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Status of fishes in the Upper San Gabriel River Basin, Los Angeles County, California

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We studied the distribution and relative abundance of fishes in the Upper San Gabriel River (USGR), Los Angeles County, California, during the spring and summer of 2007 and 2008. The USGR is one of the few basins in southern California that still supports an abundant endemic fish community, and is widely recognized as an important area for the conservation of native fishes. Three species of native fishes currently occupy the basin; the most abundant and widely distributed is Santa Ana speckled dace (*Rhinichthys osculus* ssp.), followed by Santa Ana sucker (*Catostomus santaanae*), and arroyo chub (*Gila orcutti*). Santa Ana sucker were most abundant and widely distributed in the East Fork of the San Gabriel River. Santa Ana speckled dace were most abundant in the North Fork and most widely distributed in the West Fork, and arroyo chub were most abundant and widely distributed in the West Fork. Rainbow trout (*Oncorhynchus mykiss*) also inhabit the USGR and were the most abundant and widely distributed fish in the basin. Like speckled dace, rainbow trout were most abundant in the North Fork and most widely distributed in the West Fork. The overall distribution of the native fish assemblage is comparable, albeit slightly lower, than basinwide distribution surveys conducted in 1975 and 1991. The USGR lies within one of the most frequently visited national forests in the United States, is essential to the conservation of the imperiled Santa Ana sucker and Santa Ana speckled dace, and should be managed both for endemic taxa and recreational values.

Key words: arroyo chub, *California, Catostomus santaanae*, *Gila orcutti, Oncorhynchus mykiss*, rainbow trout, *Rhinichthys osculus*, San Gabriel River, Santa Ana speckled dace, Santa Ana sucker

The Upper San Gabriel River (USGR) is one of the few basins in southern California that still supports an abundant endemic fish community, and is widely recognized as an important area for the conservation of native fishes (Swift et al. 1993, Moyle et al. 1995, Saiki et al. 2007). The USGR lies within the Angeles National Forest, which hosts over 3.5 million visitors each year, making it one of the most visited national forests in the nation. Chronic problems such as trash, recreational dam building, illegal mining, and off-highway vehicle use exist within the lower section of the USGR and threaten the health of the aquatic ecosystem.

In 2010, the U.S. Fish and Wildlife Service designated portions of the USGR as critical habitat for the federally threatened Santa Ana sucker (*Catostomus santaanae*). Along with sucker, Santa Ana speckled dace (*Rhinichthys osculus* ssp.), and arroyo chub (*Gila orcutti*), both California Species of Special Concern, are extant native species in the USGR. Rainbow trout (*Oncorhynchus mykiss*), including hatchery and naturally spawned fish, also inhabit the USGR and support popular wild trout and put-and-take fisheries. Historically the USGR was an anadromous stream that provided habitat for migratory fishes. However, the construction of four large dams during the 1930s and 1940s currently prevents anadromy. All three forks of the USGR have been stocked with out-of-basin strains of rainbow trout for over 100 years. It is not currently known if the trout population within the USGR is of native coastal rainbow trout lineage. The genetic composition of naturally spawned rainbow trout recently collected from the USGR is being examined to better understand the status of the species in the basin.

Though there have been numerous surveys of the USGR fishes, there has never been a basinwide comprehensive study and little information has been published relative to the status of these resources. Our goal was to determine fish distribution and relative abundance through comprehensive electrofishing and snorkeling surveys to provide a baseline assessment of the native fishes in the USGR.

Study Area

The San Gabriel River, located in the eastern portion of Los Angeles County, is one of the largest basins draining the San Gabriel Mountains. The drainage is approximately 1,030 km^2 and the mainstem flows for some 80 km from the mountains into the Pacific Ocean. The lower stream lies within the coastal plain of the Los Angeles basin and has been highly modified for flood management, whereas the USGR, defined here as the basin above San Gabriel Reservoir, consists mostly of cool, high gradient, mountain streams. The USGR is enclosed entirely by the Angeles National Forest, with only minor inholdings, and drains an approximately 370 km^2 catchment comprised of three main subbasins: North Fork, East Fork, and West Fork (Figure 1). Elevations within the USGR study area range from 445 meters at the West and East Fork junction to 1300 meters at the upstream end of Soldier Creek in the North Fork subbasin. The basin has highly variable runoff closely tied to precipitation. Below average rainfall occurred during hydrologic years 2007 and 2008 (15 and 20 percent of average, respectively), resulting in unusually low summer baseflow conditions during this study.

