Preliminary Investigation C:
HABITAT RESTORATION ASSESSMENT

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Introduction

This report primarily documents impressions accrued through field exposure to focal areas within the Arroyo Seco watershed, primarily those areas upstream, or north of the Jet Propulsion Laboratory (JPL). The greatest detail provided is for areas traversed on foot, which in turn, are among the most biologically complex habitats in the watershed. It is essentially written from a generalist perspective, although limited detail on plant and animal species is included. Additional detail concerning focal wildlife species and stream ecology will be forthcoming.

Field Reconnaissance Summary

Verna Jigour (project botanist, conservation/restoration ecologist) and Matt Stoecker (project stream ecologist) conducted field visits to upper and lower Arroyo Seco watershed areas on October 24-25, and November 29-30, 2000. On Oct. 24th, following a driving tour overview of the watershed, Jigour and Stoecker descended the upper watershed, accompanied by Dan Cooper (project vertebrate biologist), Lynne Dwyer, Lynnette Kampe and Ellen Mackey for part of the descent from Switzer's – to approximately the divide of the Long Canyon tributary watershed. Jigour and Stoecker included reconnaissance of the Brown Canyon Debris Dam, emerging at Hahamongna well after nightfall. The Oct. 25th trip comprised a team orientation to the Arroyo from Hahamongna downstream to the confluence with Los Angeles River, stopping at numerous points of interest. Lynne Dwyer led the orientation, while Tim Brick and Dan Cooper provided additional illumination in the Hahamongna area.

Jigour and Stoecker again descended from Switzer's on Nov. 29, getting an early enough start to investigate the lower portion of the Bear Canyon tributary. Matt then braved the sinuously incised Arroyo Seco gorge while Verna circuited back up to the high route to avoid attempting deep water crossings with widths exceeding her height. Interestingly, Stoecker and Jigour met up within moments of one another at the waterfall junction of Long Canyon with the Arroyo mainstem, downstream of the gorge. Further elaboration on those experiences is provided in following sections. Jigour and Stoecker terminated the Nov. 29 walk at Gould Mesa campground (and Arroyo Seco Gaging Station) where they had left a car. The next morning they walked the Arroyo upstream from the vicinity of the Pasadena water headworks, near the junction with the Millard Canyon trail, to Gould Mesa, and then descended to the Hahamongna basin in order to inspect this portion of the Arroyo during daylight hours. They then joined Lynne Dwyer and a City of Pasadena staff member back upstream for a tour and orientation to the Pasadena water headworks facilities.

All field days were blessed with dry weather and the previous rainy season had been relatively dry. While a tropical storm hit the entire Transverse Range system (along with much of the state) the night after our Oct. 25 trip, its effect on Arroyo flows was apparently negligible, according to USGS Arroyo Seco Gaging Station records. [URL: http://s601dcascr.wr.usgs.gov/rt-cgi/gen_stn_pg?station=11098000]

Our tour guide commented that the late October rains had just soaked into the dry ground of the upper watershed, and that he saw little increase in flows entering the City's facilities related to that storm. Thus, the stream morphological features observed during these mid-to late autumn excursions can be associated with base flow conditions – clearly supported by artesian sources.

Stream/Aquatic Ecology Overview

In addition to making subjective evaluations, Matt Stoecker, our project stream ecologist, took water temperature and other measurements and made various other notes on fish-related issues during the field trips. He will report these data as appropriate as part of Task 2.2.3 Habitat Restoration and Feasibility Study. Summarized here are some of Matt's initial impressions as conveyed to and interpreted by Verna Jigour in the field and thereafter. Stoecker has reviewed and contributed significant information to this report.

Focal target species for project restoration goals remain to be determined. For the field investigations Stoecker and Jigour used the anadromous[1] southern steelhead (*Oncorhynchus mykiss* ssp. *irideus*) as a working standard for evaluating habitat suitability and connectivity needs, since the species was historically present in the watershed, and its potential habitats and migration corridor extend from the confluence with the Los Angeles River upstream to near the highest reaches of the watershed. Furthermore, the apparent persistence of a rainbow trout population in the Arroyo Seco watershed suggests that, while connectivity may currently be limited, some of the necessary habitat features remain within the watershed (Titus et al. 1999). While records of fish stocking exist, the presence of small trout fry and parr suggest that this population has adequate habitat to support 'natural' reproduction. The historic presence in the watershed of Pacific lamprey (*Lampetra tridentata*), another wide-ranging anadromous species but with a parasitic life history, remains to be determined. However, the Pacific lamprey's habitat needs are likely encompassed by those of steelhead, which can serve as an "umbrella" species for conservation planning. Furthermore, the anadromous life history provides the only natural conduit for returning oceanic nutrients to the Arroyo Seco watershed – as the fish give up their ocean-fed carcasses to the terrestrial food web.

As agreed at the December 7, 2000 team meeting, another potential target fish species will be identified to represent aquatic habitat conditions more readily attainable in the lower watershed than those needed to support anadromous species. Such a low elevation target species remains to be determined, but the Arroyo chub (*Gila orcutti*) is a likely candidate. No site-specific evaluations of potential Arroyo chub habitat conditions have been completed to date.

