E N T R I X

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**MEMORANDUM**

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**To:** Wendy Katagi
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**From:** Camm C. Swift

**Date:** August 2, 2008

**Re:** Restoration of Brookside Park/Arroyo Seco aquatic habitat areas with particular reference to arroyo chub and possibly other native fishes.

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The historic Arroyo Seco in Pasadena, tributary to the Los Angeles River, provides several opportunities for restoration of natural habitat that has been greatly modified from its historical conditions in the mid-1800s. Some of these concern the aquatic stream habitat that still remains in some sections of the Arroyo that have not been lined with concrete. CDM was retained by the Arroyo Seco Foundation and the City of Pasadena to design restoration features for two sections of relatively natural stream for native fishes and other aquatic organisms, with special reference to the native minnow arroyo chub, *Gila orcutti* (Family Cyprinidae). In this account Camm Swift, ENTRIX, Inc. provides input to these design features relative to this fish and other native aquatic organisms.

## Methods

CDM supplied Swift with a review copy of the Brookside Park BMP Program: 15% Design Drawings and Conceptual Plan prepared earlier. In addition a field examination of the two sites took place on the morning and mid-day of October 29th with CDM personnel Wendy Katagi, Theodore (Ted) Johnson, Fred Glick, Ted Perry, and Jennifer Jones, Arroyo Seco Foundation members Andy Byrne and Timothy Brick, and Angel Escovito from CalTrans. In addition information on the biology and distribution of the arroyo chub and other native fish was gleaned from over 30 years personal experience and well-known recent references (Richards and Soltz 1986; Tres 1992; Swift et al. 1993; Moyle 2002; Feeney and Swift 2008).

Arroyo chub and other native aquatic organisms

The arroyo chub, a California Species of Special Concern (CSSC), is endemic and thus restricted to the streams of the Los Angeles Basin and other nearby coastal streams from the San Luis Rey drainage to the south to the Malibu Creek system to the north. It was widely introduced as bait and by inadvertent inclusion with hatchery trout over a much wider area of southern California streams and lakes from the 1930s. Within its native range it is much reduced while faring better in some extralimital drainages.

Arroyo chubs live to 3-4 years and attain about 6 inches in total length with the females typically reaching larger size than the males. They mostly live in low gradient streams in the local lowlands and become scarce as the gradient increases upstream in the local mountains where the Santa Ana speckled dace, *Rhinichthys osculus ssp.* (CSSC), Santa Ana sucker, *Catostomus santaanae* (Federally threatened, CSSC), and rainbow trout, *Oncorhynchus mykiss*, become more prevalent. Unlike the dace and sucker, arroyo chubs can inhabit and maintain themselves in standing backwaters and even in lakes under original conditions locally when large predatory fish were absent except for rainbow trout or steelhead.

Arroyo chubs spawn from March or April until November with most reproduction taking place from April to July. Very small individuals have been taken almost throughout the year, particularly in dry years when habitats are not disrupted by winter high flows and waters stay warm enough. They begin spawning at about 15° C. and pairs or small groups of adults deposit and fertilize the eggs while attaching them to trailing vegetation or other hard substrate in the stream. This is typically in the slower parts of runs and pools rather than riffles where speckled dace spawn. Arroyo chubs probably can accomplish this in lakes also given their rapid build up in reservoirs in the past but it has not been observed. The eggs hatch out in 4-6 days and the smallest free-swimming larvae are found near the surface in very shallow water along stream margins. As they grow in size deeper water is invaded and they forage throughout the water column. The largest individuals will be found in the deepest water available that provides cover and this is often the faster runs at the lower end of riffles in streams. They are omnivorous and feed on a wide variety of plant and animal material (Richards and Soltz 1986).

