Yolo Bypass

The Yolo Bypass is a critical component of the Sacramento River Flood Control Project (California, USA) and is a portion of historic floodplain that was reconnected to the Sacramento River in the 1930s, culminating a 50-year debate over whether levees could contain floods or whether the river would periodically require access to a portion of its floodplain (Kelley 1989). Although the Bypass was built decades before a system of multipurpose reservoirs in the Sacramento Valley, it effectively illustrates how a geographically large hydrologically connected floodplain can increase the flexibility of multipurpose reservoirs (Opperman et al. 2011). In addition to increasing operational flexibility, this integration of flood management across reservoirs and floodplains results in greater environmental performance of water-management infrastructure than could be achieved through strict reliance on engineered infrastructure.

The Bypass is a 24,000 ha section of floodplain that receives floodwaters when the Sacramento River begins to flow over a weir that separates the river from the Bypass (Figure 3). During large floods, the Bypass conveys 80% of the volume of floodwaters while the Sacramento River channel, confined between levees, carries only 20% of the volume as it flows through the city of Sacramento (Sommer et al. 2001). By conveying this volume of floodwaters, the Bypass floodplain relieves pressure on levees and substitutes for billions of cubic meters of reservoir flood storage based. Opperman et al. (2011) present an analysis of the role the Bypass played in the Sacramento Valley flood management during a flood in 1986 (a 50-80 year recurrence interval flood at the city of Sacramento).

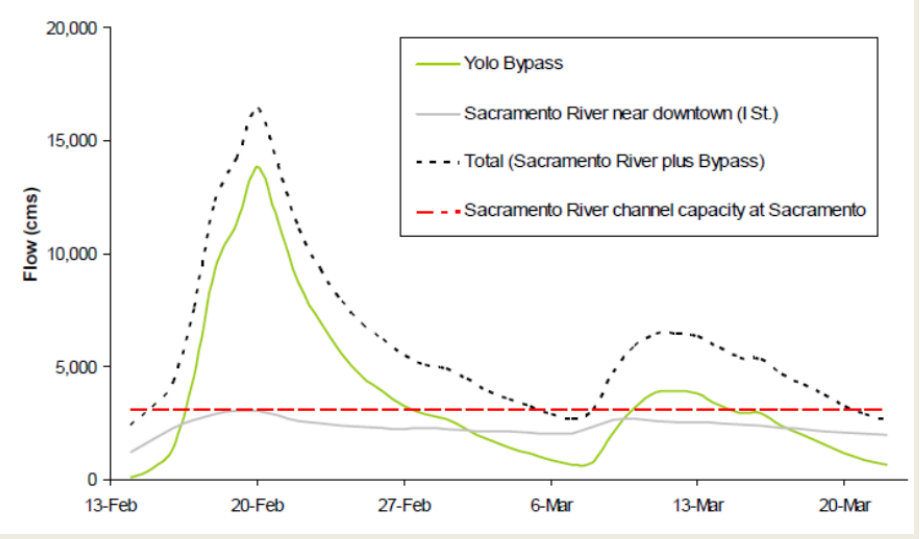

Figure 1. Hydrograph of the 1986 flood on the Sacramento River.

The channel capacity of the Sacramento River in the city of Sacramento is approximately 3,100 m^3/sec (Sommer et al. 2001) and river flows approached this capacity for much of the flood (figure 1). Thus the Bypass conveyed a flow of approximately 15,000 m^3/sec or 83% of the total flow in the system during the peak. During the three-day peak of the 1986 flood (February 19-21) 3.3 bcm flowed through the bypass, which is approximately the same volume as the combined flood-control storage of the six major reservoirs that manage floodwaters in the Sacramento River basin (Figure 3). During this peak the multipurpose reservoirs' flood storage volume was nearly full and the Sacramento River was essentially at its channel capacity (i.e., greater magnitude within the channel would have lead to levee overtopping). Thus, the the 3.3 bcm that flowed through the Bypass during the peak three days could not have been stored or conveyed by any other element of the existing flood-control system. The "green infrastructure" of the Bypass floodplain was providing a service that could not have been provided by the existing engineered infrastructure.

Figure 2. Yolo Bypass Wildlife Area. Located south and southwest of Sacramento. The Bay Delta derives from the Sacramento and San Joaquin Rivers and is the largest estuary on the west coast of North and South America. © Harold E. Malde

Although environmental flows are generally thought of in terms of managed releases of dams, more broadly, environmental flows can be considered management actions that create patterns of flow and inundation for ecological or social benefits. With this broader definition, the Yolo Bypass provides some of the most important environmental flows in the entire Sacramento River Valley.

