-level rise[107] would only increase the difficulty and expense of trying to make it a secure facility. In addition, the Delta's underlying soils would release organic material into the water.[108] These organics, when combined with disinfection chemicals such as chlorine, are

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[103] CALFED BAY-DELTA PROGRAM, PROGRAMMATIC RECORD OF DECISION 3 (2000), *available at* http://web.archive.org/web/20070710033546/calwater.ca.gov/Archives/GeneralArchive/rod/ROD8-28-00.pdf.

[104] *Id.* at 44-45.

[105] CAL. LEGIS. ANALYST'S OFFICE, 2007-08 ANALYSIS, RESOURCES 47 (2007), *available at* http://www.lao.ca.gov/analysis_2007/resources/resource_anl07.pdf.

[106] U.S. BUREAU OF RECLAMATION, INITIAL ECONOMIC EVALUATION FOR PLAN FORMULATION: LOS VAQUEROS EXPANSION INVESTIGATION, CALIFORNIA, at ES-2, 2-11 (2006), *available at* https://www.communicationsmgr.com/projects/losvaqueros/docs/FINAL%20Initial%20Econ%20Eval%20July%202006.pdf.

[107] *See* CAL. DEP'T OF WATER RES., DRAFT EXECUTIVE SUMMARY IN-DELTA STORAGE PROGRAM, STATE FEASIBILITY STUDY 10 (2004), *available at* http://calwater.ca.gov/content/Documents/library/Storage/InDeltaStorageReports_2003/Executive%20Summary/Draft_In-Delta_Executive_Summary_1-30-04.pdf.

[108] *Id.* at 10-11.

carcinogenic.[109]

No feasibility studies of the three other CALFED proposed projects have been released. A major reason is that no parties have committed to paying for their share of whatever benefits the projects might provide.[110] Without funding, a project is by definition infeasible.

This also reflects another reality of California water: the best dam sites have already been built upon.[111] Starting over 100 years ago, engineers and surveyors scoured the state looking for the most efficient sites. Initially, a relatively small dam could impound a large volume of water. As the best sites were taken, new dams had to be larger, and they stored less water.[112]

In addition, the estimation of water supply from several of the projects presumes the ability to get the water from where it would be stored, e.g., the Sacramento Valley, to areas that could use the water, e.g., Southern California. Much of the water supply from these projects would have to be conveyed through levee-protected channels in the fragile Sacramento-San Joaquin Delta.[113] This is an area with vast expanses of land already below sea level and protected by levees known to be inadequate.[114]

Water diversion from the Delta channels also requires the use of massive pumps. The operation of these pumps is a major factor known to be causing the collapse of the Delta ecosystem.[115] Uncertainties about the future of water conveyance through or around the Delta make it difficult to estimate how much water could be delivered from proposed new surface water storage projects such as those in the CALFED Record of Decision.

In evaluating such proposed new reservoir projects, the questions noted below should be considered.

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[109] Alex T. Chow, Kenneth K. Tanji & Suduan Gao, *Production of Dissolved Organic Carbon (DOC) and Trihalomethane (THM) Precursor From Peat Soils* 4475-4485, 37(4) WATER RESEARCH (2003).

[110] *See* CAL. LEGIS. ANALYST'S OFFICE, *supra* note 105, at 39-42.

[111] CAL. DEP'T OF WATER RES., BULL. 3, THE CALIFORNIA WATER PLAN 21 (1957).

[112] *See, e.g., id.* at 8 ("It is evident that the development of water in California today deals largely with 'left-over' projects and must utilize dam sites and even entire streams which were passed over in the early days as being too difficult of development.").

[113] JAY LUND ET AL., PUBLIC POLICY INST., ENVISIONING FUTURES FOR THE SACRAMENTO-SAN JOAQUIN DELTA 90-92 (2007).