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1 Anadromous fish species "hatch in fresh water and spend some portion of their life cycle there, migrate downstream to the ocean, mature in salt water, and return to fresh water to spawn". (NMFS 1997a citing WDF et al. 1992)

While stream morphology upstream of Switzer's Falls may support isolated native (or stocked) trout spawning and rearing habitat, the great depth of the falls have presumably precluded steelhead migration beyond the lowest of the Switzer series of falls. Stoecker and Jigour estimated the drop of the lowermost falls as approximately 20 feet from the top of the falls to the pool surface below. This estimate was corroborated by the account of kayakers who navigated the drop. [URL: http://www.sierraphotography.com/creeking/arroyoseco02.htm]

From that point downstream to the City of Pasadena water diversions, the Arroyo Seco supports ideal pool and riffle sequences for resident trout or potential steelhead habitat, with the exception of the vicinity of Brown Canyon Debris Dam, discussed in the following paragraph and subsequent sections. For most of that length, the interwoven roots of white alder (*Alnus rhombifolia*) stabilize the stream banks and fix nitrogen that supports stream and terrestrial ecology. Farther up the banks canyon live oak (*Quercus chrysolepis*) and bigleaf maples (*Acer macrophyllum*) further shade and cool the stream below. However, as noted in a following section, the apparent paucity of native understory species suggests that stream bank character may afford somewhat less diversity of aquatic, as well as terrestrial, niche structure than it did in the historic past. Nevertheless, the granitic gravels appeared to be of suitable size for spawning, and relatively "clean", or free of sedimentation, i.e., low embeddedness, with adequate interstitial space for egg incubation. Indeed, Stoecker and Jigour observed trout ranging from ~3 to 11 inches in residual deep pools along much of the length of the upper Arroyo within the Angeles National Forest boundaries, primarily upstream of Oakwilde. Stoecker pointed out intact adipose fins on most of these – a suggestion that they may be offspring from instream reproduction, as the California Department of Fish and Game now tries to ensure that the adipose fin of stocked trout be clipped. Other suggestions of resident trout populations were the young fry and parr observed in some pools – too young to have been stocked that year.

Stoecker and Jigour found it noteworthy that, despite apparently suitable pool structure and water temperatures, they observed no trout at all downstream of the USGS Gaging Station on Nov. 30, 2000. However, our City of Pasadena water facility guide attests to the large number of trout that terminate their downstream migration in the water facility debris ponds in the spring. This downstream spring migration is typical of anadromous steelhead behavior and may suggest that some individuals are attempting to migrate to the sea. It is also possible that some may make the migration to sea, but upstream migration to the natural streambed of the upper Arroyo Seco is not currently possible do to migration barriers. Diversion intakes are currently not adequately screened and many down stream migrating fish and other aquatic species are being killed every year.

Along the length of the Arroyo, from Switzer Falls to the City of Pasadena diversions, the most significant upstream barrier to fish passage observed was the Brown Canyon Debris Dam and the sediment deposits behind it that extend upstream to the vicinity of Oakwilde, approximately one-half to three-quarters of a mile upstream of the dam. The dam itself is a formidable barrier, rising vertically a good 90 feet or so from the water surface below. The dam is filled to capacity with sediment that has significantly altered stream geomorphology above it. As one rounds the bend descending toward Oakwilde, the closed riparian canopy of alders and maples abruptly opens onto an alluvial plain marked by scattered patches of mulefat (*Baccharis salicifolia*) and arroyo willow (*Salix lasiolepis*). As might be expected, the stream begins to braid here as it attempts to cut its way through the ever-aggrading alluvium. As one proceeds downstream, patches of alluvial scrub vegetation become noticeable, discussed further in the section on terrestrial ecology. Finally, within the last quarter-mile or so of the dam, subsurface moisture within the well-drained (aerated) alluvium supports an adventitious riparian forest of canyon live oak, perched well above the natural canyon floor, and indicative that the debris basin has been filled with sediment for decades. But far from the habitat-rich forest one might suspect, this forest is choked with a liana of exotic pest plant species, further described in the section on terrestrial ecology. The net impact of the dam and its sediment on fish connectivity is a gap of at least one-half to three-quarters of a mile where neither trout nor potential steelhead may pass.

Thus, the Brown Canyon Debris Dam is the most significant impediment to fish population expansion on the Arroyo Seco upstream of Devil's Gate Dam/ Hahamongna, the other great barrier on the Arroyo. But it is not the only one. Several sediment filled debris basin structures, one mainstem gaging station, and small diversion dams are also present and may impede or block upstream fish passage. Following are some of Matt Stoecker's notes on barriers to potential upstream adult steelhead migration. Further and more detailed assessment work of these barriers is needed to more completely understand their impacts to migration of juvenile salmonids and other fish species:

- Old concrete/boulder dam (~3' tall)just upstream of JPL road crossing (minor impediment)
- Diversion Dam in lower Millard Creek not observed but likely impassable
- CCC Dam at road crossing below filtration plant (major impediment)
- Pasadena Diversion Dam (unscreened for trout and other terrestrial/aquatic species) (likely impassable with flashboards inserted at higher flow and impassable at lower flows with diversion of water – downstream migration barrier/mortality)
- Pasadena "flow separation"? Dam structure (upstream migration impediment, downstream migration barrier/trapping fish)
- ≈18 foot tall dam at bottom of Fern Canyon (impassable)
- Gauging Station (impediment)
- Brown Canyon Debris Dam (impassable, likely downstream migration mortality)
- Approximately one mile downstream of Bear Canyon there is a waterfall around 10' tall (at low flow conditions encountered with a very large deep pool below (may be passable at ideal flows when pool depth increases and jump height decreases Rainbow trout observed upstream) (major impediment/possible upstream limit of steelhead migration depending on flows, need to observe at higher flow conditions and take detailed measurements).
- Several (4-6 foot tall) cascades upstream from Bear Canyon to the ~20' fall at base of Switzer Falls may impede passage for some adult steelhead and likely most juvenile trout. Deep jump pools are associated with these cascades (moderate to high severity impediments).

