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ISSUE BRIEF

SAVING THE LOWER SAN JOAQUIN RIVER AND ITS TRIBUTARIES: *The Importance of Instream Flow*

The Stanislaus, Tuolumne, and Merced Rivers each begin in the southern Sierra Nevada mountains, flowing westward to join the lower San Joaquin River and flowing into the San Francisco Bay-Delta Estuary. From there, they join the Sacramento River. For millennia, these beautiful rivers have flowed past majestic forests and through narrow canyons, tumbling over granite boulders and spreading out over wide floodplains. They connect a web of life that depends on healthy rivers, including salmon and trout, osprey and hawks, river otters and foxes, kingfishers and great blue herons—and people. For generations, fishermen have plied these waters, while others have enjoyed the thrill of whitewater rafting and the serene calm of paddling at sunset. Local old-timers remember being kept awake by the sound of salmon splashing as they spawned at night.

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Today, however, the Stanislaus, Tuolumne, and Merced are dying. Beginning more than a century ago, the construction of dams and canals along these rivers created diversions to supply water for agricultural irrigation and cities (including San Francisco), as well as hydroelectric power. For decades, still, the rivers teemed with fish and wildlife, flowing fresh, clean water into the delta and sustaining the health of the largest estuary on the west coast of the Americas. More recently, though, increased demand for water in the basin has diverted unsustainable amounts of water from these three tributaries.[1] Historically, rain and snow in the winter and spring months resulted in peak flows from February to June.[2] However, between 1986 and 2009, nearly two-thirds or more of the February to June unimpaired flow (the water that would flow downstream in the absence of dams and diversions; see text box) was diverted, allowing only a small fraction of water to flow downstream.

TABLE 1. MEDIAN PERCENTAGE OF UNIMPAIRED FLOW IN THE LOWER SAN JOAQUIN RIVER TRIBUTARIES

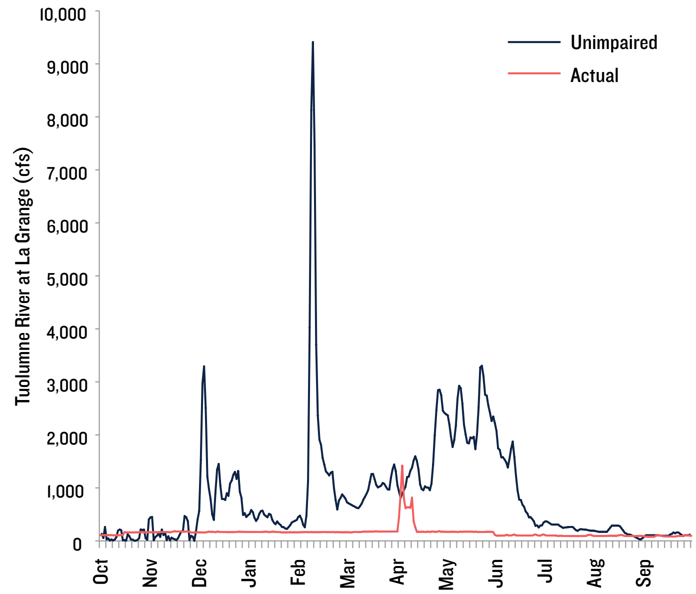
Tributary	Median February to June Percentage of Unimpaired Flow (1986-2009)
Stanislaus River	40%
Tuolumne River	21%
Merced River	26%

Data Source: State Water Resources Control Board, Bay-Delta Water Quality Control Plan Draft Substitute Environmental Document (2012).

Furthermore, in drier years, including during the recent drought, far more water is diverted from these rivers (see Figure 1).

Insufficient flow is the major reason native salmon and steelhead runs in the Stanislaus, Tuolumne, and Merced tributaries are imperiled.[5] It is also a leading threat to the river's water quality and the overall health of the estuary and entire watershed.[6] Thousands of fishing jobs in California, Oregon, and Washington depend on robust Central Valley salmon populations,[7] and restoring healthy salmon runs in these three rivers is important to sustaining the West Coast's salmon fishery into the future.

FIGURE 1. COMPARISON OF UNIMPAIRED AND ACTUAL FLOWS IN WATER YEAR 2015 ON THE TUOLUMNE RIVER



Graph courtesy of The Bay Institute (2015).

