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Angeles and San Bernardino National Forests, Mountain Yellow-Legged Frog (*Rana muscosa*) Surveys, 2001

Annual Report

Prepared for:

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U.S. DEPARTMENT OF THE INTERIOR
U.S. GEOLOGICAL SURVEY
WESTERN ECOLOGICAL RESEARCH CENTER

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ABSTRACT

Surveys for mountain yellow-legged frogs (*Rana muscosa*) (MYLF) were conducted in the Angeles National Forest (ANF), San Bernardino National Forest (SBNF), Bureau of Land Management (BLM) property, and Agua Caliente Indian Reservation (ACIR) property during the summer and fall of 2001. MYLF's were detected at 7 of the 48 drainages surveyed, including Bear Gulch, Devils Canyon, Little Rock Creek, South Fork Big Rock Creek, and Vincent Gulch in the ANF and East Fork City Creek and Fuller Mill Creek in the SBNF. Reproductive success was detected in all of the seven drainages except Fuller Mill Creek. Adult MYLF's were marked with a passive integrated transponder (PIT) tag as part of the initial stage of a mark-recapture program aimed at identifying MYLF population sizes in occupied drainages. Preliminary estimates of adult populations range from 5 (Little Rock Creek) to 47 (Bear Gulch). Future mark-recapture efforts are needed to gain a more precise population estimate. No chytrid fungus or iridoviruses were detected on any survey. Introduced rainbow trout (*Oncorhyncus mykiss*) and brown trout (*Salmo trutta*) were detected at five of the seven streams where MYLF's were detected. Trout appear to be a primary threat and removal experiments at some locations should begin immediately. Human recreational activities, including hiking, fishing, and the resultant depositing of refuse in watercourses are also pressures negatively impacting MYLF populations. Areas of current, and potential, frog habitat under heavy recreational pressures need immediate management attention to contribute to the conservation of this species in jeopardy. Continued monitoring of known populations, in addition to further searching historical localities, is imperative to gain more accurate population estimates and to determine future trends.

INTRODUCTION

In response to declining populations of mountain yellow-legged frogs (*Rana muscosa*) (MYLF), Mark R. Jennings initiated focused surveys for this species in selected drainages of the Angeles National Forest (ANF) and San Bernardino National Forest (SBNF) (Jennings 1993, 1994, 1995, 1998, 1999). Based on previous surveys, there is one known remaining population in the SBNF, East Fork City Creek, and four known populations in the ANF: Bear Gulch, Little Rock Creek, Devils Canyon, and South Fork Big Rock Creek (Backlin et al. 2001). MYLF's have not been observed in the South Fork of Big Rock Creek since the 1970's (Shoenherr 1976).

Current southern California MYLF population estimates are low (Macey et al., 2001) and known localities are few, especially when compared to historical data (Long 1970, Shoenherr 1976). Recent genetic work on *Rana muscosa* has shown that the southern California group, being genetically distinct from the Sierra Nevada populations, forms their own clade (Macey et al., 2001). To address the current sizes of MYLF populations, USGS utilized a passive integrated transponder (PIT) tag system that allows for the identification of individual frogs through multiple mark and recapture events. This technique allows for further biological insight into these populations. PIT tagging began in 2001.

These surveys are a continuation and expansion of work completed in 2000. Survey sites were chosen based on known locations and historical records of MYLF not surveyed in the previous two years. By revisiting sites where individuals were previously PIT tagged (M. R. Jennings, pers. comm.), in addition to PIT tagging captured individuals not previously marked, we can begin to obtain population data on the MYLF's throughout both National Forests. Such data is critical for several reasons: 1) to obtain population estimates of MYLF's in the drainages where they occur, 2) to compare MYLF population sizes among drainages, and 3) to begin to obtain data on MYLF population trends over time.

METHODS

MYLF surveys occurred across three mountain ranges: the San Jacinto Mountains and the San Bernardino Mountains in the SBNF and the San Gabriel Mountains in the ANF (the eastern portion of the mountain range lies in the SBNF). Additional surveys were conducted on Bureau of Land Management (BLM) lands on the east side of the San Bernardino Mountains and on the Agua Caliente Indian Reservation (ACIR) lands on the east side of the San Jacinto Mountains.

Surveys were conducted during the day by walking slowly in or near the stream channel. The frogs were usually located basking on rocks in or near the water, and were captured by hand or with the aid of a small dip net. The captured frogs were weighed, measured (snout to vent length), and examined to determine gender and any deformities. Water and air temperatures were recorded for each capture. Adult frogs were scanned with a PIT tag reader to determine their recapture status. If not previously captured, the frog was injected with a PIT tag for later identification. The frog was then photographed and its location was recorded with a Global Positioning System (GPS) unit. All frogs were released after being processed. MYLF larvae were counted and only captured to verify identification and look for evidence of oral chytridyomycosis (Fellers et al. 2002). Detailed notes, identifying potential threats and general quality of the watercourse, were taken for each survey. Species lists for all amphibians and reptiles observed were also compiled. Of particular interest was the presence of native (two-striped garter snake (*Thamnophis hammondii*)) and non-native (rainbow trout (*Oncorhyncus mykiss*); brown trout (*Salmo trutta*)) MYLF predators.

MYLF population estimates

We utilized multiple methods to obtain population size estimates for each drainage where MYLF's were detected. Estimated population sizes pertain only to adult MYLF's, as juveniles, metamorphs, and larvae were too small to receive a PIT tag. The type of method used depended on how many visits were made to each drainage. For sites that were visited on two occasions (once to mark individuals and once to recapture individuals), we used the Peterson method to estimate population size (Krebs 1989). This method involves marking individuals, releasing them, and returning to the site to recapture individuals. The estimator for population size is calculated as:

$$N = \frac{(M + 1)(C + 1)}{R + 1} - 1$$

where, N = Estimate of population size at time of marking
M = Number of individuals marked in first sample
C = Total number of individuals captured in second sample
R = Number of individuals in second sample that are marked

During the initial site visit, we treated marked individuals from previous studies as being marked for the first time. Additionally, there were several assumptions that were made. They include:

- The population is closed
- All animals have the same chance of getting caught in the first sample
- Marking individuals does not affect their catchability
- Animals do not lose marks between the two sampling periods
- All marks are reported on discovery in the second sample

Due to the short duration between mark-recapture events, we could safely assume that the population was closed; that is there were no births, deaths, immigration, or emigration between the sampling periods.

The second population estimate we used was the Schnabel method (Krebs 1989). This method is used when there are multiple sampling events. Individuals captured during each sampling event are examined for marks and, if they were not previously marked, marked and released. The estimator for population size is calculated as:

$$N = \frac{(C_t M_t)}{R_t}$$

where, N = Estimate of population size at time of marking
M_t = Number of marked individuals in the population just before the t^{th} sample is taken
C_t = Total number of individuals caught in sample t
R_t = Number of individuals already marked when caught in sample t

The Schnabel method makes all the assumptions that the Peterson method makes. However, the benefit of this method is that there are multiple sampling events, thus making it easier to detect any violations in the assumptions.

We emphasize that since these mark-recapture techniques have only occurred for a short period of time, population estimates are preliminary and will be refined as surveys continue.

RESULTS

We surveyed 48 drainages throughout the study area: 13 on the ANF, 30 on the SBNF, 2 on BLM property, and 3 on the Agua Caliente Indian Reservation (Figures 1-22). Frogs were detected at 7 of the 48 survey locations (Table 1). Five of the confirmed locations were in the ANF (Bear Gulch, Devils Canyon, Little Rock Creek, South Fork Big Rock Creek, and Vincent Gulch) and two were in the SBNF (East Fork City Creek and Fuller Mill Creek). A total of 78 adult, 22 juvenile, 37 metamorph, and 176 larvae MYLF's were observed during the 2001 surveys. Frog larvae were detected at six of the seven MYLF locations; Fuller Mill Creek in the San Jacinto Mountains (SBNF) was the only MYLF drainage where larvae were not detected.