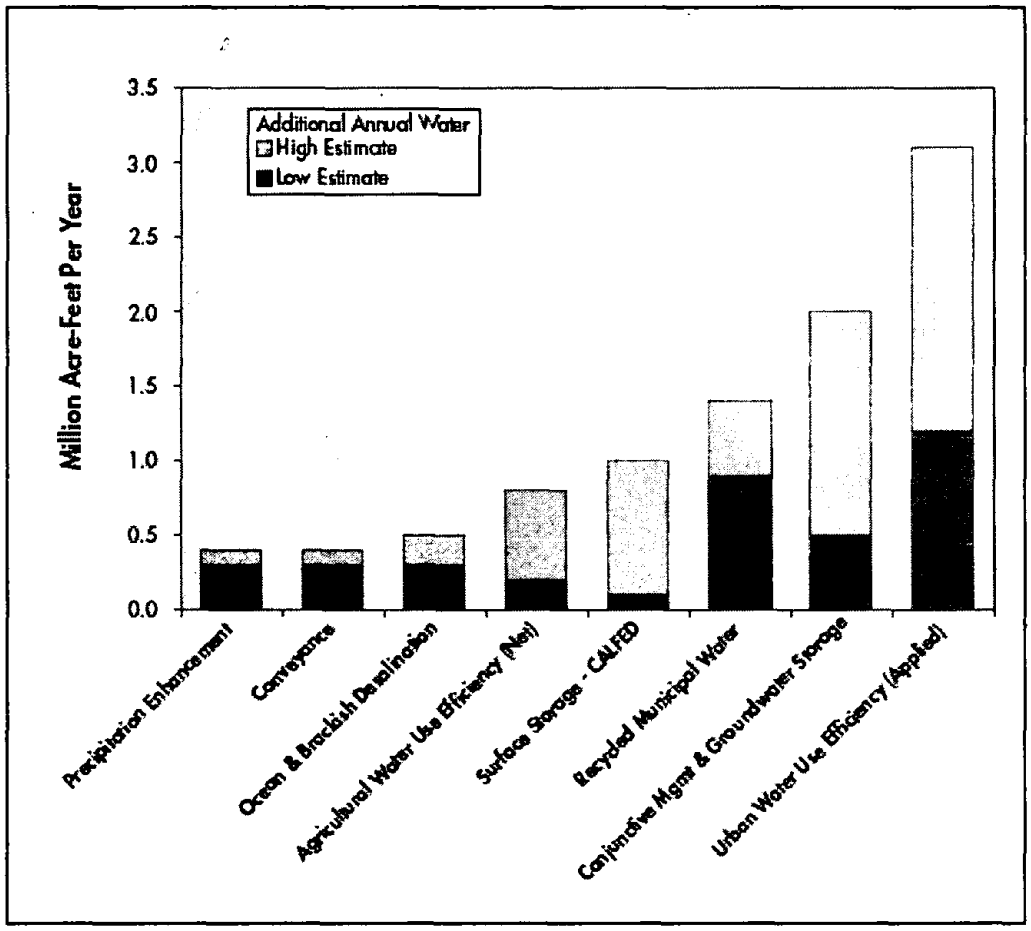
[114] *Id.* ("As Tim Quinn, vice president of the Metropolitan Water District of Southern California . . . noted, 'The current policy of the state . . . is to move water through the delta. Mother Nature, however, has not been cooperating.'").

[115] Mike Taugher, *Delta Pumps Turned Off to Protect Fish*, OAKLAND TRIB. June 1, 2007 (focusing on the pumps' impacts on Delta smelt, "the most severely imperiled of a host of declining Delta fish species").

A. ARE COST-EFFECTIVE, LESS-DAMAGING ALTERNATIVES AVAILABLE?

In 2005, DWR released its update to the State Water Plan.[116] DWR's findings, shown below from the *California Water Plan*, demonstrate that urban water conservation, water recycling, and conjunctive use of surface and ground water, could provide over five million acre-feet of water annually.[117] This is more than six times as much as the five CALFED dams might provide.[118]

fig. 1 Range of Additional Annual Water for Eight Resource Management Choices .



[116] CAL. DEP'T OF WATER RES., BULL. 160-05, CALIFORNIA WATER PLAN UPDATE (2005), *available at* http://www.waterplan.water.ca.gov/previous/cwpu2005/index.cfm.