We reviewed water quality data (dissolved oxygen, pH, conductivity, and turbidity) collected monthly from April 2001 to July 2004 (Ally 2003a[app], 2004a[app], 2004b[app]), and found broad overlap and little overall differences among the subbasins.

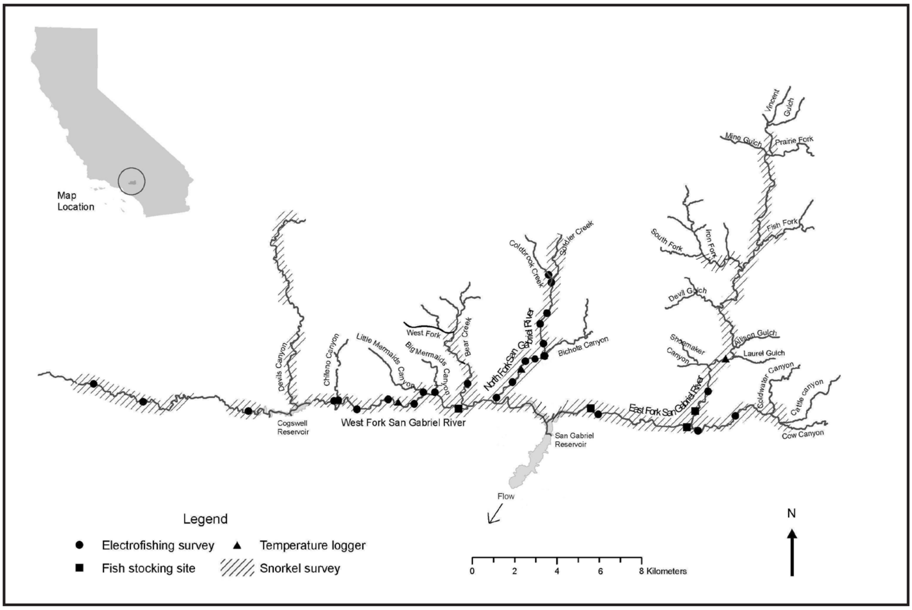

Figure 1.—Location of electrofishing and snorkel survey sites in the Upper San Gabriel River Basin, Los Angeles County, California, during 2007 and 2008.

During that period, water temperature ranged from 4-18 °C, dissolved oxygen ranged from 5-12 mg/l, pH ranged from 7-9.5, conductivity ranged from 220-500 µS/cm, and turbidity ranged from 0.4 to a high of 330 nephelometric turbidity units during storm events.

Methods

We used two-person single-pass backpack electrofishing without block nets (Smith-Root model 12-B programmable output wave, battery-powered electrofisher set at 30 Hz, 5-ms pulse width, and 300–500 V) to sample fish from April through August 2007 and March through July 2008. Backpack electrofishing was performed at 25 sites for a total distance of 4 km. Although this method underestimates absolute population abundance at the habitat unit level when compared to depletion electrofishing, Bateman et al. (2005) demonstrated that it could provide a representative pattern of abundance at the basin level, and Bertrand et al. (2006) reported that it is an effective tool for accurately identifying trends in abundance. However, Bertrand et al. (2006) also stressed the importance of standardizing procedures when using single-pass backpack electrofishing, and cautioned against extrapolating catch rates among streams with dissimilar species compositions without verification.

Fish were identified to species, measured to total length (TL), and released. We used snorkeling to (1) pinpoint the distribution terminus of each species; (2) ensure that species or size classes were not overlooked; and, (3) survey an additional 82 km of stream. When a species was no longer detected during snorkel surveys, we continued surveying upstream for at least 1 km to ensure that we had located the distribution terminus and not merely an interruption. Elevation was obtained from a hand-held GPS unit; gradient and stream order were obtained from USGS 7.5' topographic maps.

Stream temperature was recorded in the mainstem of the East Fork from mid-June to mid-October of 2008 and from early July to mid-October of 2008 in the mainstem of the North and West forks using data loggers programmed to record date, time, and temperature at two-hour intervals. Temperature loggers were placed in well-shaded pools within stream reaches where sucker, dace, and trout occurred (chub also occurred in the West Fork site).

Results

A total of 625 fish of four species was captured during 107 minutes of electrofishing at 25 sites from 10 streams (Figure 1). During the summer of 2008, mean daily water temperatures in the mainstem of the North and East forks were similar, whereas the West Fork mainstem was substantially cooler during the early summer and had slightly higher peak temperatures in late summer (Figure 2).