Thirty locations in the SBNF were surveyed on 52 days; 21 locations in the San Bernardino Mountains (38 days); 5 locations in the San Jacinto Mountains (10 days); 4 locations in the eastern San Gabriel Mountains (4 days) (Table 1). MYLF's were detected at East Fork City Creek (San Bernardino Mountains) and Fuller Mill Creek (San Jacinto Mountains). Four visits to East Fork City Creek yielded 16 adults, 3 juveniles, and 4 larvae (Figure 7). This section of stream appeared to be seldom used by visitors and no trout were observed. Two visits to Fuller Mill Creek yielded one adult. Two segments of Fuller Mill Creek were surveyed: the portion immediately upstream and downstream of CA 243 at the Fuller Mill Picnic Area and the portion at Pine Wood (Figure 10). The MYLF was detected at the Pine Wood site and was previously discovered in 2001 by the California Department of Fish and Game. No MYLF's were detected at the remaining locations across the SBNF.

Thirteen locations in the ANF were surveyed on 22 days. MYLF's were detected at 5 sites: Bear Gulch, Devils Canyon, Little Rock Creek, South Fork Big Rock Creek, and Vincent Gulch (Table 1). Three visits to Bear Gulch yielded 37 adults, 9 juveniles, 15 metamorphs, and 17 larvae (Figure 19). Devils Canyon was visited on one occasion and yielded 4 adults, 1 metamorph, and 51 larvae (Figure 16). Eight adults, 3 juveniles, 5 metamorphs, and 50 larvae were detected at Little Rock Creek on three visits (Figure 16). Four visits to South Fork Big Rock Creek yielded 8 adults, 6 juveniles, 16 metamorphs, and 4 larvae. Only one adult was detected on the main drainage approximately 1 km upstream of the South Fork Campground. The remaining MYLF's were detected on an unnamed tributary draining the west slope of Mt. Lewis (Figure 9). All MYLF's in this tributary were found upstream of a waterfall. Vincent Gulch was visited on three occasions, resulting in 4 adults, 1 juvenile, and 50 larvae (Figure 19).

Predatory species

Trout were detected in 18 of the 48 drainages surveyed (Table 1). Rainbow trout were found in 16 drainages and brown trout were found in 2 drainages. Rainbow trout were not detected in the two drainages that contained brown trout. The two-striped garter snake was detected in 7 drainages (Table 1).

Five of the streams where MYLF's were detected contained rainbow trout: Bear Gulch, Fuller Mill Creek, Little Rock Creek, South Fork Big Rock Creek, and Vincent Gulch. Although trout were found along Fuller Mill Creek, South Fork of Big Rock Creek and Little Rock Creek, they were located downstream, below a fish barrier, from where the MYLF's were detected. In Bear Gulch and Vincent Gulch, the MYLF's and the trout occupied separate microhabitats within the stream and were almost never found together. Two-striped garter snakes were detected at three of the MYLF streams: Bear Gulch, Little Rock Creek, and South Fork big Rock Creek.

MYLF population estimates

Forty MYLF adults were PIT tagged over the course of the 2001 surveys: 15 in Bear Gulch, 3 in Devils Canyon, 10 in East Fork City Creek, 4 in Little Rock Creek, 4 in South Fork Big Rock Creek, and 4 in Vincent Gulch. In addition 8 MYLF adults were found to have been previously PIT tagged by Mark R. Jennings: 7 in Bear Gulch and 1 in Little Rock Creek, for a total of 48 marked MYLF.

Preliminary population estimates were obtained for five drainages: Bear Gulch, East Fork City Creek, Little Rock Creek, South Fork Big Rock Creek, and Vincent Gulch (Table 2). Estimates for Devils Canyon are unavailable since there was only one marking event. Adult populations in three canyons (East Fork City Creek, South Fork Big Rock Creek, and Vincent Gulch) were estimated using the Peterson method, since there was a single mark and recapture event (these drainages may have been visited more than twice, however different reaches where MYLF's were not present were surveyed). Adult populations in Bear Gulch and Little Rock Creek were estimated using the Schnabel method, since there were more than two mark-recapture events.

Bear Gulch had the greatest estimated adult population size of the five drainages (47 adults). The East Fork City Creek population was estimated at 13 adults. The remaining three drainages had estimated population sizes less then 10 adults, however upper 95% confidence intervals estimated a maximum number of individuals between 7 (South Fork Big Rock Creek and Vincent Gulch) and 20 (Little Rock Creek) adult MYLF's.

MYLF movement

Nine adult MYLF adults were recaptured over the course of the 2001 surveys: 5 in Bear Gulch, 3 in Little Rock Creek and 1 in the East Fork of City Creek. Using the GPS coordinates taken at the point of capture, movements between the two capture locations were estimated (Table 3). The furthest movement recorded was 290 meters by an individual in the East fork of City Creek followed by 240 meters by an individual in Little Rock Creek. We were unable to acquire GPS locations for 2 of the frogs that were recaptured, resulting in no estimate for movement between captures. All movements recorded were along the stream channel; we did not record any movement over land.

DISCUSSION

The 2001 surveys for MYLF's were a continuation and expansion of previous work in the San Bernardino and Angeles National Forests. All known MYLF populations were revisited, in addition to several historic localities (Long 1970, Shoenherr 1976). We detected MYLF's at five of the sites where we found them last year: Bear Gulch, Devils Canyon, East Fork City Creek, Little Rock Creek, and South Fork Big Rock Creek (Backlin et al. 2001). We documented two additional drainages (Fuller Mill Creek and Vincent Gulch) where MYLF's were not detected in 2000 (Backlin et al. 2001); Jennings (1995, 1998, 1999) detected MYLF's in Vincent Gulch and Fuller Mill Creek in earlier years. Other sites have historically contained MYLF populations: Prairie Fork (ANF), North Fork San Jacinto River (SBNF), Alder Gulch (ANF), East Fork San Gabriel River (ANF), Fish Fork (ANF) and Dark Canyon (North Fork San Jacinto River) (SBNF) (Jennings 1995, 1998, 1999). Several stretches of Prairie Fork appeared suitable for MYLF, though not as ideal as the nearby tributaries. Dark Canyon appeared to have suitable frog habitat and MYLF's were found by Jennings in 1997 and 1998. Historically, MYLF's were found in several drainages in the San Jacinto Mountains; Dark Canyon is one of the most likely remaining locations. In the San Bernardino Mountains, MYLF's were found at one location: East Fork City Creek. This drainage was devoid of trout and appeared to be seldom visited by humans. Historically, MYLF's were found in several other drainages in the San Bernardino Mountains, including one we surveyed (Holcomb Creek).

Several factors are contributing to the decline of MYLF's in southern California. Many are anthropogenic in nature. Where intact habitat remains, introduced trout appear to be the most severe threat affecting MYLF's. Five of the seven sites where MYLF's were observed contained trout. Trout deleteriously impact frogs in several capacities. Trout have been observed preying on MYLF larvae and metamorphs (Hayes and Jennings 1986, Bradford 1989); additionally, experiments in Southern California have shown that the presence of trout eliminates tadpoles of other frogs in streams (Cooper et al. 1986). MYLF's are especially susceptible to fish predation as their larvae are completely aquatic and take a minimum of two years to metamorphose into frogs and juveniles never stray far from water (Zweifel 1955). In the summer and fall months many of these streams dry to perennial pools, concentrating the trout and the MYLF larvae into a small area for several months, severely reducing the larvae's chances for survival. Trout may also compete for the invertebrate prey upon which adult frogs depend. Dispersal along waterways may also be negatively impacted by the presence of trout. With dispersal routes impeded, most of the remaining MYLF populations in Southern California represent sink populations (Bradford et al. 1993). These small remaining populations of frogs are extremely susceptible to stochastic events. Very small populations, consisting of less than 10 pairs, are likely to become extinct in the short term (Pimm et al. 1988) and immediate conservation actions should be taken to stabilize and rebuild these populations. Other human induced impacts on MYLF's include the activities and byproducts of heavy recreational use. Hunting, fishing, camping, and hiking are very prevalent activities in these forests. Several drainages had well-worn trails and trash present in the waterway. Currently, the trail leading to Williamson Rock (ANF), a

popular and heavily used rock climbing area, runs along the MYLF's most densely populated section of Little Rock Creek. There are many unofficial trails leading from a turnout just above Williamson Rock down into the canyon. One solution would be to create an official trail from the turnout to the canyon bottom. This trail would not only be shorter in length but would avoid the section of stream with the MYLFs. Water and, on a broader scale, air pollution are also potential threats negatively impacting MYLF's.

