Keep the Valley Flowing: An Analysis of the Poopenaut Valley Flow Regime and its Effects on Wildlife

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Alterations of hydrologic processes due to dams and water diversion can have adverse effects on the natural processes upon which riparian ecosystems depend on (Rosenberg 2000). Poopenaut Valley, located 5.5 km below Hetch Hetchy Reservoir, is considered to be one of the locations along the Tuolumne River that is most sensitive to habitat disruption due to altered flows (Stock 2015). Wildlife biologists have recognized the valley's ecological value because it is one of the most biologically diverse and productive areas in this region of the river. The valley is also unique because it contains a low-elevation riparian and wetland habitat that is not common in the Sierra Nevada Mountain Range. Management efforts have focused on restoring a more natural hydrologic flow regime. Managing the flow regime and allowing periodic inundation of the Poopenaut Valley in order to mimic historical hydrologic conditions, would help restore the valley ecosystem that is host to threatened species. In this paper, we first describe the need to restore habitat in the Poopenaut Valley, then discuss the specific needs of native birds, bats, turtles, trout and frogs.

Restoration of the Poopenaut Valley is a project implemented by the Upper Tuolumne River Ecosystem Program (UTREP) created by the San Francisco Public Utilities Commission (SFPUC) in collaboration with the U.S. Fish and Wildlife Service, Stanislaus National Forest, and Yosemite National Park, as well as outside consultants, and researchers (Stock 2015). This long-term program is an attempt to assess the effects of the Hetch Hetchy Project on the Upper Tuolumne River ecosystem. The Yosemite National Park Division of Resources and Management have characterized the impacts of water impoundment and diversion to help better understand the effects on vegetation and wildlife (Stock 2015). Other studies conducted have

also researched how to manage environmental water releases and suggest an ongoing controlled flooding program (Russo 2012). The restoration management plan focuses on the implementation of more natural flows but is limited by how much water can be released due to the Raker Act. Releasing more water into the Poopenaut Valley could provide good conditions for benthic macroinvertebrates, frogs, garter snakes, birds, bats, and other wildlife that depend on the riparian and wetland ecosystem during the spring and summer seasons (Stock 2015).

Tuolumne River officially became an impaired river with the completion of O'Shaughnessy Dam in 1923. Poopenaut Valley is located in the reach directly below the dam and has been described as the most impacted area due to its proximity and low gradient of 0.8% (RMC, McBain & Trush 2007). These impacts include changes to the natural hydrograph regarding magnitude, timing, duration, and frequency (SFPUC 2014). Unimpaired flows at Poopenaut Valley were historically representative of Sierran river systems with predictable base flows, storm peaks, and snowmelt recession (Figure 1). As runoff patterns were altered by the dam, flow velocity and depth generally decreased. These reduced flows have allowed for upland vegetation encroachment, such as conifers, within the floodplains and wetlands of Poopenaut Valley (SFPUC 2014). As the riparian vegetation changes with impaired flows, sediment transport and habitat availability are also impacted.

Impaired flows from O'Shaughnessy Dam are currently influenced by existing agreements between the Department of the Interior and the SFPUC from 1985 and 1987 (SFPUC 2014). These 1985/87 stipulations were established to maintain fisheries in the reach directly below the dam, including Poopenaut Valley. Current reconciliation projects were initiated by SFPUC's 2006 Water Enterprise Environmental Stewardship Policy (SFPUC 2014). This policy

calls for instream flows to match the natural hydrology regarding magnitude, timing, duration, and frequency in the interest of riparian ecosystems and native species.