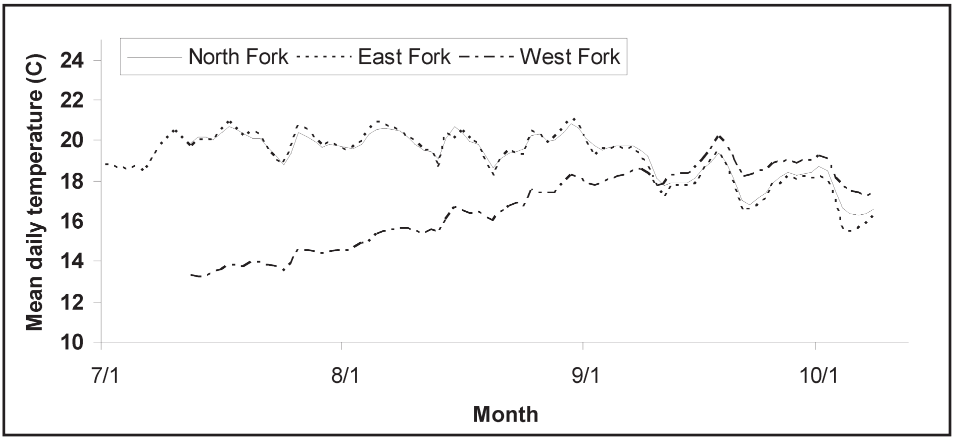

Figure 2.—Mean daily water temperature measured in the mainstem of the North Fork, East Fork, and West Fork of the San Gabriel River, Los Angeles County, California, 2008.

Santa Ana sucker inhabit four streams in the USGR for a total range of 37 km (Table 1). Suckers were most abundant, and occupied the greatest range, in the East Fork mainstem where they were detected in riffles, runs, and pools throughout the lower two thirds of the stream (Figure 3). Suckers were also common in the lower 4 km of Cattle Canyon and the lower 2 km of the West Fork mainstem. During sediment removal from San Gabriel Reservoir in 2006-07, thousands of suckers were relocated upstream into the West Fork mainstem near Bear Creek. The single greatest density of the species observed in this study was in the large West Fork-Bear Creek confluence pool. Bear Creek also supports a large population of suckers within the lower 5 km of stream and they are common in the lower 2.5 km of the North Fork mainstem. The upstream distribution of Santa Ana sucker was truncated by steep cascades or waterfalls in each stream except the West Fork

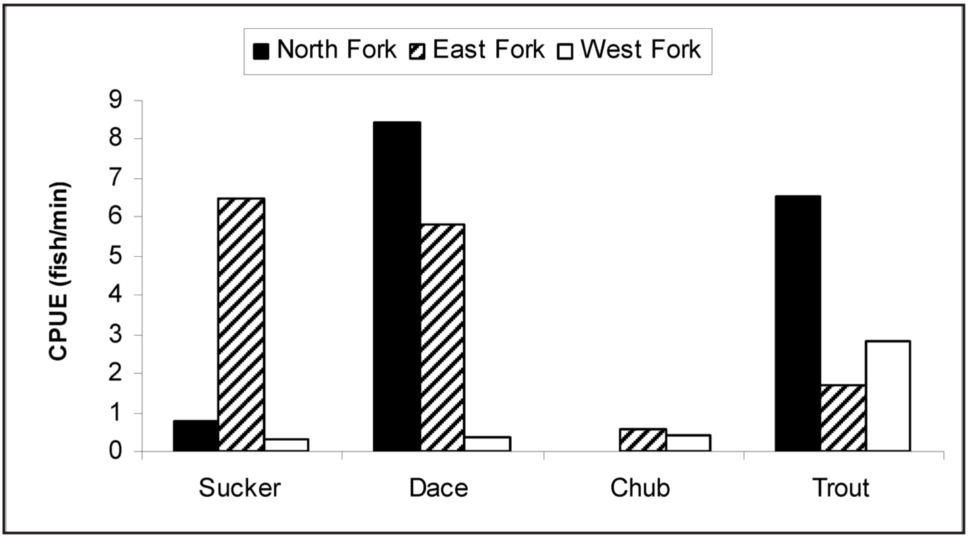

Figure 3.—Electrofishing catch-per-unit-effort (CPUE; fish/minute) of fishes from three subbasins of the Upper San Gabriel River Basin, Los Angeles County, California, April through August 2007 and March through July 2008.

mainstem, where there was no barrier to fish passage. Suckers were observed only in third order or greater streams with gradients ranging from 1% in the lower West Fork mainstem to 5% in the upper East Fork mainstem. Except in a few shallow runs, Santa Ana sucker were usually in proximity to speckled dace and rainbow trout.