Ten two-striped garter snakes (*Thamnophis hammondii*) were observed on our surveys. These snakes are associated with the presence of amphibians and may depend on MYLF's as a primary food source (Jennings et al.1992). These snakes feed on amphibians and their larvae and are a natural threat to the frogs.

We did not detect any chytrid fungus or iridoviruses. The chytrid fungus attacks the keratinized parts of the body (Berger et al.1998), affecting the frogs after metamorphosis. The fungus attacks the mouthparts of the larval stage but is not fatal to the tadpoles (Fellers et al. 2002). When a population is infected with a chytrid fungus there is a mass die off of frogs while the tadpoles remain. This contrasts our observations of mostly adults and only few tadpoles; additionally, all larvae mouthparts inspected were intact. Throughout our surveys only one dead frog (probably due to bird predation), one deformed frog and no dying frogs or tadpoles were found. It is important to note that iridoviruses can be naturally transmitted between animals from different taxonomic classes (Mao et al. 1999) i.e. from fish to amphibians. With worldwide transportation of fish more widespread than ever, it is a sufficient concern that introduced or stocked fish species may introduce an iridovirus into MYLF populations.

Several areas of research need to be pursued to aid in the conservation of this species in decline. Surveys of recently documented locations need to be continued, to confirm the presence or extirpation of local populations. This will help to determine trends at known recent locations. Surveys to rediscover populations not described in the last thirty years need to be completed. Bear Creek (ANF), San Gabriel River and tributaries (ANF), Snow Creek (SBNF) and Andreas Canyon (SBNF) are examples of areas likely to have existing populations of MYLF's. In conjunction, these surveys will provide a greater knowledge regarding the geographical distribution of the remaining populations.

Surveys for MYLF help determine whether frogs are present, but aid little in understanding the health and size of the population. In addition to determining the presence of MYLF, it is important to gain more accurate estimates of their population sizes. Pit-tag mark and recapture protocols provide this greater level of understanding and should be continued and expanded.

Detailed life history information, especially regarding movement patterns, could greatly benefit this species. In the Sierra Nevada, *Rana muscosa* commonly moved between deep lakes (refuges) and shallow ponds (feeding sites) (Pope 2000). Habitat in the mountains of Southern California is substantially different than that in the Sierra Nevada and the activity and movement patterns of MYLF are necessarily likewise dissimilar. It is

important to gain greater understanding of any seasonal movements and resource requirements to aid the conservation of MYLF's.

Trout removal experiments should be conducted at appropriate locations, Little Rock Creek and the South Fork of Big Rock Creek. These introduced fish appear to be the heaviest pressure negatively impacting MYLF's. Equally important, it is an impact that can most likely be controlled through intervention. Several techniques are effective at removing trout (i.e. seining, gillnetting, electroshocking). Areas of current MYLF populations could benefit immediately from the removal of trout. In addition, once trout are eliminated from areas of suitable frog habitat, reintroduction studies of MYLF could be initiated. The North Fork of the San Jacinto River (SBNF), Dark Canyon (SBNF) and the East Fork of the San Gabriel River complex (ANF) would make excellent candidates for these experiments due to the recent disappearance of the frogs and large numbers of trout.

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Table 1. Results of mountain yellow-legged frog (*Rana muscosa*) (MYLF) surveys.

Location	Date(s) Surveyed	Results	Figure #	Trout	THHA[1]
Agua Caliente Indian Reservation					
Andreas Canyon	July 12, 2001	No MYLF	21		
Murray Canyon	April 11, 2001	No MYLF	21		
Taquitz Canyon	April 11, 2001	No MYLF	15		
Bureau of Land Management					
Mission Creek	June 29, 2001	No MYLF	20		
Whitewater River	May 15, 2001	No MYLF	20		
Angeles National Forest					
Alder Gulch	July 16, 2001	No MYLF	1	Y	
Allison Gulch	July 19, 2001	No MYLF	1		
Bear Creek	September 26, 2001	No MYLF	14		
Bear Gulch	June 18, 2001	15A, 1J, 4M	19	Y	
	August 16, 2001	13A, 7J, 8M, 1L	19	Y	Y
	September 20, 2001	9A, 1J, 3M, 16L	19	Y	
Big Rock Creek, South Fork	June 11, 2001	No MYLF	9	Y	
	July 13, 2001	1A	9	Y	
	July 16, 2001	4A, 10M, 3L	9		
	August 22, 2001	3A, 6J, 6M, 1L	9	Y	Y
Chileno Creek	June 28, 2001	No MYLF	14	Y	Y
Devils Canyon	July 9, 2001	4A, 1M, 51L	16		
Fish Fork	July 17, 2001	No MYLF	1	Y	
Holcomb Canyon	June 12, 2001	No MYLF	9	Y	
Iron Fork	July 19, 2001	No MYLF	1	Y	
Little Rock Creek	June 5, 2001	4A, 2M	16	Y	
	July 12, 2001	1A, 1J	16	Y	Y
	August 21, 2001	3A, 2J, 3M, 50L	16	Y	
San Gabriel River, East Fork	July 19, 2001	No MYLF	1	Y	
Vincent Gulch	June 19, 2001	1A, 50L	19		
	August 17, 2001	3A, 1J	19	Y	
	September 21, 2001	No MYLF	19		
San Bernardino National Forest					
Arrastre Creek	September 21, 2001	No MYLF	13		
Badger Canyon	June 7, 2001	No MYLF	2		
	June 21, 2001	No MYLF	2		
	July 10, 2001	No MYLF	2		
Ben Canyon	June 7, 2001	No MYLF	2		
	June 21, 2001	No MYLF	2		
	July 10, 2001	No MYLF	2		
Borea Canyon	June 14, 2001	No MYLF	3		
	August 1, 2001	No MYLF	3		