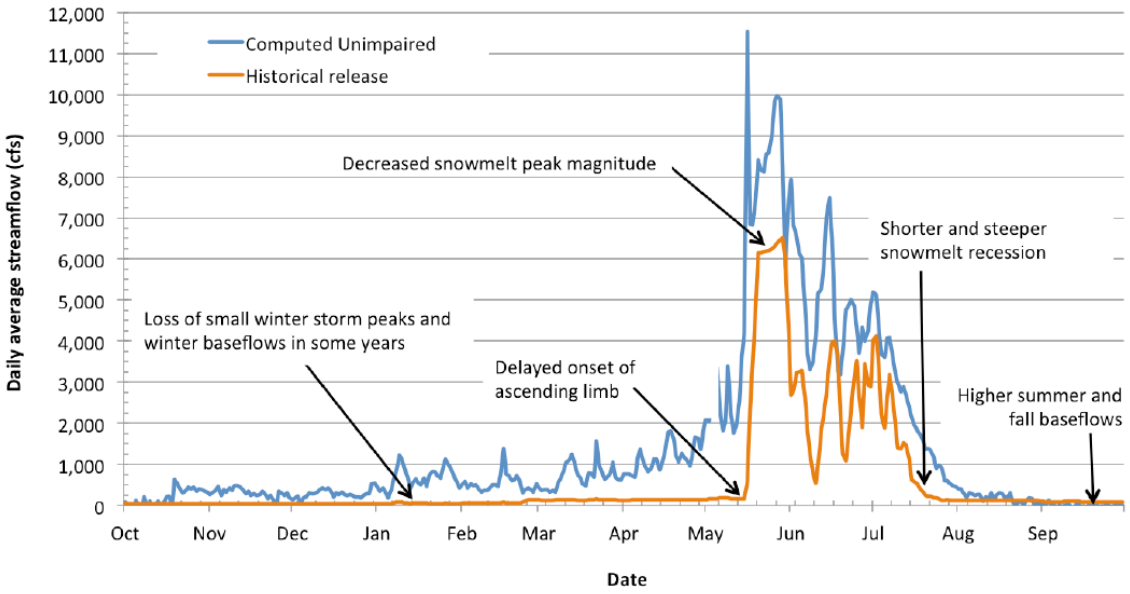

Figure 1. Computed unimpaired flows representing the historical hydrograph in a wet water year compared to historical actual releases in a wet water year as measured by USGS stream gage 11-276500 below O'Shaughnessy Dam (RMC, McBain & Trush 2007).

Many wildlife species can serve as indicators of ecosystem health. Species such as birds and bats are important to monitor because their population dynamics can be used to assess riparian habitat health, and as secondary consumers, they can also be sensitive indicators of environmental change (Stock 2015). Fish, amphibian and aquatic reptile species were also studied in an attempt to understand how altered hydrology below O'Shaughnessy Dam affected populations and to make recommendations for a flow regime that is most beneficial in the timing and amount of water released.

Bird populations were monitored from 2007 to 2014 as part of the Looking Downstream Project (LDP) by UTREP. Over 105 species were detected in the valley. The valley itself is a breeding location for many birds and a stop-over for migrant birds (Stock 2015). The project focused on species including Yellow Warblers (*Setophaga petechia*) (CA Species of Special

Concern), Song Sparrows (*Melospiza melodia*), Warbling Vireos (*Vireo gilvus*) and Black-headed Grosbeak (*Pheucticus melanocephalus*). A study by Heath and Ballard (2003) found that riparian width had a positive correlation with the occurrence of *S. petechia* and *M. melodia*. Because both species typically nest in low vegetation strata, the establishment of willow and alder shrub understory is critical to their habitat (RHJV 2004). This type of habitat occurs in systems with natural hydrologic processes and is more frequently compromised in systems with altered hydrologic regimes.

Poopenaut Valley also has a high diversity of bat species. Bat species richness as well as foraging activity can be directly linked to prey availability which can respond to fluctuations in streamflow (Stock 2015). The riparian zone of Poopenaut Valley is prime foraging habitat for many species; according to the LDP (2015), 17 bat species (out of 24 total species in California) were detected in the valley itself, and five of these species are special status species. Poopenaut Valley is important because it can serve as a refuge for many bat species that are affected by habitat destruction throughout the state (Stock 2015).

Fish, amphibian and aquatic reptilian species populations are also studied for management decisions on hydrologic regimes. For example, the native western pond turtle (*Emys marmorata*), rainbow trout *(Oncorhynchus mykiss)* and Foothill yellow-legged frog (*Rana boylii*) are species which have been used to assess why hydrologic regimes flowing through the Poopenaut Valley are worth restoring. Research shows *E. marmorata* respond to conditions in the aquatic environment depending on: (1) ephemeral stream drying cycles, (2) cold-weather conditions, and (3) avoidance of strong currents in streams (Rosenberg *et al.* 2009). The breeding season requires a moderate flow while the developing period in the summer requires ephemeral streams so they may bury themselves in soft muddy sediment and undergo aestivation or

overwinter. They mature in 8-10 years and their clutch size ranges from 2 to 11 eggs, laying every other year depending on environmental conditions (Stebbins 2003). Having a late reproductive age and low fecundity places the turtle at risk under highly fluctuating conditions. Females bury clutches near ponds and streams based on a consistent spring regression pattern not hydro-peaking flows. Any change in that regression will decrease their success, thus there must be a shift toward natural flows (Nafis 2015).