This year, the State Water Resources Control Board (SWRCB) has an opportunity—and an obligation—to establish new water quality and flow standards in the Stanislaus, Tuolumne, and Merced Rivers to restore them and the estuary to health. In 2008, the SWRCB began reviewing the existing flow and water quality standards for these rivers as part of updating the Bay-Delta Water Quality Control Plan. State and federal law requires that this plan be reviewed every three years. The instream flow and water quality standards for the Stanislaus, Tuolumne, and Merced Rivers have not been meaningfully changed since 1996, despite overwhelming scientific evidence demonstrating that current instream flows are inadequate for healthy salmon populations and healthy rivers.[11] The SWRCB will also update flow and water quality standards for the Sacramento River and the Bay-Delta in Phase II of this proceeding, scheduled to be completed by 2018.

THE BENEFITS OF A STANDARD BASED ON UNIMPAIRED FLOW

Unimpaired flow is the amount of water that would flow in a river or stream, barring dams or water diversions that reduce the flow downstream.[9] This calculation is an approximation of the annual flow that would occur naturally, given current land use patterns. An unimpaired flow standard is the percentage of that flow required to remain in the stream or river, as determined by the State Water Resources Control Board (SWRCB). For instance, with a 50 percent unimpaired flow standard, half of the water can be diverted and half must be left instream. In general, the formula mimics the changes in flow that would occur naturally, with higher flows in wetter years and during the wet seasons (winter and spring), and lower flows in drier years and dry seasons.

Unimpaired flow standards emulate the natural hydrological patterns to which native species evolved over millennia and have strong scientific support as a management tool.[10] The objective is not to revert to conditions prior to gaining statehood in 1849, but to ensure that river flows remain sufficient to support a healthy ecosystem. In a well-managed system with multiple dams—like the San Joaquin River Basin—there may be some flexibility to allow biologists and managers to adjust the timing and amount of reservoir releases. This allows them to shape downstream flows to optimize flood protection, water supply, and fish and wildlife protection, rather than strictly following the hydrology of unimpaired flow.

INADEQUATE FLOW THREATENS THE SAN JOAQUIN RIVER BASIN

Instream flows in the lower San Joaquin River and its tributaries are currently inadequate to protect fisheries and water quality. Many waterways in the basin are formally listed as impaired under the Clean Water Act, cited for water temperature, dissolved oxygen, salinity, and contaminants. These impairments are caused at least in part by inadequate instream flows.[12] Insufficient flows contribute to harmful algal blooms that threaten human health[13] and promoting the expansion of invasive plants like Brazilian waterweed (*Egeria densa*),[14] which have caused marinas and docks to close. Reduced flows and the lack of natural, seasonal variability also encourage nonnative predator species to flourish in the San Joaquin River and the Bay-Delta Estuary.[15] The scientific evidence is clear: Inadequate instream flows threaten water quality, native salmon and steelhead runs, and thousands of fishing and recreation jobs.

Photo courtesy of Dan Cox, U.S. Fish and Wildlife Service.

Chinook salmon on the lower Tuolumne River.

Salmon indicate how well we are taking care of aquatic and riparian ecosystems. As juveniles, they depend on a healthy freshwater environment. As adults, they migrate to the ocean, where they feed for several years before returning to their birthplace to lay their own eggs. Juveniles need sufficient flows at appropriate water temperatures to inundate floodplains where they mature and to cue downstream migration. Adults need adequate flows to facilitate upstream migration back to their natal streams and adequate flows and temperatures to successfully reproduce. The decline of salmon populations over the past several decades demonstrates that existing flows do not achieve these critical functions.[16]

In some years, the state allows urban and agricultural water districts to divert more than 75 percent of the water from these rivers,[17] threatening native fisheries and wildlife, including salmon and steelhead runs. Decades of data show that the winter and spring flows strongly predict survival of juvenile salmon[18] as well as the abundance of adults that return to spawn years later (see Figure 2).[19] Several mechanisms explain this relationship, including these:[20]