Table 1. Continued

Location	Date(s) Surveyed	Results	Figure #	Trout	THHA
Chino Canyon	June 25, 2001	No MYLF	15		
City Creek, East Fork	May 4, 2001	1A	7		
	May 18, 2001	2A	7		
	July 10, 2001	11A, 4L	7		
	August 23, 2001	2A, 3J	7		
City Creek Watershed	June 6, 2001	No MYLF	7		
	June 13, 2001	No MYLF	7		
	June 27, 2001	No MYLF	7		
Cucamonga Creek	July 24, 2001	No MYLF	4	Y	Y
Day Canyon	July 19, 2001	No MYLF	5	Y	
Dry Creek	August 7, 2001	No MYLF	6		
	September 6, 2001	No MYLF	6		
East Twin Creek	June 28, 2001	No MYLF	3		
	July 11, 2001	No MYLF	3		
Etiwanda Creek	May 24, 2001	No MYLF	5		
Falls Creek	August 29, 2001	No MYLF	17	Y	
Fuller Mill Creek	June 20, 2001	No MYLF	10	Y	
	September 6, 2001	1A	10		
Green Canyon	August 17, 2001	No MYLF	8		
Hamilton Creek	August 2, 2001	No MYLF	11		
Holcomb Creek	August 21, 2001	No MYLF	12	Y	Y
Little Sand Canyon	June 14, 2001	No MYLF	3		
	June 20, 2001	No MYLF	3		
Lytle Creek, Middle Fork	June 12, 2001	No MYLF	5	Y	
Mile Creek	August 3, 2001	No MYLF	11		
Mill Creek	July 25, 2001	No MYLF	17		
Mountain Home Creek	July 26, 2001	No MYLF	8	Y	
Omstott Canyon	May 23, 2001	No MYLF	22		
Plunge Creek	July 15, 2001	No MYLF	18		
Sand Canyon	August 7, 2001	No MYLF	3		
	August 29, 2001	No MYLF	3		
San Jacinto River, North Fork	June 20, 2001	No MYLF	10	Y	
	June 21, 2001	No MYLF	10	Y	
	September 6, 2001	No MYLF	10	Y	
	September 7, 2001	No MYLF	10	Y	
Strawberry Creek	July 1, 2001	No MYLF	3		
Sycamore Canyon	June 4, 2001	No MYLF	2		
	June 7, 2001	No MYLF	2		
	June 21, 2001	No MYLF	2		
	June 25, 2001	No MYLF	2		
	July 10, 2001	No MYLF	2		
Warm Springs Canyon	July 27, 2001	No MYLF	18		Y
Whitewater River, South Fork	May 22, 2001	No MYLF	17	Y	

[1] THHA: two-striped garter snake (*Thamnophis hammondii*)

Table 2. Preliminary estimates of adult mountain yellow-legged frog populations in Angeles and San Bernardino National Forests.

Location	Date(s) Surveyed	# Captures	# Adults	# Marked	# Recaptures	Adult Population Estimate		
						Pop. Size	Lower 95%	Upper 95%
Angeles National Forest								
Bear Gulch	June 18, 2001	20	15	10	-			
	August 16, 2001	29	13	7	5			
	September 20, 2001	16	9	5	1			
	Population Estimate[1]:					**47**	**22**	**108**
Big Rock Creek, South Fork	June 11, 2001	0	0	0	-			
	July 13, 2001	1	1	1	0			
	July 16, 2001	16	4	1	0			
	August 22, 2001	16	3	2	0			
	Population Estimate[2]:					**7**	**1**	**7**
Devils Canyon[3]	July 9, 2001	7	4	3	-			
Little Rock Creek	June 5, 2001	6	4	4	-			
	July 12, 2001	2	1	0	1			
	August 21, 2001	9	3	1	2			
	Population Estimate[1]:					**5**	**2**	**20**
Vincent Gulch	June 19, 2001	2	1	1	-			
	August 17, 2001	4	3	3	0			
	September 21, 2001	0	0	0	0			
	Population Estimate[2]:					**7**	**1**	**7**
San Bernardino National Forest								
City Creek, East Fork	May 18, 2001	2	2	2	-			
	July 10, 2001	14	11	8	1			
	Population Estimate[2]:					**13**	**5**	**74**

[1] Schnabel Method: estimates population size when there are more than two samples

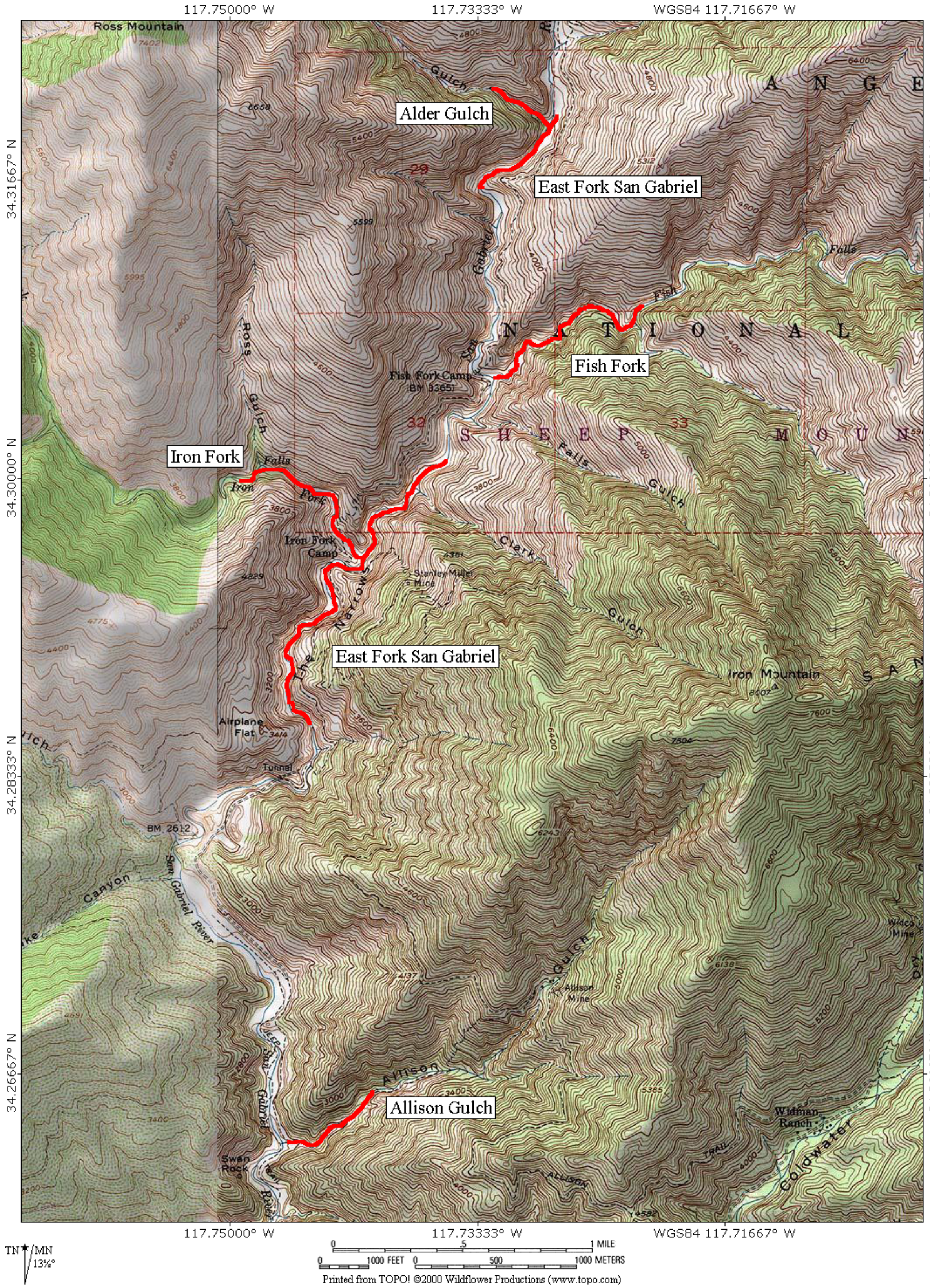
[2] Peterson Method: estimates population size when there is a single episode of marking and a single episode of recapturing individuals

[3] No estimate due to only one marking event

Table 3. Movement estimates of adult mountain yellow-legged frogs in the Angeles and San Bernardino National Forests.