Santa Ana sucker and Santa Ana speckled dace are exclusively stream fish and do not significantly inhabit standing waters such as lakes and reservoirs. Together with the arroyo chub, these three fish species have been recognized as the South Coast Minnow Sucker community now restricted to Big Tujunga Wash above Hansen Dam (Los Angeles River drainage) and the upper San Gabriel River above the dams in San Gabriel Canyon. This community once occurred in Arroyo Seco with the four other native freshwater fishes, namely steelhead or rainbow trout (Federally endangered), Pacific lamprey, *Lampetra tridentata*, Pacific brook lamprey, *Lampetra pacifica ssp.*, and unarmored threespine stickleback, *Gasterosteus aculeatus williamsoni* (Federally endangered, California fully protected species). The rainbow trout actually still occur in Arroyo Seco above the Jet Propulsion Laboratory but may not be genetically pure since

hatchery trout have been placed there for years also. The two lamprey species have been extirpated in the Los Angeles Basin for a long time. In addition to fishes, other aquatic species originally occurring in the Arroyo Seco and that could return or be re-intoduced are freshwater shrimp, *Syncaris pasadenae* (see Martin and Wicksten 2004), California redlegged frog, *Rana aurora draytoni* (Federally threatened), arroyo southwestern toad, *Bufo microscaphus californicus* (Federally endangered), and California red-sided or south coast gartersnake, *Thamnophis sirtalis infernalis* (CSSC). Two other California species of Special Concern, two striped garter snake, *Thamnophis hammondi*, and southwestern pond turtle, *Clemmys marmorata pallida*, may still occur in Arroyo Seco. In any case habitat restoration in the Arroyo Seco could ultimately lead to increases or re-establishment of some or all of these aquatic/riparian species. Big Tujunga Wash is the only place in the Los Angeles River drainage with surviving stocks of arroyo chubs and fish should be taken from there if the species is to be re-established in Arroyo Seco. This would apply to suckers and dace as will if they become important to place in Arroyo Seco.

Field Observations

The examination of the North (NRA) and South (SRA) Restoration areas on October 29 showed them to contain fairly good stream habitat for native fishes. Arroyo chub occur in similar streams elsewhere but with longer continuous stretches of native habitat. The Restoration areas occur as isolated segments of a much longer canyon limited by concrete lining for miles downstream and the impassable Devil's Gate Dam upstream. The two approximately 1500 foot restoration areas are separated by a mile or so of concrete-lined channel. The lower end of each restoration area has an impassable drop structure such that fish that go over or are washed over during high flows cannot return to the habitat and may perish in the concrete lined stretches. This drop structure in the NRA was a steep concrete slope with water flowing over in a thin sheet; at the lower end of the SRA the water largely flowed into a grated diversion sump and little went over the concrete slope. Presumably more goes over the slope during high flows. During high flows fish washed from the NRA might recover to establish downstream in the SRA.

The NRA stream is rocky with small riffle and plunge pool habitat at its upper end, run and riffle areas in the middle, and a long run leading into a shallow ponded stretch above the drop structure. This last downstream area had mostly a sandy and silty substrate. Few areas were more than a foot deep and mostly less than half a foot. Flow was about one cubic foot per second below the junction of a tributary consisting outflow from a diversion pipe along the eastern slope just above the I-210 Freeway. This channel was about 150 feet long, provided half or more of the flow, and provided additional stream habitat. The water in this outlet was 17.5° C. about 10:45 AM and the main channel was 16° C. About 30% of the stream had boulder, rocks, or marginal vegetation providing some cover for fishes. No fish or crayfish were observed at this location. About 50% of the stream had a canopy of willows or other vegetation.

The South Restoration Area

The SRA is lower gradient and flatter since its upper end is a sediment fan from the lower end of the concrete lined channel. The water in the narrow, deep central trough in the concrete-lined channel was two to three feet deep during our visit and led into a pool of about the same depth. The stream continues of mostly flat shallow runs with another deeper area along a vertical concrete and rock wall along the east side under the Colorado Street Bridge. Although deep little actual cover for fishes was observed. About 80% of the stream had a canopy of trees or other vegetation.

Analysis of 15% Design Plans

The plans consist of two aspects deserving comment; 1) temporary diversions to accommodate construction of the restoration features, and 2) the long term improvements to the habitat for aquatic species, particularly arroyo chub.