[117] CAL. DEP'T OF WATER RES., BULL. 160-05, CALIFORNIA WATER PLAN UPDATE HIGHLIGHTS 14 (2005), *available at* http://www.waterplan.water.ca.gov/docs/cwpu2005/cwphighlights/highlights.pdf. "This graph shows the potential range of more water demand reduction and supply augmentation each year for eight resource management strategies." *Id.* (citing graphic shown herein at fig. 1).

[118] *See id.*

B. WOULD THOSE WHO STAND TO BENEFIT PAY FOR PROPOSED PROJECTS?

Water supply from new dams identified in the CALFED Record of Decision is touted as a benefit for California's municipal water districts and large irrigation districts.[119] Because the best dam sites have already been utilized, and because of modern regulatory mandates, costs for construction at remaining sites are astronomical.[120] The most likely beneficiaries, such as Metropolitan Water District of Southern California, Kern County Water Agency, and Westlands Water District, know that any water from these projects will be many times more expensive than current supplies.[121]

This explains why some dam proponents argue that the dams are a vital solution to the coming impacts of global climate change[122] and that they should be built to help recover decimated fisheries.[123] However, as conservationists at California Trout wrote to Governor Schwarzenegger, "[m]ost California scientists agree that there is no proof that the new dams . . . are needed in response to global warming."[124] As for fishery enhancement, the notion is that water from these dams could be released at times most beneficial to different life stages of the fisheries.[125]

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[119] *See* Sullivan, *supra* note 3.

[120] *See id.* ("The Sites Reservoir, for example, north of San Francisco, was initially expected to cost $2 billion, but lately that cost estimate has ballooned to $5 billion. Barry Nelson, a water resources expert at the Natural Resources Defense Council, said the history suggests 'the price will go up.' . . . One of the reasons dam studies are frequently delayed is because [dams] are just not very promising investments.'"); STEVEN MALLOCH, DAMNED DAMS? NEW WATER STORAGE FOR A SUSTAINABLE WEST 1 (2006), *available at* http://cbwtp.org/jsp/cbwtp/library/documents/Damned%20Dams%20-%20PDF%20Version%5D1.pdf.

[121] Sullivan, *supra* note 3 (quoting Barry Nelson of the Natural Resources Defense Council as having "said [that] urban water agencies and agricultural water agencies have come to the conclusion (though they won't say so publicly) that these projects are a waste of their money.").

[122] *Id.* ("[Environmentalists] argue that dam advocates are trotting out climate change to 'greenwash' the same kind of projects that they stopped in the 1970s. . . . '[C]limate change is the latest reason trotted out by the same old interests who want their activity subsidized by taxpayers to build new dams,' said Steve Evans, conservation director for Friends of the River.").

[123] JOHN A. NEJEDLY, A REPORT ON THE PROJECT OF CALFED TO DESTROY THE PRESENT LOS VAQUEROS DAM AND RESERVOIR 3, *available at* http://californiawatercrisis.org/destory_los_vaqueros.htm (last visited Aug. 22, 2008).

[124] Jeff Shellito, California Trout, *Governor Proposes Major Dam Building Effort*, STREAMKEEPERS LOG, Spring 2007, at 7, *available at* http://www.caltrout.org/documents/SKL117.pdf ("With sensible management, the state's existing robust dam system, coupled with additional investments in water use efficiency and recycling, will help ensure a reliable water supply even with potential snow pack losses due to global warming.").

[125] RODNEY M. FUJITA, HEAL THE OCEAN 13 (2003); *see also* David D. Hart et al., *Dam Removal: Challenges and Opportunities for Ecological Research and River Restoration*, 52

Based on these supposed public benefits, the proponents maintain it would be appropriate for general tax revenue to subsidize these projects.[126] This principle is known as "OPM"—using "other people's money" to pay for a project that does not benefit them.[127] However, the proponents' appeal falters when they are asked for specifics on how the projects would help fisheries—especially since other central components of CALFED would divert massive amounts of water for human use from already stressed habitats like the Sacramento-San Joaquin Delta.[128] In addition, the proponents do not provide assurances that the dams would actually be operated to benefit fish.[129]