Fish within the Tuolumne River historically occurred only up to Preston Falls, below Poopenaut Valley, but both native and non-native species were introduced at high elevations for recreational purposes. The two major fish found in the Poopenaut Valley are the rainbow trout (*Oncorhynchus mykiss*) and the brown trout (*Salmo trutta*), the latter is not native to California and may compete with the native *O. mykiss* for food, cover and space. To favor *O. mykiss*, their spawning and developing needs must be considered within the system and the hydrology downstream of Hetch Hetchy. As a spring-spawning fish, they require spring snowmelt recession; however, since they are adapted to CA wet and dry year cycles, the droughts allow them to also adjust to regulated streams which mimic drought conditions (Moyle 2004). The difference between natural drought and regulated flow is that the latter is either prolonged or disrupted for recreational flows. Currently, the managed flows have a late snowmelt recession that is determined by minimum flow requirements (LDP Report 2014). This benefits the non-native *S. trutta,* a fall-spawning species. To best maintain the presence of native species, the snowmelt recession limb must be timed to a natural spring recession period.

Restoration of Poopenaut Valley hydrology also would secure the proposed reintroduction of *Rana boylii* in the valley. *R. boylii* benefits from winter flows that have a predictable snowmelt recession period indicating when to lay eggs. Shallow and low velocity

flows, on rocky sediment allow breeding to occur mid-June in unimpaired flows (Fig.1; Kupferberg 1996; Lind 2005; Yarnell 2005; Yarnell *et al*. 2010; Bondi *et al.* 2013). Tadpoles then develop in the low flow summer streams and metamorphose to adults in early fall (Bondi *et al.* 2013). In Poopenaut Valley floods fill ponds, form ephemeral structures, and healthy riparian areas which provide habitat for developing frogs (Bondi *et al.* 2013). Poopenaut Valley is one of few meadow complexes that contain a combination of ephemeral streams and off-channel ponds which provide habitat for *R. boylii* to potentially repopulate. The habitat is suitable for the reintroduction of frogs but requires strategic flow regime management in order to reduce impacts of O'Shaughnessy Dam.

Currently, the SFPUC is beginning to address concerns of environmentalists, conservationists and the public undergoing the UTREP (Sears 2015). To improve hydrologic restoration and compliance under the ESA, SFPUC has begun negotiations to implement policies to adjust flows to a more natural flow regime. Ideal management strategies are deducted by analyzing the ecology of native organisms present in Tuolumne River and matching their critical life stages as best possible with the flow regime of the river (Figure 3). Each native organism within the Tuolumne watershed is adapted to cyclical wet and dry years capable to withstand droughts and floods, thus low flows can occur during summer, after the end of the spring recession (Yarnell et al. 2012). Therefore, based on research, a managed flow regime which mimics a historical, unimpaired hydrograph is recommended to the SFPUC in order to maintain and increase the success of the Poopenaut Valley. In addition, we recommend that there be an immediate implementation to the policies, as there are meadows drying and shrinking due to the combination of the current flow regime and drought.

Figure 3. Adapted from the USGS modeling module of the Upper Consumnes River, O'Shaughnessy 2014 and SFPUC, 2014.