Location	Capture Date	PIT tag #	Latitude[1]	Longitude[1]	Notes	Distance between points	Direction of movement
Angeles National Forest	6/18/2001	410348784F	34.355117	117.708067		40m	Upstream
Bear Gulch	8/16/2001		34.355083	117.70858			
Bear Gulch	6/18/2001	41034F6C54			No GPS location		
	8/16/2001				No GPS location		
Bear Gulch	6/18/2001	4103506B1D	34.352867	117.709533		40m	Downstream
	8/16/2001		34.353067	117.70968			
Little Rock Creek	6/5/2001	44382316	34.36355	117.878000		240m	Downstream
	7/12/2001		34.36156	117.87849			
Little Rock Creek	6/5/2001	44325072	34.360683	117.880183		80m	Upstream
	8/21/2001		34.36076	117.87982			
Little Rock Creek	6/5/2001	44338618	34.3606	117.880350		50m	Upstream
	8/21/2001		34.36076	117.87981			
Bear Gulch	6/18/2001	44095371			No GPS location		
	8/16/2001		34.356017	117.70738			
Bear Gulch	6/18/2001	44310813	34.352867	117.709533	30m upstream of this point	20m	Downstream
	8/16/2001		34.353	117.70953			then
	9/20/2001		34.352933	117.70958			Upstream
San Bernardino National Forest	5/18/2001	44094047	34.18462	117.17849		290m	Upstream
East Fork City Creek	7/10/2001		34.18658	117.17707			

[1]GPS locations were recorded in WGS 84.



Survey reach
MYLF larvae
MYLF adult/juvenile

Figure 1.

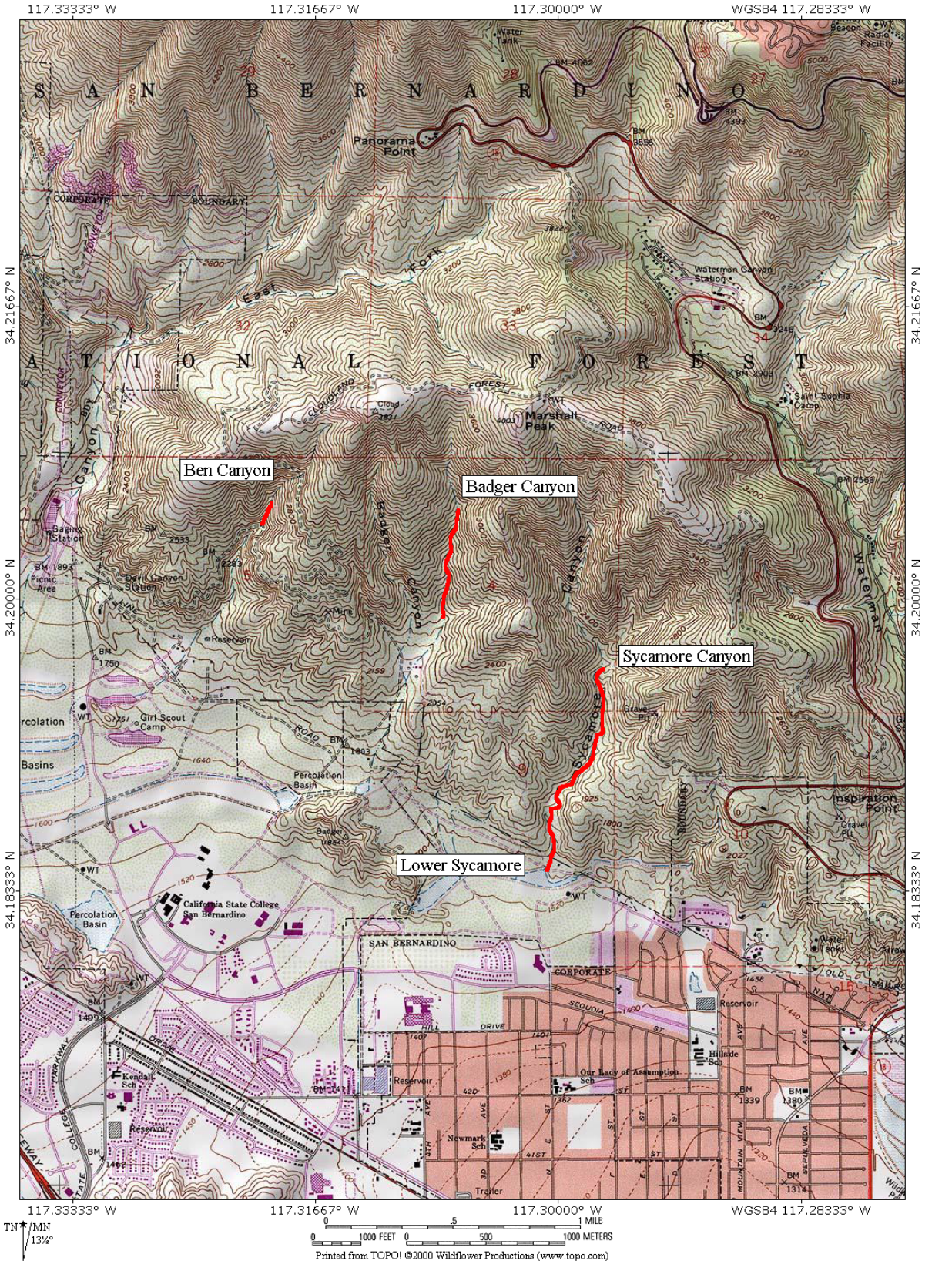
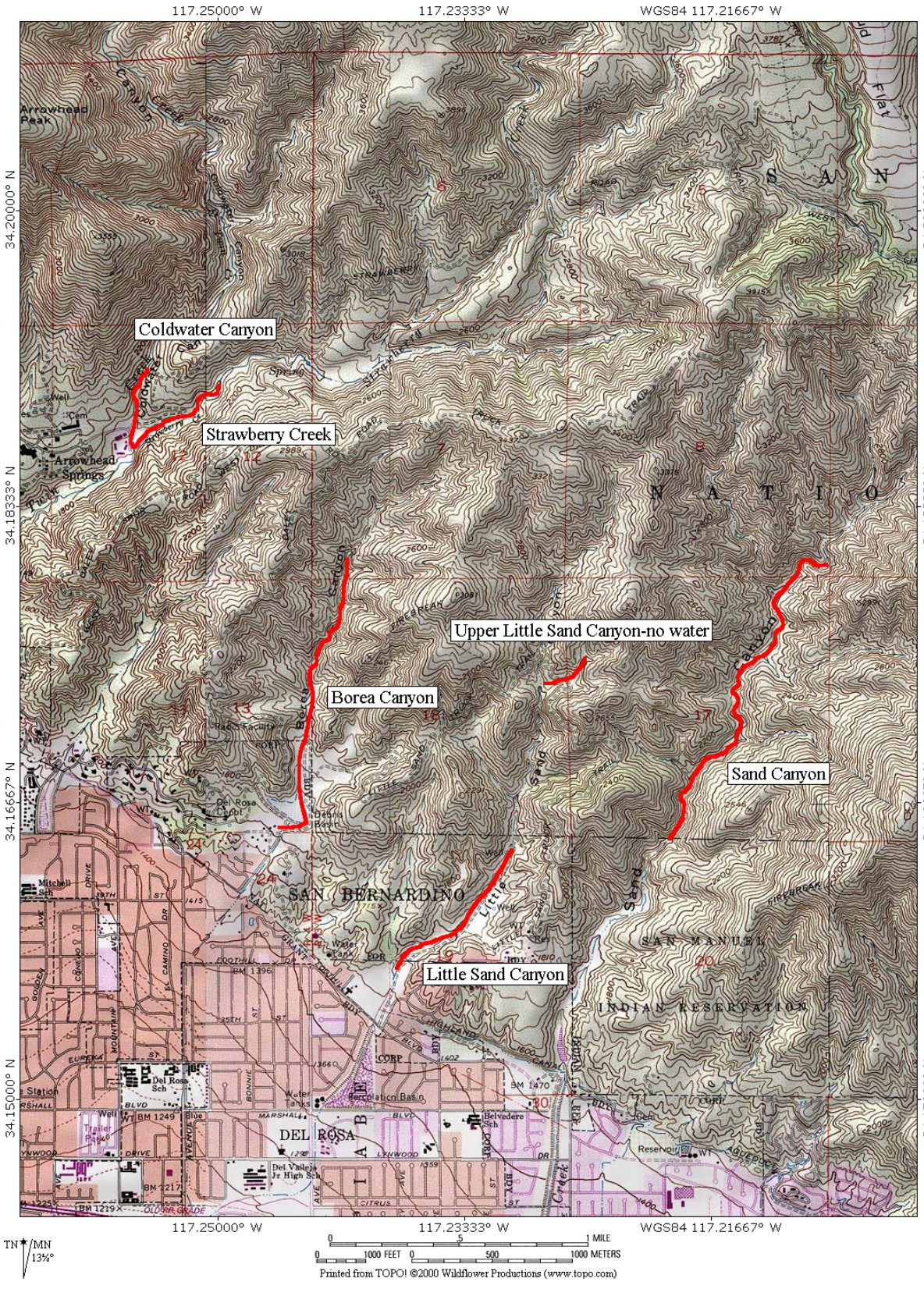