C. WHERE WOULD THE WATER FOR THE PROPOSED PROJECTS COME FROM?

Two of the potential reservoirs proposed in the CALFED Record of Decision, Sites and Los Vaqueros expansion, would be off-stream. The advantage of off-stream sites is that they avoid the placement of new structures on rivers, with the attendant problems of fish blockage, inundation of riparian areas, and the like. However, off-stream proposals do not answer the question of where the water would come from. Water to fill Sites Reservoir would have to be pumped from the Sacramento River.[130]

Proponents of the Sites and Los Vaqueros reservoirs aver that only excess or surplus flows would be diverted.[131] According to fluvial geomorphologists, however, those are precisely the flows that allow the

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BIOSCIENCE 669, 679 (2002).

[126] *See, e.g.*, Sullivan, *supra* note 3; *see also, e.g.*, Kevin Yamamura, *Governor Still Set On Two New Dams*, SACRAMENTO BEE, May 10, 2007, at A3, *available at* http://www.sacbee.com/111/story/174055.html.

[127] "OPM" stands in stark contrast to the "beneficiary pays" principle that is supposed to guide CalFED funding decisions. *See* CAL. LEGIS. ANALYST'S OFFICE, *supra* note105, at 40.

[128] NEJEDLY, supra note 123, at 3.

[129] In recent court decisions, state and federal agencies were found to be non-compliant with endangered species protections. Elizabeth Larson, *Water Crisis Focus of 2007*, CAPITAL PRESS, Jan. 4, 2008, *available at* http://www.capitalpress.info/main.asp?SectionID=67&SubSectionID=616&ArticleID=38121&TM=45660.58 (referring to Watershed Enforcers v. Cal. Dep't of Water Res., No. RG06292124 (Alameda County Super. Ct. Apr. 18, 2007), and Nat. Res. Def. Council v. Kempthorne, No. 1:05-CV-01207-OWW (E. D. Cal. May 25, 2007)).

[130] CAL. DEP'T OF WATER RES., TEMPERANCE FLAT AND SITES RESERVOIRS 2 (2007), *available at* http://www.publicaffairs.water.ca.gov/newsreleases/2007/091707temperancefaq.pdf.

[131] *See, e.g.*, Editorial, *New Reservoir May Help Satisfy Thirst For Water*, REDDING REC. SEARCHLIGHT, Feb. 5, 2001, *available at* http://www.awra.org/state/socal/news_clippings_press_releases/Feb%202001%20Newsclippings.pdf.

river to naturally meander.[132] This meandering keeps riparian processes functioning.[133] For instance, regeneration of cottonwood trees on the banks occurs because of erosive events[134]—and it is the cottonwoods that provide important shaded habitat to protect fish in the water.[135]

D. HOW WOULD CLIMATE CHANGE AFFECT THE PROPOSED PROJECTS AND HOW WOULD THE PROPOSED PROJECTS AFFECT CLIMATE CHANGE?

The general consensus at this point is that, with global warming, more of the precipitation hitting California will be in the form of rain rather than snow.[136] Hydrologists estimate that every one degree centigrade increase in temperature will raise the snow level 500 feet in elevation.[137] This is particularly significant because the Sierra snow pack functions as the state's largest reservoir.[138] Snow that falls in the winter gradually melts during the spring and is available to refill reservoirs and provide a water supply to agricultural and urban needs.[139] If more of the winter precipitation comes down in the form of rain, it will then run off well before water demands peak in the summer.[140]

However, studies also suggest considerable variation among models and emissions scenarios, including some models that predict not only a decrease in snowfall but also a decrease in total precipitation in California as a result of global climate change.[141] If that prediction is correct, then California may already have adequate or excess reservoir

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[132] KOLL BUER ET AL., USDA FOREST SERVICE GEN. TECH. REP. PSW-110, THE MIDDLE SACRAMENTO RIVER: HUMAN IMPACTS ON PHYSICAL AND ECOLOGICAL PROCESSES ALONG A MEANDERING RIVER 24 (1989).

[133] *Id.* at 26.

