Floodplain Reconnection on Butano Creek - Design, Implementation and Results from the First Season

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Abstract

Butano Creek, the largest tributary to Pescadero Creek, drains 23 sq. mi. (60 sq. km.) of the Santa Cruz Mountains, San Mateo County, California, U.S.A. Located in the lower portion of the watershed is the rural agricultural community of Pescadero, and the Pescadero Creek Estuary, which provides habitat for a number of threatened and ESA listed animal species including California red-legged frog (Rana draytonii), San Francisco garter snake (Thamnophis sirtalis tetrataenia), tidewater goby (Eucyclogobius newberryi), coho salmon (Oncorhynchus kisutch), and steelhead (Oncorhynchus mykiss).

Analysis completed by the San Francisco Bay Regional Water Quality Control Board has documented that land management activities (primarily logging, tilling and road building) and channel management practices (primarily channel straightening, riparian vegetation clearance and large wood removal) in the last two centuries have doubled sediment inputs and disconnected channels from their floodplains through incision, virtually eliminating floodplain sediment storage (SFBRWQCB In prep.). This increased sediment load has led to the system being listed at impaired for sediment under the Clean Water Act. Incision and floodplain disconnection not only eliminated sediment storage in the valley but also transformed floodplain storage areas into sources substantially contributing to elevated sediment loads. The delivery of this additional sediment load to the lower watershed has resulted in substantial channel aggradation in the very low gradient, downstream reaches of Butano Creek, which has resulted in chronic flooding of adjacent agricultural areas as well as Pescadero Creek Road, which provides the primary access and egress to the rural community of Pescadero. This channel aggradation has both restricted access/passage to the Butano Creek watershed by salmonids, and has also been linked to poor water quality in the Pescadero Creek Estuary, which has suffered nearly annual mortality events for aquatic species (also called fish kills) present in the estuary for over two decades. Poor water quality conditions in the Estuary are a result anoxia resulting from sheet flow across the marsh plain, subsequent flow through decomposing vegetation, as well as artificially created depressions that don't mix. When the sand bar that forms the bar-built estuary breaches (naturally or unnaturally) poor quality water in the adjacent marsh plain is drawn into the lagoon. The lack of a defined channel both results in sheet flow across the marsh plain as well as a lack of an egress pathway for fish trying to escape poor water quality conditions

Removal of large wood, channel incision, and floodplain disconnection are the main drivers of a significant reduction in the complexity and function of aquatic habitats that are home to a number of sensitive and ESA-listed species. Channel change and sediment budget analyses revealed that, historically, the lowland valley functioned as a wet meadow and included an extensive well-connected floodplain that provided a diverse array of habitats. This extensive floodplain also provided sediment storage upstream of the Pescadero Creek Estuary, which is a key nursery habitat for juvenile, anadromous fish.

A feasibility study for restoration of Butano Creek, commissioned by the San Mateo Resource Conservation District, was completed in 2014. While operating within the constraints present, the study identified a number of possible solutions to the elevated sediment load and the plethora of impacts that it drives (e.g., chronic road flooding, reduced fish passage, simplification of aquatic habitats, poor water quality in the estuary resulting in fish kills, etc.). This effort, led by cbec inc. eco engineering, identified several potential actions including:

- implementation of upland sediment control activities to reduce the amount of sediment delivered to the project area;
- reconnection or restoration of floodplains to absorb sediment and flood water energy, thereby reducing transport of sediment to downstream reaches;
- creation of additional flow capacity at Pescadero Creek Road, through construction of a new bridge/causeway, and/or channel dredging; and
- restoration or creation of a stable and open channel to provide habitat connectivity for salmonids and other aquatic species from Butano Creek upstream of the road downstream into the lagoon.

The focus of this presentation is on the first project implemented to reconnect and restore floodplains along Butano Creek.

A project implemented in the summer and fall of 2016enhances channel habitat and reconnects the floodplain along a roughly one-mile (1.6 km) reach of Butano Creek and restores approximately 100 acres (~40.5 hectares), or approximately 10%, of the historical floodplain of Butano Creek. The project was led by the San Mateo Resource Conservation District, funded by the California Department of Water Resources Urban Stream Restoration Program, and located on land owned and managed by the Peninsula Open Space Trust.

The design of the project was informed by the results of a detailed topographic survey of the reach, and the development of a two-dimensional hydrodynamic model (SRH-2D). The local (reach-scale) intent of the project was to provide physical features that would roughen the channel, force channel aggradation, limit channel capacity, and therefore increase floodplain inundation and sediment deposition. The pre-project channel capacity ranged from the magnitude of a 5-10-yr recurrence interval event, while the design resulted in floodplain inundation in flows at approximately a 1.5-yr recurrence interval event. Reducing the channel capacity further was not possible without generating flood impacts to nearby insured structures.

Project elements include a roughened channel/rock ramp grade control structure, two constructed engineered log jams, two jams constructed by induced recruitment of live bankside alders into the channel, and bankside berm breaches. Each of these features is described in greater detail below.

The roughened channel/rock ramp raised the channel thalweg by approximately 5 feet, providing grade control to limit future incision, and also limiting the channel conveyance capacity. This rock ramp has a slope of ~4.25% and includes seven structural rock ribs (built of 1-2 ton quarry rock) with 1 foot (0.3 m) elevation drop between each, with the remainder of the structure comprised of an engineered streambed material mixture which was generated through onsite blending of quarry products and locally soured streambed material. The engineered streambed material was engineered to resist movement up to a 25-yr return interval flow event, making it a stable feature through typical flows.

The two porous engineered log jams are keyed into one of the channel banks and span approximately two thirds of the channel. They are constructed from five Coast redwood and Douglas fir logs ranging from 24-36 inches (0.6-0.9 m) in diameter, two of which with rootwads attached. The logs are pinned together, as well as ballasted with two 4-ton rocks to provide stability.

Two additional log jams were constructed through the recruitment of seven to nine alder trees rooted near the top of the creek channel banks. The perimeter of each root wad was excavated and then the stems were toppled across the channel forming a simple jam, intended to catalyze the recruitment of additional stream wood. Efforts were made to keep many roots intact such that the alder trees would continue to live and therefore not degrade/decompose as rapidly.

A berm that appears at least partially unnatural is present along the left bank, presumably resulting from previous channel relocation efforts. This berm further limits floodplain connectivity. The result of this berm is that a higher flow rate is required to achieve the initiation of floodplain inundation. Bankside berm breaches (also referred to as connector channels), which emulate natural crevasses, were implemented in two locations (upstream of the rock ramp and upstream of one of the engineered log jams) connecting the main channel to the adjacent floodplain. These connector channels allow for floodplain connectivity at lower discharges/stages.

Analysis of the monitoring results of the first few flow seasons is underway and include: channel bed and floodplain morphology (via ground-based LiDAR), channel habitat type, groundwater level changes and floodplain inundation/off channel habitat increase. Topographic monitoring of the channel bed has documented both scour and deposition resulting from the project. The volume of in-channel, pool habitat increased by a factor of 20, although a net depositional trend was documented. Regrettably the survey effort was unable to cover much of the floodplain due to thick riparian vegetation. Consequently, although floodplain deposition was observed in these areas sedimentation rates could not be quantified. Shallow groundwater elevations adjacent to the project reach increased by over 4 feet, bringing it in much closer proximity to the floodplain surface. Additional results will be discussed during the presentation.

References

SFBRWQCB (San Francisco Bay Regional Water Quality Control Board). In preparation. Pescadero-Butano Watershed Sediment TMDL and Habitat Enhancement Plan. Staff Report.