117.33333° W
117.31667° W
117.30000° W
WGS84 117.28333° W
34.21667° N
34.20000° N
34.18333° N
Ben Canyon
Badger Canyon
Sycamore Canyon
Lower Sycamore
SAN BERNARDINO
NATIONAL FOREST
Panorama Point
Marshall Peak
Waterman Canyon Station
Devil Canyon Station
Girl Scout Camp
California State College San Bernardino
Percolation Basin
Reservoir
Inspiration Point
Our Lady of Assumption Sch
Kendall Sch
Newmark Sch
Hillside Sch
Printed from TOPO! ©2000 Wildflower Productions (www.topo.com)
Survey reach
MYLF larvae
MYLF adult/juvenile

Figure 2.



Survey reach

MYLF larvae

MYLF adult/juvenile

Figure 3.


117.65000° W
117.63333° W
117.61667° W
WGS84 117.60000° W
34.21667° N
34.20000° N
34.18333° N
34.16667° N
Cucamonga Creek
San Antonio Heights
Water Tank
Percolation Basin
GRANT
BDY
HILLSIDE
ROAD
Printed from TOPO! ©2000 Wildflower Productions (www.topo.com)
Survey reach
MYLF larvae
MYLF adult/juvenile

Figure 4.

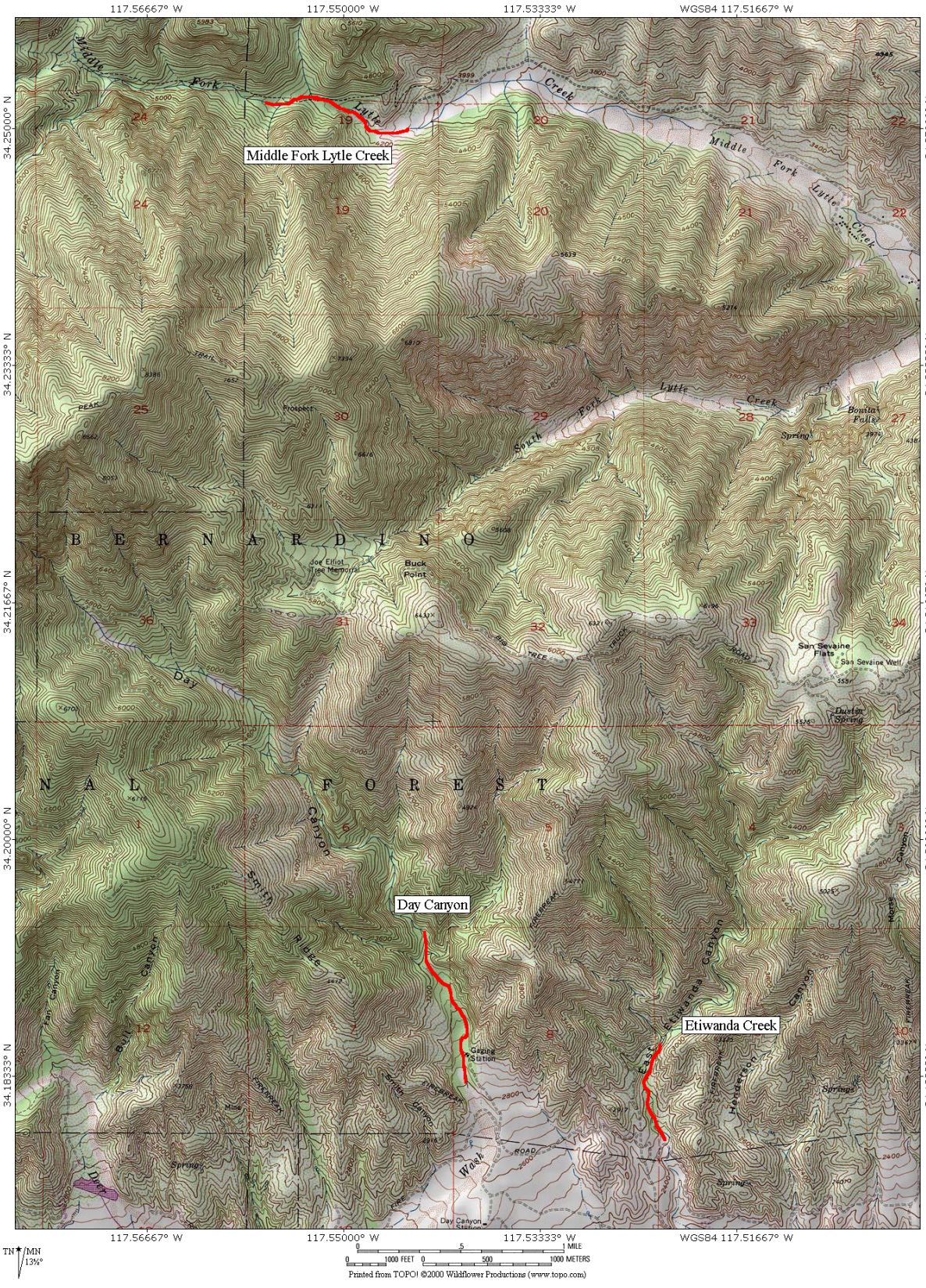

117.56667° W
117.55000° W
117.53333° W
WGS84 117.51667° W
34.25000° N
34.23333° N
34.21667° N
34.20000° N
34.18333° N
Middle Fork Lytle Creek
Day Canyon
Etiwanda Creek
B E R N A R D I N O
N A L F O R E S T
Printed from TOPO! ©2000 Wildflower Productions (www.topo.com)
Survey reach
MYLF larvae
MYLF adult/juvenile

Figure 5.