One of the primary objectives of the Nov. 29 descent of the Arroyo was to investigate Bear Canyon, reportedly the wildest part of the watershed. While it may indeed be the wildest tributary watershed, it proved disappointing with respect to potential trout or steelhead habitat. Interestingly, the structure of the Bear Canyon tributary differs markedly from that of the Arroyo mainstem. Bear Canyon is marked by large boulders that would appear to significantly impede potential fish migration upstream. The first of these barriers occurs within a few hundred feet of the junction of Bear Canyon with the Arroyo. Rainbow trout were observed in the pool below this first boulder cascade and no fish were observed upstream. Furthermore, the overall structure of the tributary appeared to offer a less rhythmic sequence of pools and riffles, with many pools being separated from one another by great distances of low, to subsurface flows. Stoecker and Jigour continued up the canyon for approximately .75 miles before mutually agreeing that their time would be better spent elsewhere. Covered by the thick blanket of autumn leaves, soil features along both the Arroyo and Bear Canyon were less than obvious, but slight differences in stream-side vegetation suggest that Bear Canyon soils may differ from those along the mainstem. In any case, the presence of base flow in the Bear Canyon tributary in late November, after limited rainfall to that point in the season, illustrates that artesian sources in that tributary contribute to the base flow in the Arroyo mainstem.

As stated in the field reconnaissance description, Matt Stoecker walked, or boulder-hopped the length of the steeply and sinuously incised Arroyo Seco gorge, which is apparently seldom traveled by humans. Stoecker did encounter a couple of rock ledges that made passage difficult for him, including one waterfall ~10' tall with a very deep pool (too deep to determine in feet) below that may block fish passage upstream at low flows. At higher flows the pool below this structure will likely raise 2 or more feet reducing jump height and the deep pool may provide adequate depth for an adult steelhead to jump the falls. Generally, aquatic habitat conditions appeared similar within the gorge to other parts of the Arroyo, with the continuous alder canopy evident to Jigour, who observed it from the trail above. Stoecker encountered one point far within the gorge where the riparian canopy gave way to a patch of alluvial scrub vegetation. Otherwise, potentially viable fish habitat extended through the gorge.

As mentioned previously, Long Canyon disgorges into the Arroyo in a waterfall at least 40 feet high, so natural fish passage upstream into Long Canyon is presumably precluded. On both Oct. 24 and Nov. 29 the falls were limited to a steady trickle, but nevertheless indicative of artesian flow. Stoecker and Jigour ventured up Dark Canyon for about a quarter-mile upstream of Oakwilde on Nov. 29. The canyon appeared to host adequate fish habitat but terrestrial vegetation has become dominated by exotic pest plants.

Stoecker and Jigour also ventured up Fern Canyon for some distance past the debris basin that completely alters the character of this tributary, at least near its junction with the Arroyo. This debris basin was approximately 18 feet high, and filled to capacity with sediment, like the others the team observed. While its character has been garishly altered by cumulative effects arising from the debris basin, remnants of the historic Fern Canyon features suggest that it may have once supported Arroyo steelhead populations and could potentially become viable in the future. Approximately one-quarter mile downstream (along the Arroyo) of Fern Canyon, another filled debris basin marks the mouth of a perhaps unnamed tributary. This tributary has been so thoroughly altered that it is difficult to speculate on its potential historic or future fish habitat.

The next feature one encounters on a downstream trek of the Arroyo is the beginning of the City of Pasadena water diversion facilities. Downstream of those facilities, Stoecker and Jigour observed no significant flow in the Arroyo until they reached the Millard Canyon drainage. On Nov. 30, 2000, those flows were enough to replenish a limited base flow in the Arroyo that extended until it disappeared into the deep alluvium in the vicinity of the JPL bridge. Stoecker and Jigour followed the trail of moist alluvium downstream to additional intake and spreading facilities in the Hahamongna basin. This discontinuity of flow caused by the diversions and exacerbated by the dammed up alluvium, combined with the elevation break of the Devil's Gate Dam itself, constitute the second great barrier to fish passage on a downstream tour of the Arroyo.

The project team investigated existing possibilities for fish passage past Devil's Gate Dam. One faint glimmer of hope lies in a tunnel midway up the dam surface, large enough for the team to walk through. This could provide minimal opportunities for fish passage with a fish ladder on the downstream side. However, in order for it to work, water levels in the reservoir would have to be at the height of the tunnel during important migration periods – a highly unlikely co-occurrence. Therefore, other alternatives should be evaluated. Jigour felt that that unusual relationship between Flint Canyon, the 210 freeway and that northern side of the dam merits further investigation for possibilities of some sort of dam bypass structure that could facilitate fish passage there. However, as mentioned above, part of the obstacle associated with Devil's Gate Dam is the impounded alluvium backed up to the JPL bridge, combined with the low-to absent flows that typically reach Hahamongna during dry periods. Unfortunately, it appears that insufficient flows to support fish migration are being allowed to reach that area during critical times of the year (such as the time of the field reconnaissance), despite the fact that the City of Pasadena allows some level of minimum flow in response to California Department of Fish and Game requirements.