[134] *Id.* at 25.

[135] PHILIP W. RUNDEL & ROBERT GUSTAFSON, INTRODUCTION TO THE PLANT LIFE OF SOUTHERN CALIFORNIA 198-202 (2005).

[136] CAL. ENVTL. PROT. AGENCY, CLIMATE ACTION TEAM REPORT TO GOVERNOR SCHWARZENEGGER AND THE LEGISLATURE 28 (2006), *available at* http://www.climatechange.ca.gov/climate_action_team/reports/2006-04-03_FINAL_CAT_REPORT.PDF.

[137] MAURICE ROOS & MICHAEL L. ANDERSON, MONITORING MONTHLY HYDROLOGIC DATA TO DETECT CLIMATE CHANGE IN CALIFORNIA (2006), *available at* http://www.climatechange.ca.gov/events/2006_conference/poster_session/Roos+Anderson_Hydrolic_monitoring.pdf.

[138] Laura Edwards, W. Reg'l Climate Ctr., *Today's Snow, Tomorrow's Tap Water*, CAL. CLIMATE WATCH, June 14, 2005, *available at* http://www.calclim.dri.edu/climatewatch/ccw200505.html.

[139] ROOS & ANDERSON, *supra* note 137.

[140] *See id.*

[141] DAN CAYAN ET AL., CAL. CLIMATE CHANGE CTR., SCENARIOS OF CLIMATE CHANGE IN CALIFORNIA: AN OVERVIEW 8 (2006), *available at* http://www.energy.ca.gov/2005publications/CEC-500-2005-186/CEC-500-2005-186-SF.PDF.

space for the amount of water that can cost-effectively be captured in the future.

E. WILL THERE BE ENOUGH WATER TO FILL NEW RESERVOIRS IN CALIFORNIA UNDER THE NEW NORMAL?

Two recent studies call into question the availability of precipitation and runoff to fill reservoirs behind new dams.

Richard Seager, from Columbia University, studied whether climate change will result in a drier or wetter Southwest.[142] He reviewed the results of nineteen different global climate change models developed by international contributors to the *Intergovernmental Panel of Climate Change Fourth Assessment Report.* Seager concludes:

Standing where we are now in 2007 it would be a reasonable conclusion that southwestern North America—and the subtropics in general—will have a drier climate in the future and that transition may already be underway. Or to put it another way, though wet years will still occur, on average they will be drier than prior wet years while the dry years will be drier than prior dry years. The two decade period of overall wet conditions from 1976 to 1998 is likely to never be repeated as the region faces an intensifying aridity that will simply get worse as the century progresses (barring actual stabilization and then reduction of atmospheric GHGs (green house gases)).[143]

Another recent study, *Changes in Aridity in the Western United States,* highlights the impact of climate change in reducing the runoff from whatever amount of precipitation does occur.[144] The authors found that with the warming from climate change, a larger percentage of the precipitation will be evapo-transpired and a smaller percentage will be available as surface water runoff or groundwater recharge.[145] Furthermore, they report that under the potential for more frequent droughts, "any persistent reductions in precipitation might be expected to shift water budgets even more towards less overall blue-water [i.e., runoff or groundwater recharge] generation and more green-water use [i.e. more evapo-transpiration], because the blue fractions decline more

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[142] RICHARD SEAGER, CAL. DEP'T OF WATER RES., MAKING A BAD SITUATION WORSE 70-81 (2008).

[143] *Id.* at 75.

[144] H.G. HIDALGO, M.G. DETTINGER & D.R. CAYAN, CHANGES IN ARIDITY IN THE WESTERN UNITED STATES (2007), as published in CAL. DEP'T OF WATER RES., CALIFORNIA DROUGHT, AN UPDATE 54-59 (2008), *available at* http://watersupplyconditions.water.ca.gov/DroughtReport 2008.pdf.

[145] *See id.* at 57-58.

than the precipitation in drought years."[146]

This raises serious questions about how frequent and significant future wet periods will be. At a minimum, the studies for new storage reservoirs should include sensitivity assessments for the new reservoirs and consider how the functioning of new reservoirs would be affected by climate change. In essence, it is time for California's water planning to recognize that California is entering a "new normal" that will likely continue to get drier.