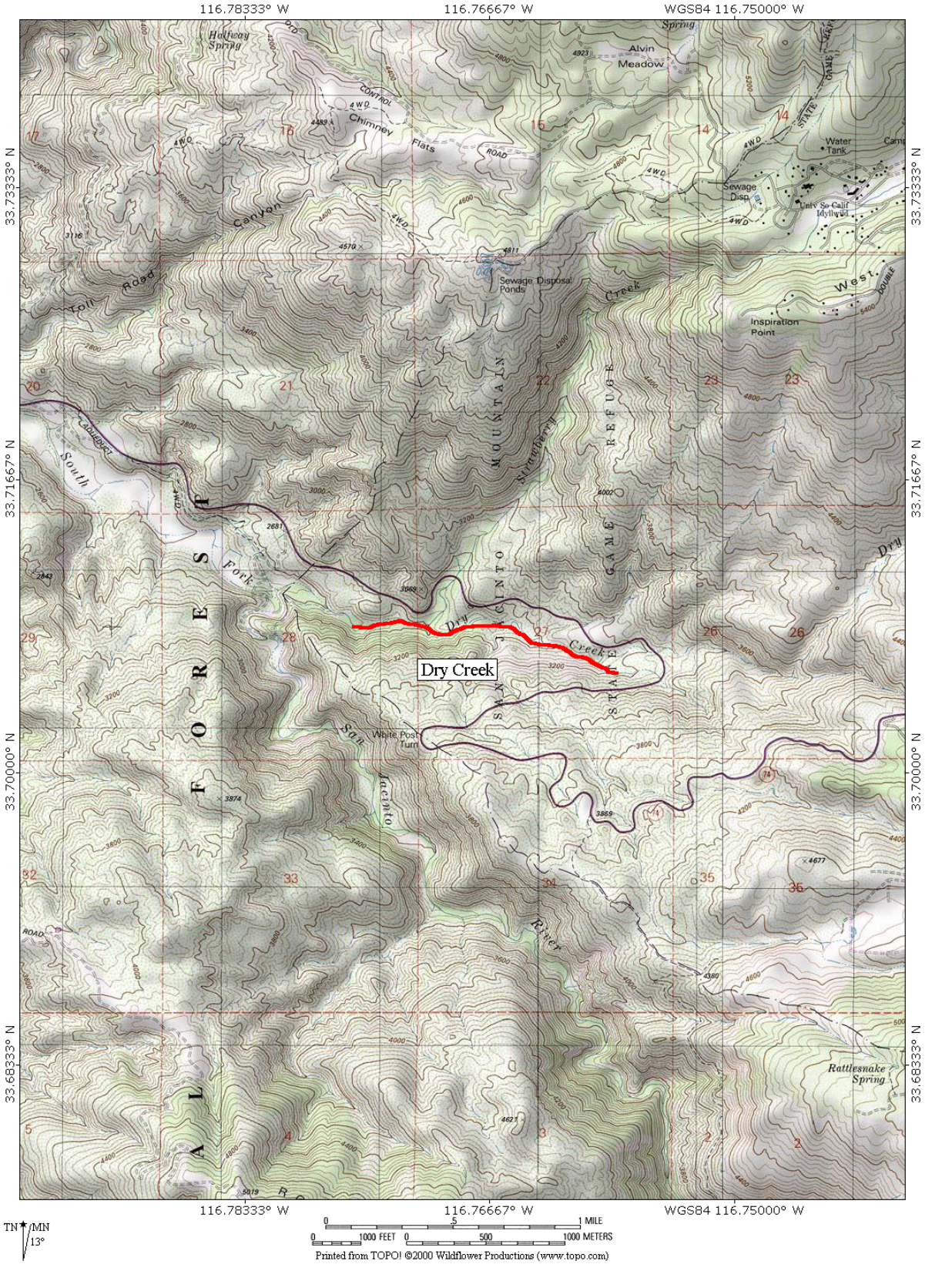

116.78333° W
116.76667° W
WGS84 116.75000° W
33.73333° N
33.71667° N
33.70000° N
33.68333° N
Holloway Spring
Alvin Meadow
Chimney Flats
Water Tank
Sewage Disp.
Sewage Disposal Ponds
Toll Road
Canyon
Inspiration Point
South Fork
San Jacinto Mountains
Dry Creek
White Post Turn
San Jacinto River
Rattlesnake Spring
CLEVELAND NATIONAL FOREST
SAN JACINTO STATE GAME REFUGE
TN 13° MN
0 1 MILE
0 1000 FEET 0 .5 1000 METERS
Printed from TOPO! ©2000 Wildflower Productions (www.topo.com)
Survey reach
MYLF larvae
MYLF adult/juvenile

Figure 6.

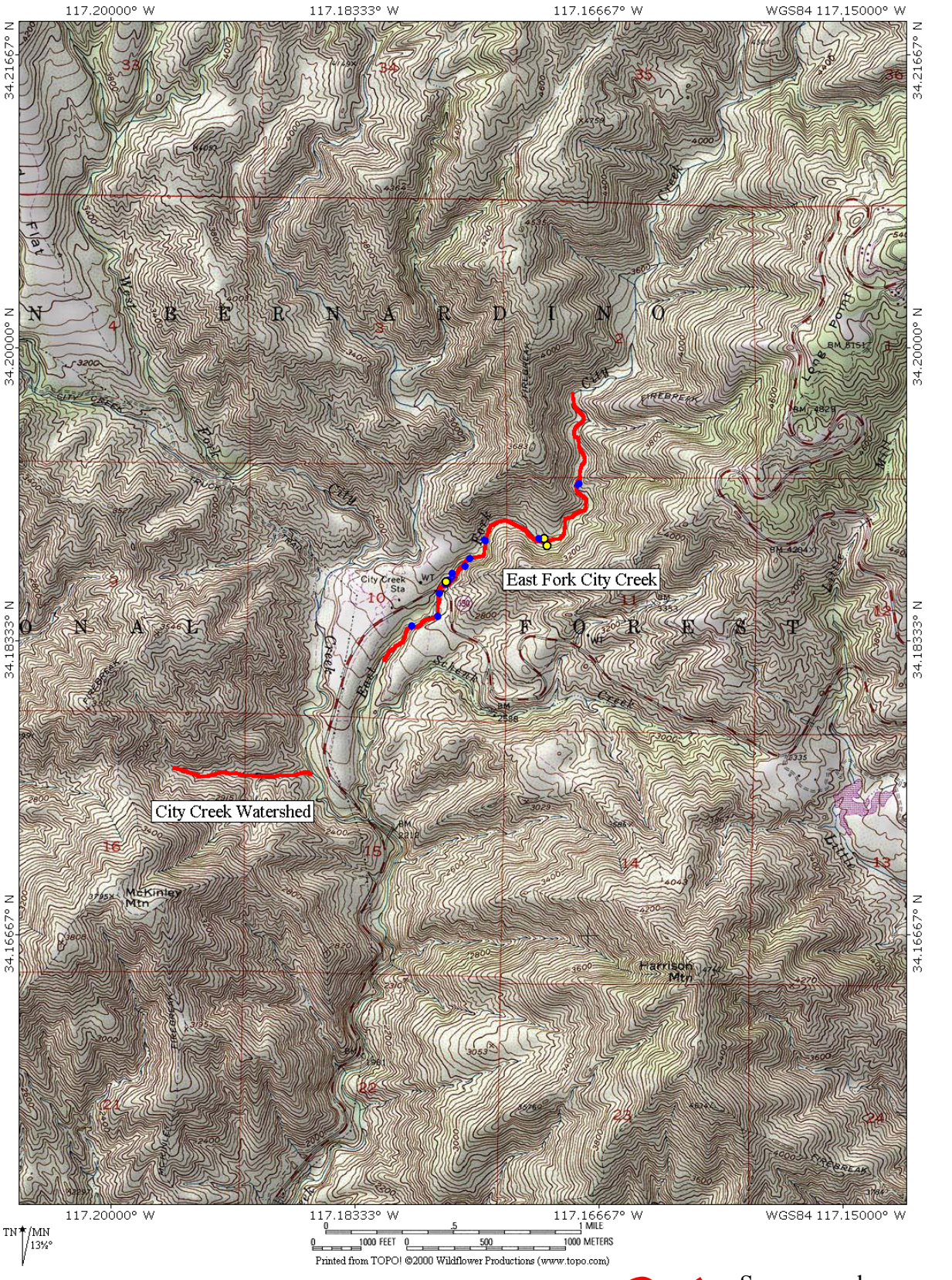

117.20000° W
117.18333° W
117.16667° W
WGS84 117.15000° W
34.21667° N
34.20000° N
34.18333° N
34.16667° N
East Fork City Creek
City Creek Watershed
City Creek Sta
McKinley Mtn
Harrison Mtn
SAN BERNARDINO NATIONAL FOREST
TN 13¾°
MILE
1000 FEET
1000 METERS
Printed from TOPO! ©2000 Wildflower Productions (www.topo.com)
Survey reach
MYLF larvae
MYLF adult/juvenile

Figure 7.