Throughout the upper Arroyo, Matt Stoecker pointed out various aquatic macro-invertebrates important in the food webs of native fish populations. Mayfly and damselfly nymphs, along with caddisfly larvae were among the invertebrates observed in upper Arroyo aquatic habitats. Interestingly, along one channelized section of the lower Arroyo, below the York Boulevard Bridge, where the channel is composed of cemented cobble, Stoecker, Dwyer and Jigour found mayfly nymphs, water pennies and unidentified algal species colonizing the cobbled surfaces, despite the absence of vegetation that would shade and cool the water in the channel. The team took this as a sign of fair water quality in that stretch, likely influenced by the aerating effect of water turbulence initiated by the cobbled surfaces. It also suggests that elements of the aquatic invertebrate community are available to recolonize any available niches that might be created through habitat restoration measures. While some areas like the cobbled section seem to have reasonably good water quality, visual and olfactory clues observed suggest possibly serious water pollution problems in the Central Arroyo especially.

Time constraints prevented the team from traversing the entire channelized section of the Arroyo on foot, though several stops were made on the whirlwind tour. Substrates, physical parameters and niche opportunities are, of course, much less diverse in the channelized section, compared with the upper Arroyo. Among the saving graces of the channelized sections are features such as the cobbled surfaces referred to above, and the apparent shading of some channel sections by groves of mature sycamores, such as in the vicinity of Debs Park and possibly some other sections along the Arroyo Seco Parkway. Such canopies on the southerly side of the channel are likely most effective at cooling the waters, although where the channel has a west-oriented bank (e.g., the Sycamore Grove along the parkway) the canopies may mediate afternoon solar exposure. While the habitat restoration project on the Lower Arroyo receives its water artificially and is not currently subject to the fluvial dynamics that typically shape riparian habitats, it will no doubt enhance habitat opportunities there greatly as it matures. Furthermore, the developing vegetation could offer future opportunities for channel removal – as the tree roots mature they can hold the bank. Of course, an array of proven biotechnical slope stablization techniques is available to be used in any potential channel removal projects. Such techniques have been shown to exceed the hardscape approach in long-term durability, maintenance requirements, and cost, as well as in providing habitat opportunities.

Many aspects of the channelized section are problematic with respect to restoration of native fish populations. These structures designed to move the water swiftly as possible out to the ocean are at opposite purpose to the nature of flows needed by fish to migrate upstream. The lack of eddies, pools and other resting areas necessitate a near heroic effort on the part of a fish trying to get upstream. This basic lack of aquatic habitat structure is compounded by the lack of shade over much of the area. Presumably water temperatures in the channelized sections may sometimes exceed optimal parameters for cold water species such as steelhead. These problems are further exacerbated by tainted urban runoff flowing into the channel at numerous points, completely unmediated by any biological processes.

Having moved steadily downstream in our overview of observed aquatic ecological conditions, it is appropriate to end this discussion with a reiteration of Matt Stoecker's comment about the relationship of the Arroyo Seco confluence to the soft-bottom section of the Los Angeles River, just upstream of the confluence. Stoecker noted that, in the event of potential restoration of steelhead to the Arroyo Seco tributary, fish migrating upstream to spawn would find valuable resting habitat in the willow-shaded pools of the river. Stoecker notes that he has observed such behavior along viable salmonid streams of the Pacific Northwest, wherein the salmon and steelhead will wait up to weeks in upstream resting niches until conditions become suitable for migration up the tributary, even if it is located downstream of the resting niches. Meanwhile, a grove of cottonwoods and sycamores, planted at the confluence by North East Trees, quietly approaches readiness for the rebirth of its natural affiliations.

Terrestrial/Watershed Ecology Overview

The limitations of the current project preclude compiling more than an overview of terrestrial ecology as observed on the field reconnaissance described previously. Honoring the watershed focus of the project, as well as time/budget constraints, the bio-ecology team field visits have focused on areas relatively near the Arroyo Seco mainstem. Therefore, the following summary of field observations should be viewed within that context.

The team has made an effort to report their observations here within the context of widely accepted classification schemes. A suite of systems is currently used to describe vegetation and habitat types in California. The most generalized of these is the California Wildlife Habitat Relations (WHR) system. In more closely describing vegetation, the California Natural Diversity Database (CNDDB) employs the plant community descriptions delineated by Holland

(1986), while the California Native Plant Society (CNPS) has promoted a newer system that recognizes finer divisions of plant association series (Sawyer and Keeler-Wolf 1995). Even more specific classification of southern California coastal wetland types is available in Ferren et al. (1996). Geographic Information System (GIS) maps of land cover types using both the WHR and CNDDB systems at the relatively coarse scale of 1:100,000 are publicly available via the California Gap Analysis. [URL: http://www.biogeog.ucsb.edu/projects/gap/gap_home.html] While the scale is probably inappropriate for use in the current project, the land cover data may prove useful as a reference. It is anticipated that the Angeles National Forest will make their presumably finer-scale digital vegetation data available to this project. The classification system used for those data remains to be revealed to the project team, but we will adjust our reports accordingly. Additionally, we hope to have access to the Weislander Vegetation Type Maps (Weislander 1932) to aid our understanding of the historic biogeography of the watershed.