Santa Ana sucker ranged from 33-210 mm TL (*n*=70), and several size classes (modal groups) of suckers were observed (Figure 4). Most suckers were between 70 and 120 mm TL and likely in the second or third year of life (Greenfield 1970, Drake 1988[app]). The 33 mm TL fish was collected in July, indicating that spawning occurred several weeks to a month earlier. This is several months earlier than Saiki et al. (2007) reported for the East Fork mainstem, but similar to what Greenfield et al. (1970) found in the Santa Clara River. It is later, however, than the late March to May spawning in the middle Santa Ana River (Feeney and Swift 2008). Breeding suckers, characterized as having tubercles, and in some instances pronounced dark lateral stripes, were observed in May, June, and July in the mainstem of East and North forks and in Bear Creek. Breeding fish were observed over gravel substrate in pools in the East Fork near the upstream limit of the species range. Ten suckers over 150 mm were captured; one (162 mm TL) from the West Fork mainstem and nine from the North Fork mainstem.

Santa Ana speckled dace were found in five streams for a total distribution of 44.1 km (Table 1). Dace were most widely distributed in the East Fork mainstem but the highest densities were in the North Fork mainstem and its tributary Bichota Canyon. Dace were common in portions of the West Fork mainstem but only abundant in Bear Creek, a major West Fork tributary, where the distribution is very similar to that reported from an electrofishing survey performed in 2000 (J. R. Ally, California Department of Fish and Game, unpublished data). Several gravid dace, identified by their large size and distended bellies, were observed in Bear Creek during May. Dace were found in stream gradients from 1%

Table 1.—Distribution of fishes as determined from snorkel surveys in the Upper San Gabriel River Basin, Los Angeles County, California, April 2007 through July 2008.

Species and Location	Survey distance (total stream length)(km)	Distribution (km)	Stream order	Stream gradient (%)	Elevation range (m)
Santa Ana sucker					
North Fork					
Mainstem	7.5 (7.5)	2.5	3	5	475-490
East Fork					
Mainstem	26.5 (26.5)	15.5	4	3	445-820
Cattle Canyon	6 (12)	4	3	4	565-725
West Fork					
Mainstem	25 (28.5)	10	4	2	450-590
Bear Creek	8 (17)	5	3	3	490-640
Total	73 (91.5)	37			
Speckled dace					
North Fork					
Mainstem	7.5 (7.5)	4.5	3	5	475-700
Bichota Canyon	2 (6)	0.1	2	10	660-675
East Fork					
Mainstem	26.5 (26.5)	14.5	4	3	445-800
Cattle Canyon	6 (12)	5	3	4	565-790
West Fork					
Mainstem	25 (28.5)	14	4	1	450-735
Bear Creek	8 (17)	6	3	2	490-680
Total	75 (97.5)	44.1			
Arroyo chub					
East Fork					
Mainstem	26.5 (26.5)	5	4	2	445-500
West Fork					
Mainstem	25 (28.5)	14	4	1	450-735
Total	51.5 (55)	19			

Table 1.— continued

Species and Location	Survey distance (total stream length)(km)	Distribution (km)	Stream order	Stream gradient (%)	Elevation range (m)
Rainbow trout[a]					
North Fork					
Mainstem	7.5 (7.5)	7.5	3	7	475-1000
Bichota Canyon	2 (6)	2	2	5	660-720
Coldbrook Creek	0.5 (2.5)	0.5	2	8	1000-1035
Soldier Creek	0.5 (4.5)	0.5	2	20	1180-1300
East Fork					
Mainstem	26.5 (26.5)	26.5	4	4	445-1350
Cattle Canyon	6 (12)	6	3	4	565-815
Coldwater Canyon	0.5 (10)	0.5	2	3	780-790
Iron Fork	2 (9)	2	2	7	936-1090
Fish Fork	0.5 (11)	0.5	2	6	1020-1045
West Fork					
Mainstem	25 (28.5)	25	4	1	450-1100
Bear Creek	8 (17)	8	3	3	490-680
Devils Canyon	8.5 (16)	7	2	5	740-1230

[a] Upper distribution limit not ascertained for: Bichota Canyon, Coldbrook Creek, Soldier Creek, Coldwater Canyon, Iron Fork, Fish Fork, or Bear Creek.