The plans for diversion of water and construction footprint appear adequate and presumably will not impact any native fish since none are known in the area currently.

The restoration features fall into five main categories; 1) Backwater and sediment basins, 2) Cross channel W-weirs, 3) cross channel vortex weirs, 4) wing deflectors, and 5) snags. Backwaters and sediment basins will create much more habitat for arroyo chubs since they can utilize such habitats. The weirs and wing deflectors will increase flow speed and riffle creation which will increase oxygenation and potentially deepen local areas due to increased scour. The interstices of the large boulder will also provide cover for fishes. Wing deflectors will also cause deepening and provide cover in a similar manner. The snags will mostly provide cover for larger fish and to a lesser extent provide a deepening effect from scour. Scour also exposes coarser material like gravel the Conceptual Plan considers important for spawning in arroyo chub. It is important for dace and suckers but, as noted above, studies have shown arroyo chubs spawn primarily on trailing vegetation, logs, and other objects in the water column rather than on benthic gravel. Thus the depth created and cover from these structures are important for arroyo chubs but the gravel exposed here and in riffles created will typically not be used for chub spawning. Gravel is important for spawning of the other native fishes originally present such as speckled dace, Santa Ana sucker, and rainbow trout.

Backwaters pools will be advantageous to arroyo chubs by providing expanded habitat for them as well as areas they can retreat to during high flows. Trout and stickleback are the only other two potential native fishes that would make use of them; sucker and dace are restricted to flowing waters. The larvae and small juveniles of these latter two species could make limited use of backwater pools. A downside of the backwaters pools is that they are favorable habitat for a variety of non-native species that can adversely affect the natives, including some local exotics that may be in the system already such as green sunfish, *Lepomis cyanellus*, bullhead catfishes, *Ameiurus species*, largemouth bass, *Micropterus salmoides*, red swamp crayfish, *Procambarus clarki*, and bullfrog, *Rana*

*catesbiana*. Backwater pools may encourage these species and thus some plan for keeping them out or managing them if present is desirable. Otherwise the restoration features could have a negative effect on native species by facilitating increase and spread of these exotics.

An issue not directly addressed by the Conceptual Plan is the predicted water depths associated with these restoration features. For small fishes like arroyo chub absolute depth can serve as cover if more than about a foot deep. As depths become less cover of some kind in the water becomes more important. Many smaller streams in southern California have broad bands of marginal water cress and Veronica that provides cover in shallower streams. After winter scouring removes much of it, deep pools and other more resistant structural cover become much more important. It appears that the deep canyon and extensive trees may prevent such extensive vegetation development in the Arroyo Seco. If so relatively more cover in the form of boulders, logs, etc may be desirable. Only the upper one third or so of the NRA and its artificial tributary appeared to have substantial marginal vegetation as cover. Several areas in the stream were observed to be up to about 1.5 feet deep but these were few and one was associated with the downstream end of the concrete lined channel at the upper end of the SRA. Presumably the cleaning out of the debris basin will create a depth of several feet at least and provide a large body of water for chubs. The other backwaters may not be very deep as alternate flow channels during high water. To be effective as native fish habitat they should have considerable area a foot or more in depth. If they are primarily for protection during high flows, their depth will increase during these high flows and the usual turbidity at such times will also provide cover until the storm flows pass and fish can return to the main stem. If they are largely shallower than about one foot they will serve mostly for use by larvae and juveniles in spring and summer and as these fish get larger they will move to deeper flowing water or possibly upstream to the debris basin in the SRA at least. Depth is also important for two other vertebrates, the redlegged frog and southwestern pond turtle that need pools more than about three feet deep for cover and to escape from predators.