For the purposes of this preliminary report we have attempted to include both the Sawyer & Keeler-Wolf and Holland/CNDDB systems where our limited exposure allows us to make a specific determination of plant association. In cases where the specific plant composition remains to be determined through review of available vegetation maps and data, we use the more general WHR system here to describe the land cover.

As visible from our relatively brief field reconnaissance, the upper Arroyo Seco watershed is clothed with a mosaic of mixed chaparral, coastal scrub, riparian forest and associated hardwood forest that merges into montane coniferous forest at the highest elevations of the watershed. The geographic distribution of these associations closely follows microclimatic patterns effected by combinations of topography, slope-aspect (insolation or solar orientation), elevation, soils and available moisture. Fire and background erosional processes have further influenced the vegetation distribution, as have our relatively recent human impacts on fire and fluvial ecology, along with our influences on erosion patterns resulting from such historic activities as logging and construction of the Angeles Crest Highway.

In their unadulterated, healthful states, the hardwood and montane coniferous forests are undoubtedly the most absorptive major vegetation/soil combinations in the watershed. They occupy some very steep slopes, though, so their ability to hold back onslaughts of rain has limitations. In any case, based on the team's observations of base flow in the Arroyo and its tributaries many months after any significant rainfall, it appears that fractures in the watershed's bedrock systems allow it to "drink" in moisture, releasing it months or perhaps even years later through artesian flows.

Probably the most widely distributed forest type in the watershed is that dominated by canyon live oak (*Quercus chrysolepis*). It represents the Canyon live oak series in the Sawyer & Keeler-Wolf system. In the Holland/CNDDB system it would include both the Canyon live oak forest and Canyon live oak ravine forest types. This handsome species shades and cools the forest throughout the year and its extra-large acorns (the largest of any North American oak species) are a rich food source for forest inhabitants. Based on the abundant acorns observed on the ground during the field reconnaissance, Jigour concludes that the year 2000 was a high mast year. The next frequent tree species in the Canyon live oak series is probably California bay (*Umbellularia californica*), followed by bigleaf maple (*Acer macrophyllum*), especially in the ravines and looking particularly fetching in its autumn splendor during the field visits. Occasional bigcone Douglas-fir (*Pseudotsuga macrocarpa*) (historically referred to erroneously as big cone "spruce") hug the upper riparian zones at mid-elevations of the montane watershed. This species was particularly noticeable in the Bear Canyon forest.

At higher elevations bigcone Douglas-fir may approach co-dominance with canyon live oak and rise high up the slopes of protected northerly slope-aspects. Along the highest elevation, north-facing slopes along the Angeles Crest Highway, bigcone Douglas-fir appears to dominate some forest patches. The foregoing two permutations are classified respectively as the Bigcone Douglas-fir – canyon live oak series and Bigcone Douglas-fir series. Both would fall into the Bigcone spruce – canyon oak forest in the Holland/CNDDB system. Fire ecology may be the most distinguishing feature in the gradient between these two dominant species. While canyon live oak forests are adapted to withstand episodic, primarily low-intensity fires, as are most oak forests and woodlands, bigcone Douglas-fir is apparently not particularly well-adapted to fire and thus proliferates in steep, moist, relatively fire-free zones (Stephenson and Calcarone 1999).

As previously mentioned, the riparian zone is dominated by the deciduous white alder (*Alnus rhombifolia*) throughout the montane portion of the watershed, except in the few impoundments of alluvial material. Bigleaf maple, canyon live oak and bigcone Douglas-fir may occupy the edges of this zone, but the stream channel itself is typically defined by the intertwined roots of white alder, which are dependent on saturated, but well-aerated soils for their survival. This flood disturbance-adapted species can readily resprout from residual roots if its trunk becomes broken during episodic floods. Its nitrogen-fixing symbionts also help restore nutrient cycles to fluvially scoured soils. This tree-dominated montane riparian association is classified as the White alder series; – White alder riparian forest in the Holland/CNDDB system.

As lush as these forests may appear from an aerial view, the team's limited field exposure revealed striking patterns of understory degradation throughout the watershed. Along the length of the Arroyo Seco mainstem observed by Verna Jigour, exotic pest plants dominated the greatest expanses of understory vegetation – to the near-exclusion of native understory species. (Note that since the field reconnaissance occurred in mid- and late autumn, certain species may not have been apparent due to dormancy.) Evidence of native understories was strikingly limited – especially along the Arroyo Seco mainstem.

In the descent from Switzer's, the first major stand of understory vegetation observed was the invasive exotic periwinkle (*Vinca major*), likely planted during the historic hey-day of Switzer's as a recreational mecca. Jigour observed surprisingly restricted stands of mugwort (*Artemisia douglasiana*) upstream of Switzer Falls, but these were far outnumbered, first by the periwinkle and then by eupatory, or sticky eupatorium (*Ageratina adenophora*), also observed upstream of the falls.