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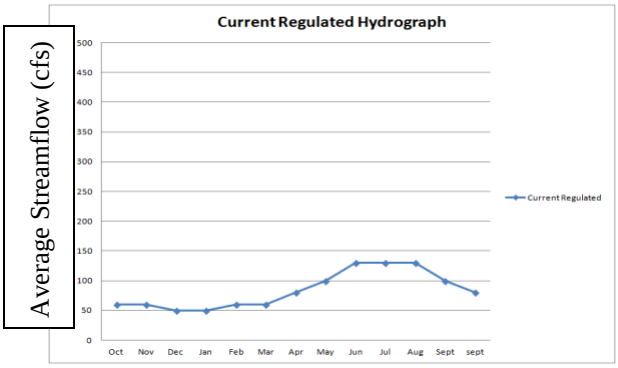

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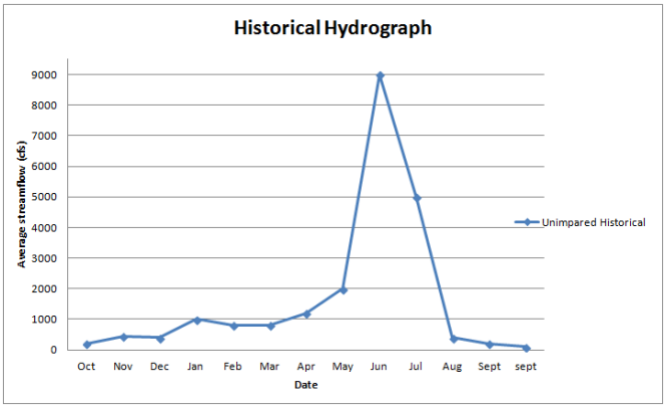

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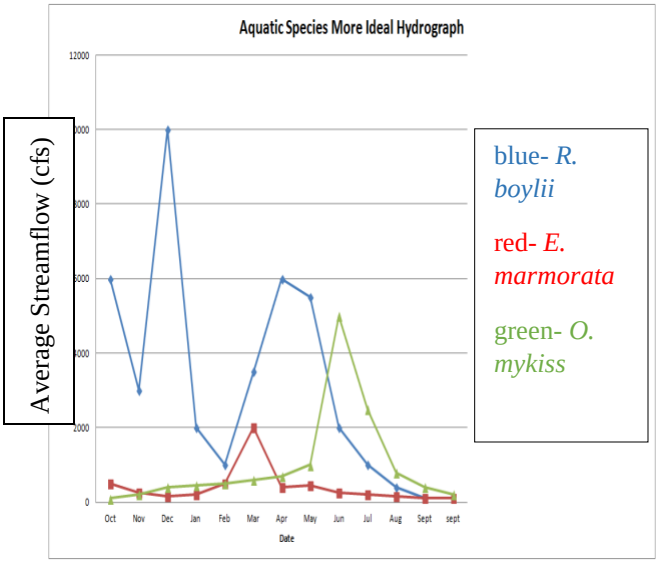

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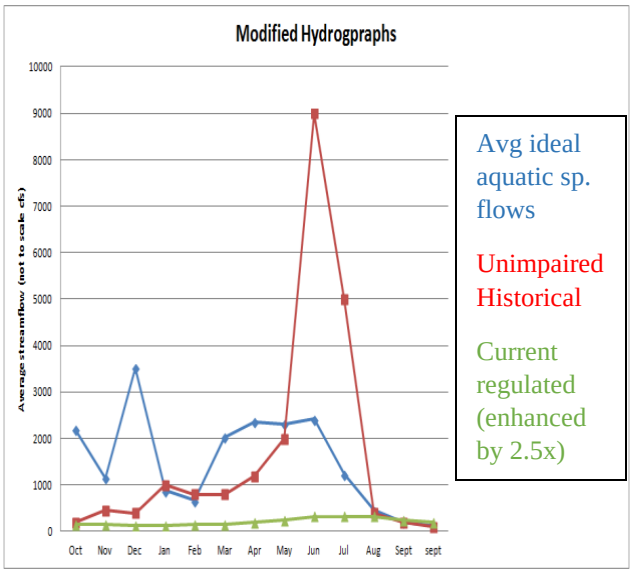

As can be seen the difference in the recession is shifted to the right in the graph (a) leading to a later and warmed flow. Graph (b) represents a more historical flow with high snow peaks and a recession closer to the end of spring rather than fall. Some rain peaks are not visible due to the points used. Graph (c) is the composition of the several aquatic species that depend on a more historical graph and we can see the slight overlap in the months of April, May and June. (d) To really highlight the need to shift regulated flows back to a more historical (red) we modified the graphs to represent an average of the aquatic species flows (blue) and the regulated graph (green) which is at very low flows thus needed to be enhanced to show the late recession.

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