Unlike water conservation, which actually reduces energy use, new water supplies increase energy and greenhouse gas output. Off-stream reservoirs require energy to pump the water into them from the host rivers. In addition, massive amounts of energy are required to deliver and treat new water supplies. In California almost one fifth of the state's total electrical energy use is for water.[147] As we look to reducing our carbon footprint, reducing water use is a major opportunity.

F. WHAT ARE THE IMPACTS ON DISADVANTAGED COMMUNITIES?

When Shasta Dam and Reservoir were constructed, over 90% of the ancestral lands of the Winnemem Wintu Indians were inundated.[148] Negotiated treaties that would have provided some redress and compensation were ignored. The proposed raising of Shasta Dam would inundate additional Wintu sacred sites, including twenty-six sites (such as burial grounds and prayer rocks)[149] that have been sacred since long before Europeans occupied California.[150] The environmental justice question is what rights indigenous peoples have to access lands that have been part of their heritage. Can another culture override these rights because it has the power to do so?

In addition, there is the environmental justice issue of how repayment of state bonds used to subsidize these dams would impact the ability to pay for other governmental services. For fiscal year 2008-2009,

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[146] *Id.* at 58.

[147] CAL. ENERGY COMM'N, FINAL STAFF REPORT NO. CEC-700-2005-011-SAN FRANCISCO, CALIFORNIA'S WATER–ENERGY RELATIONSHIP 1 (2005), *available at* http://www.energy.ca.gov/2005publications/CEC-700-2005-011/CEC-700-2005-011-SF.PDF.

[148] Mark Franco, *On Water: Hidden Costs of Water Development*, S.F. CHRON., Aug. 27, 2007, *available at* http://www.sfgate.com/cgi-bin/article.cgi?file=/c/a/2007/08/27/EDDMRP3EM.DTL.

[149] Dylan Darling, *Shasta Dam Expansion Plan: Flood of concerns - Anglers, Wintu Fear Shasta Dam Raising Will Drown Treasured Sites*, REDDING REC. SEARCHLIGHT, Feb. 19, 2007, *available at* http://www.redding.com/news/2007/feb/19/flood-concerns/.

[150] Jacques Leslie, *Six Hundred Feet and Rising*, ON EARTH, Summer 2006, *available at* http://www.nrdc.org/onearth/06sum/shasta1.asp.

California is facing a $14.5 billion deficit in its State General Fund.[151] This is the same source of taxpayer-provided money used to fund health, public safety, and educational services. California has already made painful cuts in these services.[152] Issuing bonds used to subsidize dams would add hundreds of million of dollars to California's debt.[153]

V. CONCLUSION

Many—if not most—of the existing dams in California will remain in place in the near future and will continue to provide multiple benefits. In a small number of instances, a combination of factors will lead to consideration of removal; when there would be significant benefits, when funding is available, and when institutional issues can be resolved, some dams will be removed.

Meanwhile, existing proposals to construct new dams generally fail to answer several key questions. What would the true costs be? Who will pay them? Who will truly benefit from the projects? How will they perform as the climate changes? How might they further damage California's threatened ecosystems? Decisions to provide multi-billion dollar subsidies for such projects cannot properly be made until these questions are answered.

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[151] Governor's Budget 2008-09, The State Faces a $14.5 Billion Deficit in 2008-09, http://www.ebudget.ca.gov/BudgetSummary/INT/32270934.html (last visited Aug. 8, 2008).

[152] *See* Matthew Yi, *California Lawmakers OK Big Budget Cuts*, S. F. CHRON., Feb. 16, 2008, *available at* http://www.sfgate.com/cgi-bin/article.cgi?f=/c/a/2008/02/16/MNB5V3K99.DTL.

[153] Letter from Elizabeth Hill, Cal. Legis. Analyst's Office, to Edmund Brown, Cal. Att'y Gen. (Feb. 5, 2008), *available* http://www.lao.ca.gov/ballot/2008/080085.pdf.