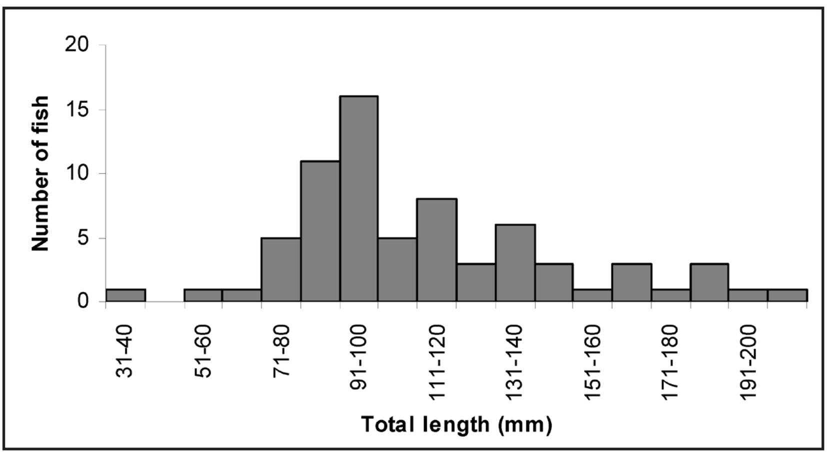

Figure 4. —Length frequency distribution of Santa Ana sucker from the Upper San Gabriel River, Los Angeles County, California, April through July of 2007 and April and May of 2008.

in the West Fork mainstem to 10% in Bichota Canyon, where their distribution was limited by a 3-m waterfall. Dace occupied most habitats, but were typically associated with riffles or areas of current.

One hundred and ninety six speckled dace ranging from 43-116 mm TL were measured. A distinct mode in the length-frequency distribution occurs at 60-70 mm TL, and there appears to be at least two size or age classes present (Figure 5). Dace between 50 and 80 mm TL are likely in their second year of life and those >90 mm TL are likely in their third year of life (Robinson and Childs 2001, Moyle 2002). Dace <50 mm TL were captured in the North Fork mainstem from April to late July, indicating that spawning occurred during spring and summer. Young-of-the-year dace (<30 mm TL), which were too small to be captured using electrofishing gear, were commonly observed along stream margins in the East Fork mainstem during June 2008.

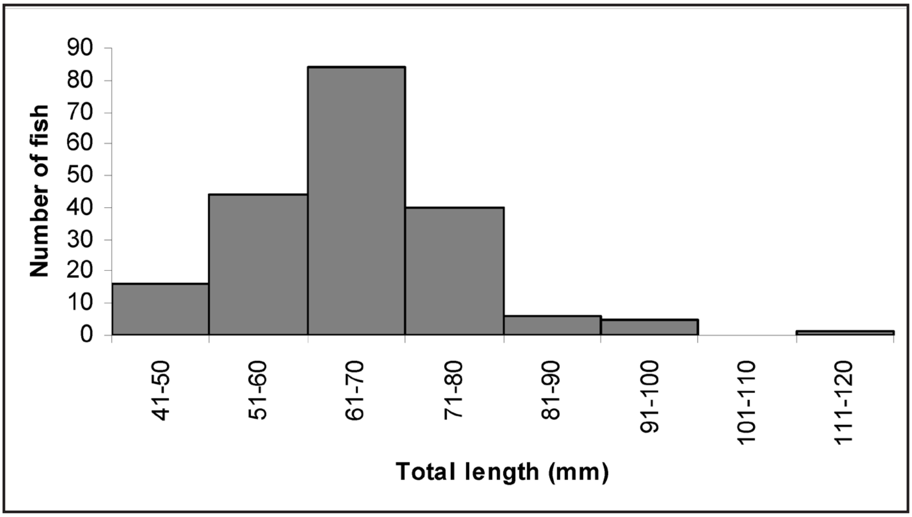

Figure 5. —Length frequency distribution of speckled dace from the Upper San Gabriel River, Los Angeles County, California, May through July 2007 and April through July 2008.

Arroyo chub were the least abundant species and occupied the smallest range of the native fish species in the USGR. Chub were only detected in the mainstem of the East and West forks, where they were widely scattered throughout approximately 20 km of stream. They were restricted to pools and glides in low gradient reaches (2% maximum), and were usually associated with emergent vegetation. We observed a very large population of chub within Cogswell Reservoir and they are abundant immediately upstream of the reservoir in the West Fork mainstem.

Thirteen chubs, ranging from 26 to 112 mm TL, were measured and the length frequency distribution indicates several size or age classes (Figure 6). This size range encompasses fish from young-of-the-year to over four years (Tres 1992). Drake and Sasaki (1987[app]) aged chubs from the West Fork mainstem and found that two-year-old fish ranged from 87 to 107 mm fork length, which indicates that the majority of chubs captured in this study were two years-of-age. The largest chub observed was in the East Fork and was approximately 150 mm TL.