Another issue not directly addressed is flow velocity associated with the weir structures. They appear relatively gentle in slope but the large boulders on the downstream side may increase local flow velocities through narrow gaps or create falls not passable by small fish. A “rule of thumb” for small stream fish (about 2-6 inches) is that some portion of the water near the bottom and/or edges of the stream should remain at a velocity of one foot per second or less for upstream passage. Typically an abundance of gravel and cobble (bottom roughness) provides such flow speed near the bottom and margins of natural stream unless they are very steep (much steeper than Arroyo Seco). Arroyo chub adults can probably jump small barriers under the same conditions that prevail for trout of similar size. Of course larger drops would be a barrier to movement. It is particularly important that no barriers exist in such a short section of stream so fish can get to the various habitats needed at different times of the year. The smallest free swimming larvae need quite shallow margins, small juveniles need slow flows with abundant cover or water more than a foot deep, and half grown to adult fish will be restricted to the deepest pools and

fastest runs with cover. The larvae tend to disperse downstream and as they grow juveniles try to return upstream. Thus any barrier will further restrict each habitat already designed to be only about 1500 feet long.

Some fish from the NRA could drift all the way to the SRA particularly during winter high flows. An additional beneficial function of an expanded debris basin at the upstream end of the SRA would be to provide a catchment for such fish. Thus these fish might survive rather than be flushed through. Flow speeds in the concrete-lined are probably too high for fish to return up to the NRA from the SRA since the smoothness of the concrete probably does not provide for slow enough velocities to allow passage over such a long distance.

Temperature effects may be substantial during the warm months. The NRA is largely groundwater fed or comes from the pipeline from the east. This combination probably keeps the temperature down and also provides a refuge area for fish during high storm flows at least as long as they do not rise to the level of the mouth of the pipe outlet. The main flow and the tributary were both cool during our visit and are probably cool throughout the year (low 20's Centigrade or less). The SRA receives most if not all its water from the concrete-lined channel flowing from the NRA to the SRA. This water could be considerably warmed during this transit in warm, sunny weather. Thus the SRA may get into the mid or high 20s Centigrade in summer. Both temperature regimes are sufficient for growth and reproduction in arroyo chubs and most of the other native fish presuming these are maximums and lower temperatures would occur in winter. The rainbow trout is the only fish that requires low 20s or less all year and thus probably cannot be maintained in the SRA under current conditions, at least in the warm months.

In summary the Conceptual Plan offers several useful additions for native fish, including arroyo chubs. They will reduce the amount of shallow water and soft substrate and increase flow, depth, and percentage of riffle environment, the latter particularly in the lower one third or so of the NRA and in much of the SRA. As noted these will also provide benefits for other possible native aquatic vertebrates that might be returned to the area. Currently the rainbow trout is the only native fish known to occur within a mile or two upstream and might be washed down into the system. All the other native species would have to be brought in from Big Tujunga Wash. At least a few non-native species occur or have been recorded from the system including mosquitofish, green sunfish, black bullhead, and possibly crayfish and bullfrog. The restoration efforts can be beneficial in some ways to them as well and needs to take them into account in management of the area.

References

Feeney, R. and C. C. Swift. 2008. Description and ecology of larvae and juveniles of three native cypriniforms of coastal southern California. Ichthyological Journal, 55(1) (IN PRESS)

Martin, J. W. and M. K. Wicksten. 2004. Review and redescription of the freshwater shrimp genus *Syncaris* Holmes, 1900, in California. Journal of Crustacean Biology, 24(3):447-462.

Moyle, P. B. 2002. Inland fishes of California. Revised and expanded. University of California Press, Berkeley, CA xv + 502 pp.

Richards, C. and D. L. Soltz. 1986. Feeding of rainbow trout (*Salmo gairdnerii*) and arroyo chub (*Gila orcutti*) in a California mountain stream. Southwestern Naturalist, 31:250-253.

Swift, C. C., T. R. Haglund, M. Ruiz, and R. Fisher. 1993. Status and distribution of the freshwater fishes of southern California. Bulletin of the Southern California Academy of Sciences, 92(3):101-167.

Tres, J. 1992. Breeding biology of the arroyo chub, *Gila orcutti* (Pisces: Cyprinidae). MS Thesis, California State University, Pomona, CA 73 pp.