- Increased flows provide access to side-channel and floodplain habitats, in which juvenile salmon find food and protection from predators. Salmon reared in these areas grow faster and larger, and ultimately have greater survival rates.[21]
- Reduced flows tend to increase predation by invasive fish that feed on native salmon.[22]
- Reduced flows are associated with increased water temperatures, which inhibit salmon growth and their ability to migrate downstream, increase mortality for eggs and juveniles, and can cause disease and mortality of adults.[23]
- Inadequate flows can result in lack of sufficient dissolved oxygen in the water, which is needed for successful migration, spawning, maturing, and feeding.[24]

Historically, hundreds of thousands of salmon returned to these rivers each year.[25] However, in recent years, far fewer salmon have returned.[26] In addition, most of the salmon that return today come from hatcheries that release millions of juvenile salmon each year, indicating that wild populations of salmon are in even worse shape.[27] In the 1980s and 1990s, the state and federal governments established population

FIGURE 2. THE RELATIONSHIP BETWEEN SAN JOAQUIN RIVER FLOWS AT VERNALIS AND CHINOOK SALMON ABUNDANCE

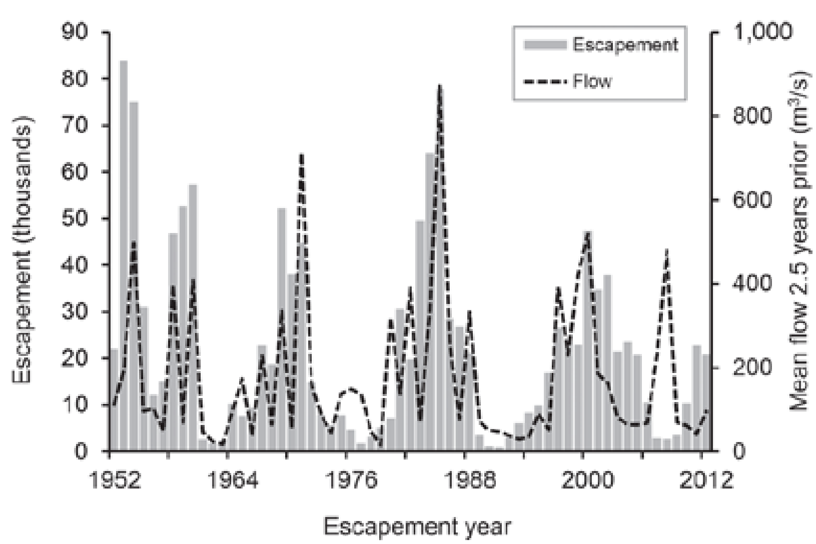


Figure 2 shows the relationship between adult salmon produced in the San Joaquin River Basin (bars) and the spring flows (dashed line) that these fish experienced as juveniles two and a half years earlier during their migration downstream.

Source: Sturrock et al. (2015).

goals for salmon in the Sacramento and San Joaquin Rivers and their tributaries. These goals include doubling the abundance of wild salmon from the average populations from 1967 through 1991, when salmon population levels were already drastically lower than historic levels.[28] These are commonly referred to as the "salmon doubling goals." Unfortunately, salmon populations have continued to decline since the adoption of these targets.

SCIENTISTS AGREE THAT CURRENT STANDARDS FAIL TO PROTECT THE HEALTH OF THE STANISLAUS, TUOLUMNE, AND MERCED RIVERS

In 2010, following extensive public hearings and testimony from scientists, agencies, and stakeholders, the SWRCB concluded that the flows for the Stanislaus, Tuolumne, and Merced Rivers were inadequate. They recommended that 60 percent of the unimpaired flow remain instream to fully protect salmon and other public trust resources.[29] In 2012 and 2013, the SWRCB analyzed the effects of altering the flow standards in the lower San Joaquin River and its tributaries, as required under the California Environmental Quality Act. This environmental analysis compared potential impacts to fisheries, water quality, groundwater, agriculture, and socioeconomics under three scenarios: a 20, 40, and 60 percent unimpaired flow standard.[30] To allow for adaptive management, the SWRCB proposed setting the unimpaired flow standard as a range of flow levels from 25 to 45 percent for February to June flows, as well as establishing quantitative biological objectives to measure progress.