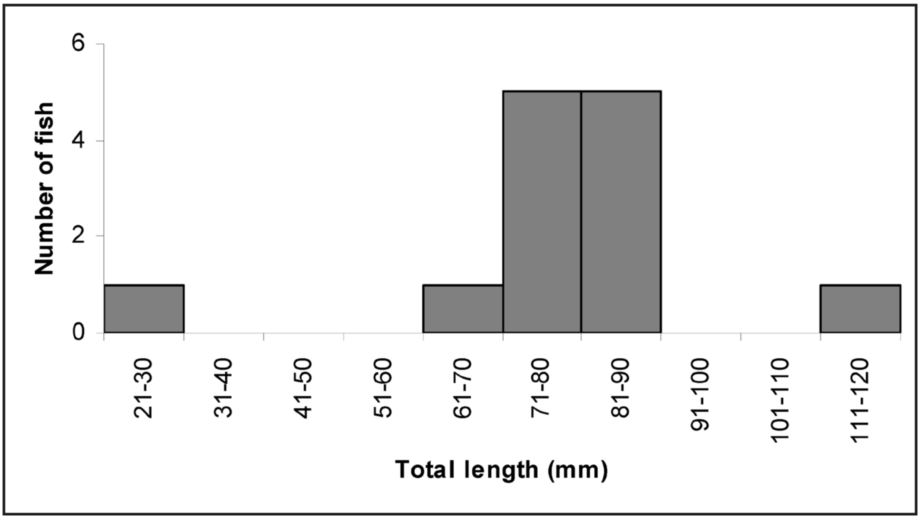

Figure 6. —Length frequency distribution of arroyo chub from the mainstem of the East and West forks of the San Gabriel River, Los Angeles County, California, June 2008.

Rainbow trout, the most widely distributed fish species in the basin, were captured in every electrofishing survey, and were detected in every snorkel survey. They were typically the most abundant species encountered in the West Fork subbasin, but were often less abundant than sucker and dace in shallow water habitats, such as riffles and runs, within the East Fork subbasin. Young-of-the-year and juvenile trout less than 150 mm TL were most abundant in riffles and runs, whereas adults were most abundant in pool and pocket water habitat.

Rainbow trout comprised the greatest percentage of the total catch from the electrofishing surveys. Seventy-nine rainbow trout were measured, ranging from 28 to 240 mm TL (Figure 7). This size range likely represents fish from young-of-the-year to over three years old (Drake and Sasaki 1987[app]). Trout up to 400 mm TL were observed during snorkel surveys in the largest pools of the West and East Fork mainstem, but fish >300 mm TL were uncommon. The greatest densities of juvenile trout were found in the middle and upper North Fork mainstem, whereas the greatest densities of adult fish were found in the lower and middle West Fork mainstem.

Hatchery reared rainbow trout, easily identified by their eroded caudal fin rays and overall pale appearance, were observed in a few pools below the East Fork stocking sites, in one pool above the uppermost site, and in several pools below the West Fork stocking site (Figure 1). Hatchery reared trout were abundant only immediately after being stocked and only within the pools where they were placed. Hatchery reared trout were detected up to 3.5 km upstream from the nearest planting site, but were rarely seen outside of the immediate area where they were stocked.

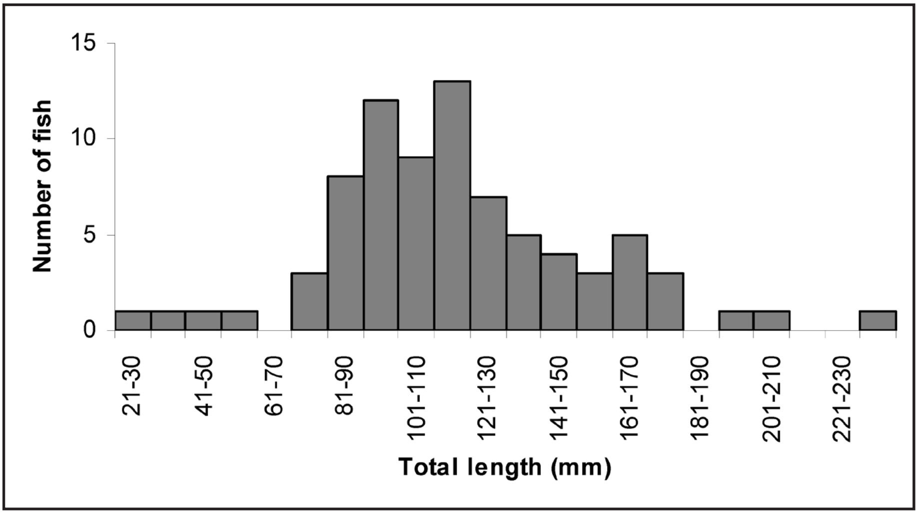

Figure 7. —Length frequency distribution of rainbow trout from the Upper San Gabriel River, Los Angeles County, California, April 2007 and April through July 2008.