Inundation of the Bypass occurs in approximately 60% of all years and often lasts for a month or more (Schemel et al. 2004). The vast majority of floodplain habitat in the Central Valley of California has been converted to agricultural and residential land uses and flow regulation by reservoirs has greatly altered the processes that occur on floodplain habitats that remain (The Bay Institute 1998). The Bypass provides by far the greatest extent of hydrologically connected floodplain that still experiences frequent, long-duration flooding in the Spring, a type of flood that provides the most benefits for native fish (Williams et al. 2009). Recent research has demonstrated that the Bypass provides many functions of a natural floodplain and, at 24,000 ha, it represents the largest remaining floodplain habitat in the Central Valley. The Bypass supports large populations of wading birds and waterfowl and, during inundation, provides habitat for 15 native fish species. The Bypass is particularly important as rearing habitat for juvenile Chinook salmon (*Oncorhynchus tshawytscha*) and spawning habitat for the Sacramento splittail (*Pogonichthys macrolepidotus*), an endemic cyprinid that is an obligate floodplain spawner (Sommer et al. 1997, Sommer et al. 2001).

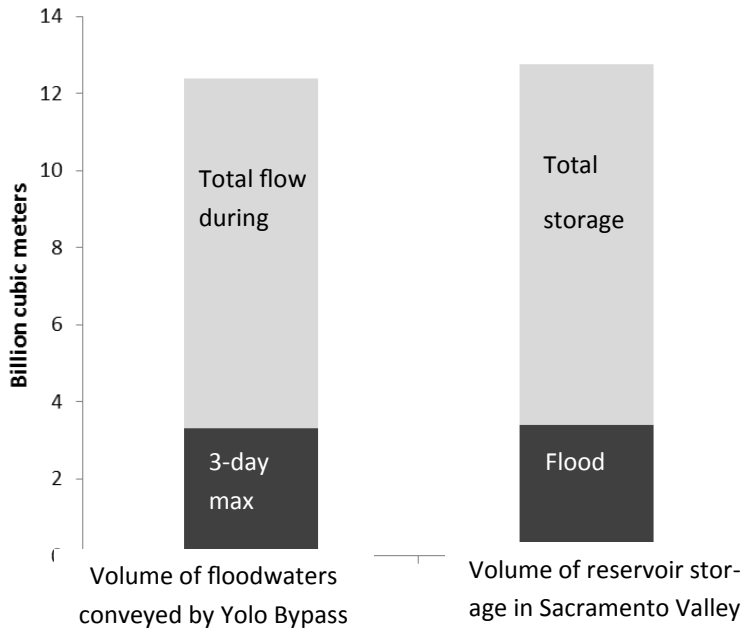

Figure 3. Volumes of water conveyed by Yolo Bypass during 1986 flood event and volumes of water in Sacramento River reservoirs.

References—Yolo Bypass case study

Kelley, R. 1989. *Battling the Inland Sea: floods, public policy, and the Sacramento Valley*. University of California Press, Berkeley, California.

Opperman, J. J., A. Warner, E. H. Girvetz, D. Harrison, and T. Fry. 2011. Integrated reservoir-floodplain management as an ecosystem-based adaptation strategy to climate change. Proceedings to American Water Resources Association 2011 Spring Specialty Conference on Climate Change and Water Resources. American Water Resources Association, Baltimore, MD.

Schemel, L. E., T. R. Sommer, A. B. Muller-Solger, and W. C. Harrell. 2004. Hydrological variability, water chemistry, and phytoplankton biomass in a large floodplain of the Sacramento River, CA, USA. *Hydrobiologia* 513:129-139.

Sommer, T., R. Baxter, and B. Herbold. 1997. Resilience of splittail in the Sacramento-San Joaquin estuary. *Trans. Am. Fish. Soc.* 126:961-976.

Sommer, T., B. Harrell, M. Nobriga, R. Brown, P. Moyle, W. Kimmerer, and L. Schemel. 2001. California's Yolo Bypass: evidence that flood control can be compatible with fisheries, wetlands, wildlife, and agriculture.

The Bay Institute. 1998. *From the Sierra to the Sea: The Ecological History of the San Francisco Bay-Delta Watershed*, San Francisco.

Williams, P. B., E. Andrews, J. J. Opperman, S. Bozkurt, and P. B. Moyle. 2009. Quantifying activated floodplains on a