Like periwinkle, the eupatory was likely introduced by well-intentioned inhabitants of Switzer's resort. Eupatory may be the most widespread of the exotic pest plant species in the upper portions of the watershed. At the bottom of Switzer Falls and downstream, it appeared to be the dominant understory species for long stretches of the Arroyo riparian zone, as well as on some of the tributaries. The good news about this particular species is that it can be managed to some extent by non-chemical means. Especially incipient stands of eupatory may be pulled or pried out of moist ground. As the individual plants mature, however, their root masses may become too formidable for the average person to pull. Jigour inspected a few such elderly specimens at the base of Switzer Falls – regrettably the dominant understory species there. Given her understanding of eupatory behavior, Jigour hypothesizes that upper portions of the eupatory shrub are torn off during high flows – these land and take root downstream. (The species also propagates by wind-blown seed.) New shoots then arise from the parent root mass, which increases in mass and girth. Such massive roots would require leverage combined with impressive strength to uproot. Periwinkle presents other challenges.

On the Nov. 29th trip, Jigour and Stoecker inspected the Arroyo stream channel downstream of Switzer's Falls, including Bear Canyon. As they approached a particularly rocky section of the Arroyo, they observed grassy clumps lining the edges of the stream channel, their autumn-tinged leaves glistening in the dappled sunlight filtering through the alders. Closer inspection of the finely serrated leaf blades revealed these plants to be one of two possible species of pampas grass (*Cortedaria* sp.), specific identification requiring the floral inflorescence, absent from all specimens observed. Perhaps the most surprising aspect of this infestation is that one typically expects to see either pampas grass species in higher light level conditions than those of the Arroyo Seco canyon bottom. However, the deciduous character of the white alder forest may allow sufficient winter light to support the exotic pest grass. The fact that most specimens were observed hugging the stream banks, often nestled into the granitic boulders at the water's edge, suggests that this may be *Cortedaria selloana*, the species most commonly used in landscape plantings, and one that often invades wetland sites. *Cortedaria jubata* more typically invades upland sites, but often along the humid coastline, so this species cannot be ruled out without further investigation. Regardless of which species this is, the management problems are similarly difficult. Further discussion of exotic pest plant species follows in subsequent paragraphs and a list of exotic pest plant species observed appears at the end of this section.

A word about the implications of native understory degradation is appropriate here. Based on observations of other, less impacted streams in the San Gabriel Mountains, as well as in other parts of the state, it seems reasonable to imagine that the banks of the Arroyo were once partly shaped by native understory species. The loss of these species has undoubtedly changed aquatic, as well as terrestrial niche structure, and has likely impacted both aquatic and terrestrial food webs. Furthermore, such understory species would presumably play an important role in filtering sediments from overland flows before they reach the stream. It is difficult to speculate how many native species may be missing or severely reduced, but it's clear that native diversity along the Arroyo and its tributaries is rapidly being replaced by a relatively limited palette of exotic pest species of limited habitat and food web value. This ecological simplification may be accruing potentially serious impacts on the diversity of native plant and animal species that the forests and streams of the watershed can support.

One species that Jigour expected to see along the Arroyo mainstem, but didn't, is the statuesque chain fern (*Woodwardia fimbriata*), often a denizen of streamside niches. Jigour did observe a stand of chain ferns, associated with some patches of wood fern (*Dryopteris arguta*) along the main trail, high in the Long Canyon drainage within the coast live oak forest. But her later observance of patches of bullrush (*Scirpus* sp.) father downstream in this drainage caused her to suspect that soils in Long Canyon may have a higher clay content than those of the Arroyo proper, which might account for the absence of chain fern along the Arroyo. Nevertheless, isolated patches of wood fern were observed along the Arroyo, but in contrast with the chain fern, this species is most likely to occupy upland, as opposed to streamside locations. The most populous fern species observed during the field visits is polypody fern (*Polypodium californicum*). Frequently large patches of this species occupy primarily upland sites, often on north-facing slopes beneath the canyon live oaks. The verdantly tender masses of this diminutive fern afford a striking contrast juxtaposed against the sharp blue-green blades of chaparral yucca (*Yucca whipplei* a.k.a. our Lord's candle), as was observed more than once. The yucca itself was surprising in its colonization of fairly well-shaded sites, in contrast with its typical occupation of exposed slopes.

Given the virtual absence of native understory along the Arroyo mainstem, Jigour was heartened when she entered Bear Canyon to find sizable, though dormant, populations of at least one native species. It was apparently a member of the Saxifrage family, possibly round-leaved Boykinia (*Boykinia rotundifolia*), although the absence of flowers and fruits precluded positive identification. While Bear Canyon was disappointing with respect to potential fish habitat, this suggestion of native understory was some testimony to the touted "wildness" of the drainage. As mentioned previously, Bear Canyon was also noteworthy for the apparently increased frequency of bigcone Douglas-fir there, relative to that observed in other canyon areas. This difference may arise from a combination of solar orientation, soil type and fire history, among other factors.

While Bear Canyon didn't quite live up to its name during the field reconnaissance, Matt Stoecker found the Arroyo Seco gorge to be perhaps the wildest spot visited. Partway along his trek through the gorge he encountered fresh (steaming) piles of scat laden with the seeds of holly-leafed cherry (*Prunus ilicifolia* ssp. *ilicifolia*), so beloved by cismontane black bears (*Ursus americanus*). Holly-leafed cherry is frequent in both the nearby chaparral and coastal scrub associations of the watershed.

It should be understood that grizzlies (*Ursus arctos*), the golden species gracing our state flag, were the historic bear occupants of the San Gabriel Mountains, prior to their extirpation from the state early in the 20th century. The black bears who live there now are apparently descendents of a population transplanted into the mountains by the California Department of Fish and Game during the early 1930s (Stephenson and Calcarone 1999:328, citing Burgduff 1935 and Vaughan 1954). The forerunners of populations in Ventura and counties northward apparently migrated there on their own, likely across the Tehachapis, from their historic range in the Sierra Nevada.