Discussion

Stream gradient appears to be the primary factor controlling fish distribution in the USGR. Gradients in excess of 5% typically were associated with numerous steps, cascades, and small (<2 m) waterfalls that impede or prevent sucker, dace, and chub from moving upstream. The combination of higher gradient and associated fish passage barriers limited the distribution of sucker, dace, and chub in all streams except the West Fork mainstem, where it was not clear what limited the upstream distribution of sucker.

The overall distribution of the native fish assemblage is comparable, albeit slightly less, than basinwide distribution surveys conducted in 1975 (Wells et al. 1975[app]) and 1991 (Haglund and Baskin 1992[app]). We found sucker in all five streams and dace within five of six streams where they were reported in 1975. Dace were captured near the mouth of Devils Canyon where it joins Cogswell Reservoir in 1975. This area has intermittent flow and was dry during our survey but speckled dace, a species known to inhabit lakes (Moyle 2002), probably occupy Cogswell Reservoir and will likely return to the stream when conditions permit. Compared with 1975, the area occupied by sucker has decreased by approximately 2 km in the West Fork mainstem and the area occupied by dace decreased by approximately 2 km in the North Fork mainstem. The most notable difference in fish distribution between the 1991 survey and this study was that we did not detect sucker or dace in Big Mermaids Canyon or dace in Coldwater Canyon. In Big Mermaids Canyon, a 7-m waterfall located 300 m upstream of the West Fork mainstem confluence is a barrier to upstream fish passage, and several other smaller barriers exist below the waterfall that currently limit the ability of fish to use this stream in probably all but the most favorable hydrologic conditions. It was not clear why dace were not detected in Coldwater Canyon, although the amount of habitat available to fish is limited by a 3-m waterfall approximately 400 m upstream from the confluence with Cattle Canyon that likely prevents upstream fish passage.

We compared our fish abundance (fish/meter) with that reported by Wells et al. (1975[app]) who collected fishes in June of 1975 using the same techniques and from many of the same general areas as in our study (abundance data were not collected during the 1991 study). Our catch per unit effort was lower for all four species in most streams. One possible reason for the decline is that annual rainfall totals were similar and near the long-term mean in the years prior to 1975, whereas annual rainfall varied greatly prior to our survey. The greater variability in total annual rainfall produced very low base flows and flood flows during and prior to our study, creating an unstable environment that would likely have a negative impact on fish abundance. It is also possible that the abundances observed during our study are within the typical interannual variability of these species. Indeed, the abundance of many stream fishes often fluctuates greatly from one year to the next (Grossman et al. 1990, Strange et al. 1992). Fish abundance data collected in the West Fork mainstem during the 1980s, 1990s, and 2003-2004 showed that the populations of all species varied widely from year to year with no obvious temporal trend (Deinstadt et al. 1990; Haglund and Baskin 1995[app], 1996[app]; Ally 2003b[app], 2004b[app]; Deinstadt 2007[app]).

The only obvious trend in relative abundance across collection sites was that where sucker, dace, and trout co-occurred, dace were typically the most abundant species, followed by trout and sucker. The only obvious association between the species was the presence of dace at each site where sucker were collected. Moyle (2002) described riffles and fastwater habitats as the preferred habitat for stream-dwelling dace, and Haglund and Baskin (2002[app]) reported that dace preferred riffle habitat in the mainstem of the West Fork. Although this may be the preferred habitat of dace, we observed them, along with sucker, residing in all habitats of the East Fork mainstem including deep (>2 m) pools where they were often abundant. Perhaps they use these deep thermally stratified pools as refuges from high water temperatures, which peaked at 25°C in the East Fork.