State and federal biologists from the California Department of Fish and Wildlife and other agencies, as well as conservation groups including NRDC and The Bay Institute, recommended a 50 to 60 percent unimpaired flow standard from February to June to protect and restore the Stanislaus, Tuolumne, and Merced Rivers and their salmon populations.[31] Although the SWRCB initially proposed a 35 percent unimpaired flow standard and an adaptive management range of 25 to 45 percent, the California Department of Fish and Wildlife and other agencies and conservation groups concluded that range would be inadequate to protect fish and wildlife. In fact, in most years a 35 percent unimpaired flow standard would actually reduce flows on the Stanislaus River, likely leading to further declines of salmon on this river.[32]

Flows and habitat are not interchangeable, and we need to both restore floodplains and other habitats and improve flows in order to successfully restore the health of these rivers. If habitat restoration, pollution control, and other actions are able to restore these rivers, the delta ecosystem, and salmon runs to health, the SWRCB could approve a standard at the lower end of the adaptive management range. Flows at the higher end of the range, however, would be necessary until these other measures take effect and are proven to benefit the species.

The SWRCB is expected to release a revised substitute environmental document in spring of 2016 and make a decision on new standards in the fall of 2016.

IMPROVED WATER USE EFFICIENCY CAN HELP SUSTAIN FARMS AND CITIES WHILE REDUCING WATER DIVERSIONS

We can increase instream flows to restore the Stanislaus, Merced, and Tuolumne Rivers and their salmon runs while sustaining farms and cities that rely on these rivers. California's 2012 draft environmental analysis estimated that a 40 percent unimpaired flow standard would reduce regional agricultural revenue by 1.5 percent, while a 60 percent standard would reduce agricultural revenues by 4.5 percent (Table 2).[33] The impacts may be even lower, since the analysis did not account for potential water supply increases from improved water use efficiency, water recycling, groundwater recharge, and similar tools.

TABLE 2. PREDICTED AGRICULTURAL IMPACTS UNDER TWO UNIMPAIRED FLOW STANDARD SCENARIOS

Predicted Impact	40% UIF Standard	60% UIF Standard
Crop Revenue Loss	1.5%	4.5%
Agricultural Economic Output Reduction	1.5%	4.5%
Agricultural Job Loss	1.5%	4.5%

Data Source: State Water Resources Control Board, Bay-Delta Water Quality Control Plan Draft Substitute Environmental Document (2012).

Many farms have increased water use efficiency in recent decades, by using more precise systems such as sprinklers or drip irrigation to increase crop yields.[34] However, much of the irrigated acreage in the region still uses inefficient flood irrigation. Many agricultural water districts do not have pressurized systems, which are necessary in order to support sprinkler or drip irrigation and to reduce seepage losses from unlined canals. A recent project by the South San Joaquin Irrigation District found that pressurizing the conveyance system was a cost-effective method of increasing irrigation efficiency and water savings without decreasing groundwater levels.[35]

According to the SWRCB, in 2010 more than 33 percent of the irrigated acreage in each of the four counties that divert from these rivers (Madera, Merced, San Joaquin, and Stanislaus Counties), and as much as 57 percent of the acreage in Merced County, still relied on inefficient flood and furrow irrigation.[36] This demonstrates that significant opportunities remain to improve agricultural yields and revenues in the region through improved water use efficiency.

Although agriculture accounts for most of the water diversions from the Stanislaus, Tuolumne, and Merced Rivers, urban use is another factor. Water recycling, improved water use efficiency, and other water supplies can help offset the reduction in cities' water diversions.[37] For instance, reducing San Francisco's diversions from the Tuolumne River could be offset by increasing water recycling and efficiency in the greater metropolitan area. Improved groundwater management, including groundwater storage in wet years, can benefit urban and agricultural water users and increase the amount of water available for dry years, while allowing for higher instream flows.

IMPROVING AGRICULTURAL WATER USE EFFICIENCY

In 2013, the Pacific Institute published a study of potential tools to increase agricultural water use efficiency in the region that diverts from these three tributaries to the Lower San Joaquin River. (Note that the yield from these tools cannot necessarily be aggregated.)[38]

IMPROVED IRRIGATION TECHNOLOGY

Potential Water Savings: 173,000 acre-feet

Drip or other precision systems, as opposed to flood irrigation, generally yield a high return on investment through increased crop yield and quality (more "crop per drop"). The Pacific Institute estimated that converting 20 percent of regional field crop acreage and orchards and vineyards using flood irrigation to more precise systems could save 173,000 acre-feet (AF) of water annually and yield a profit of $2.6 to $5.3 million. In fact, the improved yields and reduced cost of pumping and inputs (like fertilizer) more than offset the initial investment over time.