Not far from the steaming scat, Stoecker observed the characteristic bear tracks to confirm the identity of the individual who had apparently just vacated the premises – possibly upon hearing Matt's footfalls. As he continued down the gorge, subsequent steaming piles and other traces suggested to Stoecker that his presence was flushing the bear down the Arroyo. He paused at moments in an effort to let the critter escape, but the steep side walls of the gorge prevented ascent from the canyon floor. Eventually they came to a spot where the bear was apparently able to scramble up a slope, to the relief of Stoecker, as well as, presumably, the bear.

It is likely that this and any other bear residents do find their way to Bear Canyon, among the more isolated areas of the watershed. But Stoecker's experience in the gorge illustrates that it is likely fortunate for resident bears, as well as other wildlife species, that some areas of the watershed are unmarked by trails, and thus infrequently visited by humans. The difficult access down the gorge may be among its saving graces in keeping it relatively wild. Perhaps the downside of that relationship is that, if the gorge has been colonized with as many exotic pest plants as other sections of the Arroyo, management will pose a significant challenge. Since Jigour did not travel through the gorge, the specific exotic species there remain to be determined, but it's reasonable to assume that the gorge understory has been supplanted by exotic pests, just as has occurred elsewhere in the drainage.

While the periwinkle, eupatory and pampas grass were an annoying presence in the upper watershed, nothing could have prepared the team for the sheer horror of the assemblage they first encountered Oct. 24th above the Brown Canyon Debris Dam.

As mentioned in the section on stream ecology, on the team's descending journey the first sign of change was the abrupt cessation of the riparian forest canopy in the vicinity of Oakwilde. Here the white alder forest drops out, and the canyon opens onto an alluvial plain, punctuated with mulefat (*Baccharis salicifolia*) arroyo willow (*Salix lasiolepis*) and occasional mugwort (*Artemisia douglasiana*). This assemblage would fall into the Arroyo willow series, or the Southern willow scrub community. Patches of this mulefat/willow scrub alternate with bare alluvium and patches of incipient alluvial scrub vegetation as one continues downstream. Native scrub species observed included California buckwheat (*Eriogonum fasciculatum*) and California fuchsia (*Epilobium canum*), blooming gloriously during the field reconnaissance, but notably not scalebroom (*Lepidospartum squamatum*), the signature alluvial scrub species. Also observed in this section, as well as in a few other alluvial sites, was the exotic pest plant Spanish broom (*Spartium junceum*), virtually leafless at this point in the season.

But as Jigour and Stoecker rounded another bend approaching the dam, they encountered a "green wall". For approximately one-quarter to one-third of a mile upstream of the Brown Canyon Debris Dam, an adventitious canyon live oak forest has emerged on the alluvium that apparently topped out the dam decades ago, judging by the apparent maturity of the trees. On the surface this might seem a happy accident that created additional forest niches for some wildlife species (while creating yet one more barrier for anadromous fish species). However, this shady forest camouflages an insidious secret – a liana of exotic pest plants, enveloping the forest floor and reaching high into the canopy, threatens to smother the forest from within, with potentially disastrous consequences. In this case, the most prolific invaders appear to be the English and Algerian ivies (*Hedera helix* and *H. canariensis*, respectively) that have ascended to near canopy level, and drape gracefully from the highest canyon live oak branches. It is conceivable that these vines may eventually clamber over the tops of the canyon live oaks, cutting off their light source and thus setting off a potential chain reaction decline of health that could lead to the ultimate death of the forest there. If there's anything worse than a topped-out 90 foot dam filled with a forest invaded by exotic pest plants, it's a topped-out 90 foot dam filled with a dead forest overcome by exotic pest plants.

While the English and Algerian ivy species are apparently the most successful exotic pest colonizers of this forest, Cape ivy (*Delairea odorata*, formerly known erroneously as German ivy, *Senecio mikanoides*) is also present here. In more coastal situations Cape ivy is the pest plant most often seen overtopping riparian tree canopies. But here it has not achieved such status – yet. The leaves of Cape ivy have also been found toxic to fish, so the species poses a potential threat to water quality, on top of its other noxious qualities. Other pest species observed in this forest included French broom (*Genista monspessulana*), castor bean (*Ricinus communis*), eupatory, periwinkle and Bermuda grass (*Cynodon dactylon*). Keep in mind that this is only a partial listing, as a complete inventory was outside the limitations of this current project. This exotics invasion is currently concentrated on the areas of impounded sediment, but the pests appear to be spreading outward from their existing concentration. Within this vicinity virtually no native understory persists. It is indeed a premier example of how the absence of natural disturbance (as from flooding) leads to greater disturbance (exotic pest plant invasion), in a hideously cataclysmic spiral.

While it is premature to begin discussing restoration strategies at this point, it is appropriate to point out that this dam has outlived the function it was designed for. But any considerations of dam removal must also consider provisions for dealing with the exotic pest infested forest. Plant propagules allowed to wash downstream from this infestation have a high probability of invading new sites downstream. Potential management scenarios for this infestation are complicated by the fact that the use of herbicides commonly used to treat extensive exotic pest infestations is not permitted on the Angeles National Forest, as is the case for most other national forests. But other forests, notably the Monterey Ranger District of Los Padres National Forest, have prepared Environmental Assessments to lay the groundwork for using herbicides on exotic pest plant invasions. This could conceivably happen on the Angeles NF.