We encountered numerous recreational dams throughout the lower 6 km of the North Fork mainstem, 2 km of the lower West Fork mainstem, 1 km of lower Bear Creek, and 12 km of the lower East Fork mainstem. These dams, a common feature in the lower mainstem of the North, East, and West forks, are built mostly by day users but also by recreational suction dredge miners, and are constructed primarily of streambed materials. Most dams span the entire stream and are usually less than 1 m high. The structures are typically destroyed during high winter flows and rebuilt when warm weather and baseflow conditions return in late spring. A survey of these structures during the fall of 2001 recorded over 200 such dams within a 6 km stretch of the East Fork mainstem (Ally 2003c[app]). These structures can impact fishes directly during construction by killing or injuring fish, eggs, and macroinvertebrates, and indirectly by impeding movement, disrupting spawning, and altering habitat such as flow, depth, and substrate compaction and composition (Porto et al. 1999). Tieman et al. (2004) concluded that lowhead dams negatively impacted lotic macroinvertebrates and, thus, degraded habitat quality in a Midwestern stream. Helfrich et al. (1999) suggested that a series of lowhead dams might present a serious cumulative challenge to fish passage, leading to gradual alteration of fish assemblage structure in a river. Although it does not appear that the dams altered the fish assemblage in the East or West Fork subbasins, they may be responsible for limiting the upstream distribution of sucker in the North Fork mainstem, and studies are needed to assess the impacts these structures have on these species.

Nonnative species such as largemouth bass (*Micropterus salmoides*), green sunfish (*Lepomis cyanellus*), and black bullhead (*Ameiurus melas*) are known to occur in the mainstem of the West and East forks (Wells et al. 1975[app], Deinstadt et al. 1990, Haglund and Baskin 2002[app]). Along with threats to native fishes from predation and competition, these nonnative species can transmit disease including the nonnative white spot disease caused by *Ichthiopterious* sp., which was found in dace from all three sub-basins of the USGR by Kuperman et al. (2002). Although we did not capture any nonnative species during the electrofishing surveys, we did observe two common carp (*Cyprinus carpio*), one in the lower West Fork mainstem and one in the lower East Fork mainstem, during snorkel surveys. Bass and sunfish are probably still extant in the basin but appear to be rare; flood events during the winter of 2005-2006 probably greatly reduced, if not eliminated, the populations. However, because the mainstem of the West and East forks flow unimpeded into the San Gabriel Reservoir where these species persist, nonnative fishes will continue to be a threat to native fishes in the lower sections of those streams. Nonnative fishes can also gain access to the USGR via releases from Cogswell Reservoir.

Nonnative invasive plants, such as the giant reed (*Arundo donax*) and salt cedar (*Tamarix ramosissima*), were observed in the East and West fork mainstems but were generally confined to the lowermost stream sections. Salt cedar was more abundant and more widely distributed than giant reed, particularly in the East Fork mainstem, and the potential for these small, widely scattered populations to become a serious threat to the aquatic ecosystem is of concern.

Several opportunities to expand the current range of sucker and dace became apparent during our surveys. In the East Fork mainstem these species could be moved upstream of the fish passage barriers (preferably above the Iron Fork confluence where recreational mining activity is minimal) where a number of low gradient reaches with suitable habitat exist. The upper West Fork mainstem above Cogswell Reservoir is another area to which sucker could be relocated. If these species can persist in these areas, they could help ensure the survival of the populations should a catastrophic event occur in their current range (perhaps an even greater possibility in the West Fork given the presence of the dam). Until there is a better understanding of the genetic structure of the populations within the basin, however, fish should only be moved within their respective streams.

The present distribution of native fishes within the basin is comparable to the 1975 and 1991 surveys. This is particularly noteworthy given that a fire burned an estimated 30% of the basin (2002 "Curve Fire"), the two driest years (2001-2002 and 2007-2008) and the wettest year (2005-2006) of record occurred, and impacts associated with heavy recreational use within the lower sections of the North, East, and West forks have continued. We concur with Saiki (2007) and other fishery managers that sucker populations are healthy in the USGR; however, the lower abundance of fish observed at most sites when compared with the 1975 study is of concern and the population should be monitored, ideally following a period of more stable annual rainfall, to determine if this is part of a long term trend. The picture is not as clear for the Santa Ana speckled dace, which has vastly diminished throughout most of its historic range within the upland portions of the Santa Ana, San Gabriel, and Los Angeles river systems. Dace should be closely monitored in the USGR to determine if the decreased abundance and slight contraction in the distribution are temporary, or part of a long term basinwide trend.

The USGR is one of the last mostly protected basins where sucker, dace, and chub occur and future management decisions within the watershed, including operations at Cogswell Dam, should carefully consider any potential impacts to these imperiled native fish. Moyle et al. (1995) and others have recommended that a native fish refuge be established in the USGR basin to ensure the future survival of these species, and this should be considered by state and federal resource management agencies. The California Department of Fish and Game is currently analyzing potential impacts to these species associated with its fish stocking program. Impacts from recreational dam building and mechanical sluice mining should also be investigated.

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APPENDIX I: UNPUBLISHED DOCUMENTS CITED IN THE TEXT

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