Photo courtesy of Texas A&M AgriLife Research.

Subsurface drip irrigation applies water at the plant's roots, making it 11 percent more efficient than sprinklers (which are 5 percent more efficient than flood irrigation).

IMPROVED IRRIGATION SCHEDULING

Potential Water Savings: 166,000 acre-feet

The California Integrated Management Information System is a network of automated weather stations and soil moisture sensors that provides real-time local data to better understand the water requirements of crops throughout the state. Prior studies found the system increased yields by 8 percent and reduced water use by 13 percent. The Pacific Institute estimated that if 25 percent of irrigated land began using scientific irrigation scheduling, the region could reduce water use by 166,000 AF annually, while saving $21.6 million.

REGULATED DEFICIT IRRIGATION (RDI)

Potential Water Savings: 100,000 acre-feet

RDI is a precision irrigation practice that reduces water use during certain drought-tolerant phases of plant growth in order to maximize water productivity rather than total yield. This practice stresses the crop but generally increases the "crop per drop" that is produced. It can only be used for certain crops without substantially affecting yields. This strategy has been successfully applied in the Central Valley for growing alfalfa, almonds, pistachios, and grapes. Prior studies have demonstrated the ability to reduce water use by 17 percent without substantially impacting yield. According to the Pacific Institute's estimates, if RDI were applied to 25 percent of nut orchards, vineyards, and alfalfa fields in the region, it could save approximately 100,000 AF in drier years.

THE BENEFITS OF RESTORING FLOWS

Restoring the health of the Stanislaus, Tuolumne, and Merced Rivers will generate substantial benefits:

- **Thriving commercial fisheries**

  Improving salmon runs in these three rivers would help sustain and increase salmon fisheries statewide, thereby protecting California's fishing industry. Even though these rivers are degraded, in some years as much as 10 percent of the salmon caught in the ocean fishery comes from the San Joaquin Basin.[39] Restoring flow and salmon populations could also help reduce the risks of fishery closures. In 2008 and 2009, the state's salmon fishery was completely shut down, for the first time ever, resulting in the loss of more than 2,200 jobs and $255 million in annual revenue.[40]

Paddler on the Lower San Joaquin River.

Photo courtesy of Rick Cooper, Flickr, Creative Commons License.

Photo courtesy of California Department of Fish and Game

South Fork of the San Joaquin River.

- **Recreation and tourism opportunities**
  Improved flows will help sustain and increase recreational economies, such as whitewater rafting and recreational fishing. According to a 2011 survey by the U.S. Fish and Wildlife Service, 7.8 million people hunt, fish, or otherwise participate in wildlife-related recreation (such as bird-watching) in California. These activities generate $7.5 billion in annual revenue.[41] Many recreational businesses in the region support increased flows for this important economic reason.[42]

- **Restoring the San Francisco Bay-Delta Estuary**

  Improved flows in these three tributaries will help restore the health of the estuary and its water quality and native species. These represent critical state priorities.[43] There is strong public support for restoring the Bay-Delta Estuary, and the state has estimated the value of restoration ranges from $13 to $55 billion in public benefits.[44] This far outweighs the economic impacts of reduced water diversions. Improved water quality in the estuary will produce benefits beyond the immediate environment, including for the more than 25 million Californians who depend on the delta for some of their water.

CONCLUSION

Decades of scientific research and monitoring demonstrate that the nearly 20-year-old water quality standards for the San Joaquin River and its tributaries are inadequate. Increased flows are necessary to restore and support healthy rivers and the thousands of jobs and communities that depend on them. The SWRCB should adopt scientifically sound instream flow standards that will increase flows to restore these rivers and water quality. They should also require restoration of floodplains and other habitats. Furthermore, water use efficiency, water recycling, groundwater recharge, and similar projects should be implemented to reduce water supply impacts. Together, these measures can help to sustain both local economies and healthy rivers for future generations.

ENDNOTES

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