Lest we convey the impression that the Brown Canyon Debris Dam is the only site so thoroughly enveloped by exotic pest plants – note that the team observed similar aerial infestations in Dark Canyon and along the Arroyo itself, downstream of the gaging station. The exotic liana has not yet established in Fern Canyon, but the canyon above and below the debris basin is crowded with eupatory to the exclusion of any of its namesake ferns, or any other native understory species. Traveling down the Arroyo, increasing populations of French broom, tree tobacco and edible fig appear as one approaches Hahamongna, along with various other horticultural plantations, including Eucalyptus sp. and non-native pines. A rather large exotic tree plantation is also situated high in the watershed on a gentle slope above the Angeles Crest Highway.

Farther downstream in the Central Arroyo area, the players change slightly but the native understory has been mostly supplanted by exotic pest plants. Eupatory continues as a prominent streamside invader. So-called "tree of heaven" (*Ailanthus altissima*) and edible fig become more frequent and strands of Cape ivy dangle from the bigleaf maple branches. It is anticipated that the biological inventories being developed by Jim Eckert (Parsons Biological Services) for the City of Pasadena will reveal a greater array of exotic pest plant species. The following table ranks some of these species according to the breadth of their geographic invasiveness.

Table 12 : Exotic Pest Plant Species:
Exotic pest plant species observed on the Arroyo Seco field reconnaissance, grouped according to their rank on 1999 California Exotic Pest Plan Council (CalEPPC) lists:
[http://www.caleppc.org/index.html]

CalEPPC List A-1: Most Invasive Wildland Pest Plants; Widespread	
Arundo donax	Giant Reed
Cortedaria sp.	Pampas Grass
Eucalyptus globulus	Tasmanian Blue Gum
Genista monspessulana	French Broom
Delairea odorata	Cape Ivy
Senecio mikanoides	German Ivy
CalEPPC List A-2: Most Invasive Wildland Pest Plants Regional	
Ailanthus altissima	Tree of Heaven
Ficus carica	Edible Fig
CalEPPC List B: Wildland Pest Plants of Lesser Invasiveness	
Ageratina adenophora	Eupatory, Sticky Eupatorium
Hedera helix	English ivy
Ricinus communis	Castor Bean
Spartium junceum	Spanish Broom
Vinca major	Periwinkle
CalEPPC "Need More Information" list	
Hedera canariensis	Algerian ivy
Nicotiana glauca	Tree Tobacco
Other (not on CalEPPC lists)	
Cynodon dactylon	Bermuda Grass

Biological Data Resources

It is the team's understanding that biological inventories have been completed for the Hahamongna, Central and Lower Arroyo area by Jim Eckert, as mentioned above. We anticipate that those data will provide a complete picture of the biological resources (and detriments) in these areas – far beyond the scope of this cursory overview. North East Trees has secured digital vegetation maps from the Angeles National Forest. Ellen Mackey is working with the California Department of Fish and Game to map lower elevation vegetation in the watershed. Our understanding is that this will be done only on private lands, so the project team may be left with a gap of vegetation mapping for public sections of the lower watershed. A real boon to the watershed restoration effort is anticipated from an Occidental College plan to map historic vegetation.

Wildlife Connectivity Issues

Among the goals of this project is to illuminate opportunities to improve wildlife habitat connectivity for diverse terrestrial, as well as aquatic wildlife species – especially those with limited dispersal capabilities. At this point, the obvious points of interest are the connections among the Arroyo with the San Rafael Hills and Debs Park. Dwyer, Stoecker and Jigour examined a tributary drainage to the lower Arroyo that offers potential opportunities for a channel removal demonstration project, as well as possible wildlife movement corridor.

Additional Notes

In the interest of wrapping up this preliminary summary report, the following notes are included in lieu of additional text:

Alluvial scrub – to date Jigour has not observed the type of alluvial scrub vegetation that is associated with slender-horned spineflower (*Dodecahema leptoceras*), a federally Endangered plant species that historically occurred in the region. Rubio Canyon was one of its historic documented occurrences, but we understand that it apparently lies just outside the Arroyo Seco watershed. Jigour is interested in examining any potential alluvial scrub habitats that may occur in the watershed to evaluate their suitability for slender-horned spineflower reintroduction.

Bridge undersides (e.g., 210) along the Arroyo are often unvegetated and eroding. Such publicly obvious sources of sedimentation offer some potential for erosion control demonstration projects.

Oak Grove Park – Evidence of severely compacted soil that compromises the health of the oak grove and virtually eliminates understory that would otherwise provide habitat diversity. Fellow arborist Jan Scow told me he was contracted to evaluate the situation and provide recommendations – the sooner the better.

Next Steps

As we enter Phase II of the project, the biology team plans to review literature, photographs and maps we have requested to gain a better understanding of the natural history of the watershed, as well as current opportunities and constraints. Working with Dan Cooper, project vertebrate biologist, we will identify focal wildlife species and assemblages that can serve as restoration targets. As the results of the spatial analyses (overlay and/or GIS) become available, we will use them to evaluate potential restoration opportunities and work with the rest of the project team to prioritize future actions. We anticipate providing extensive input regarding the overall restoration strategy, as well as specific technical features of proposed demonstration projects.