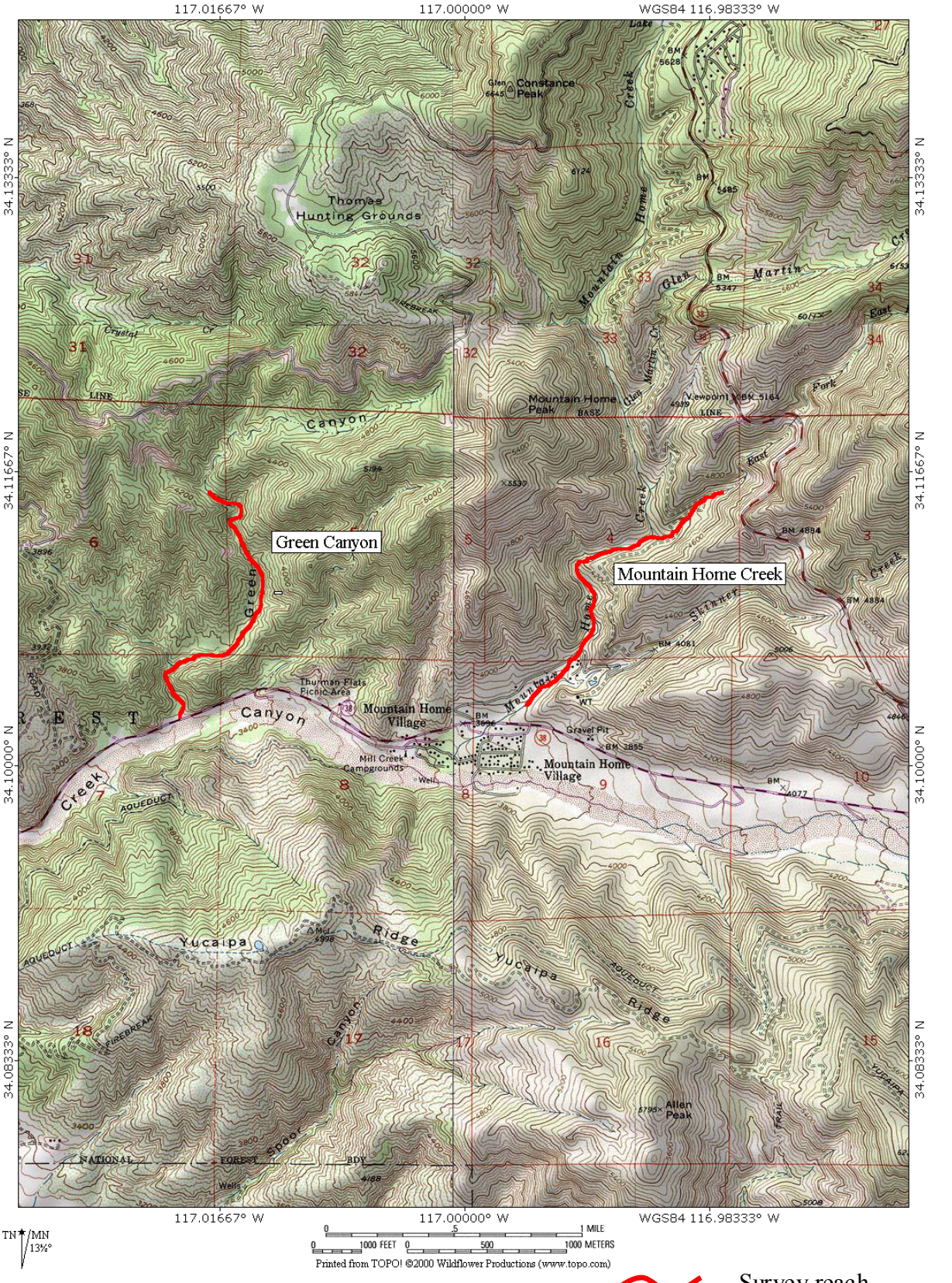
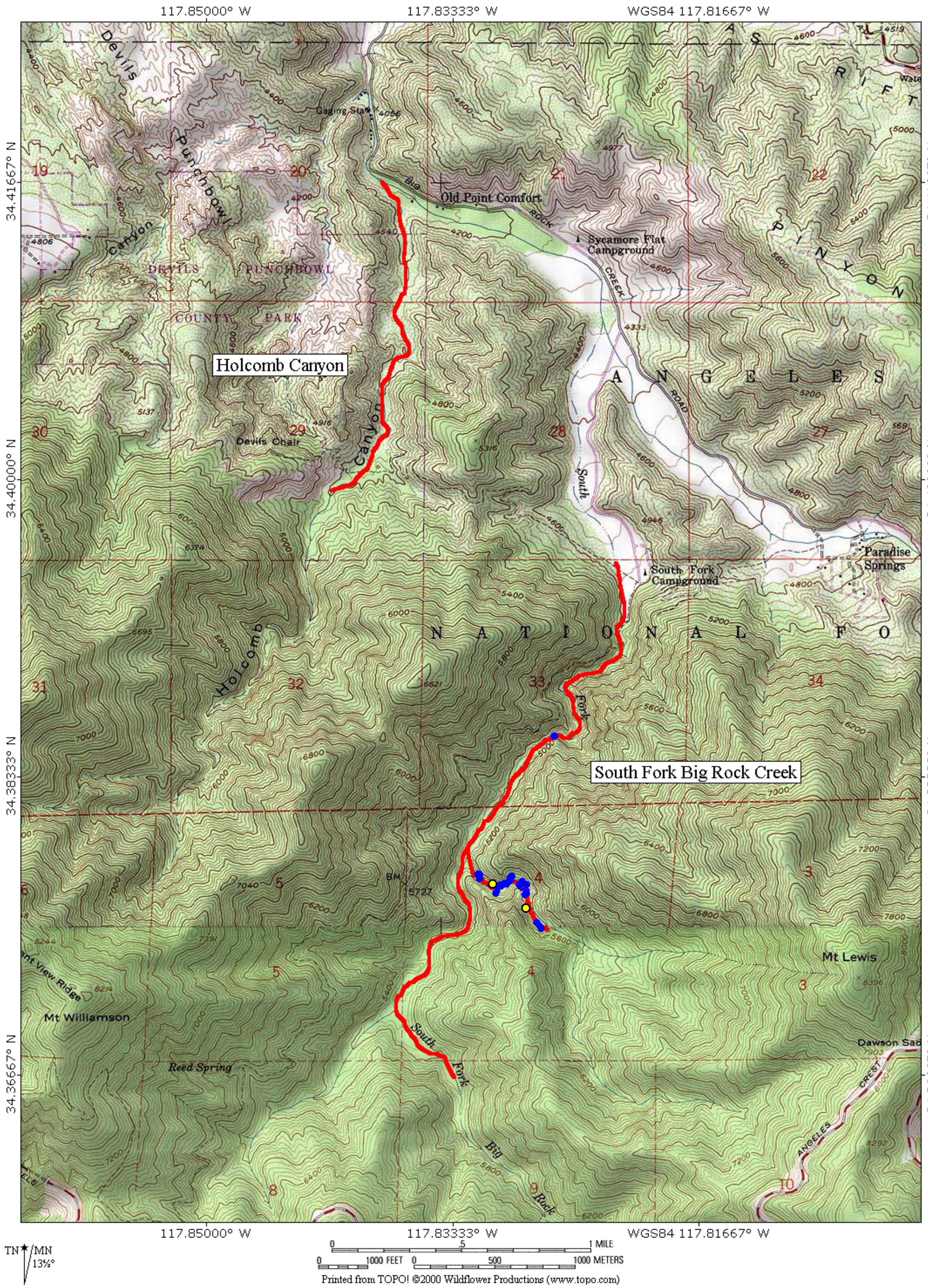
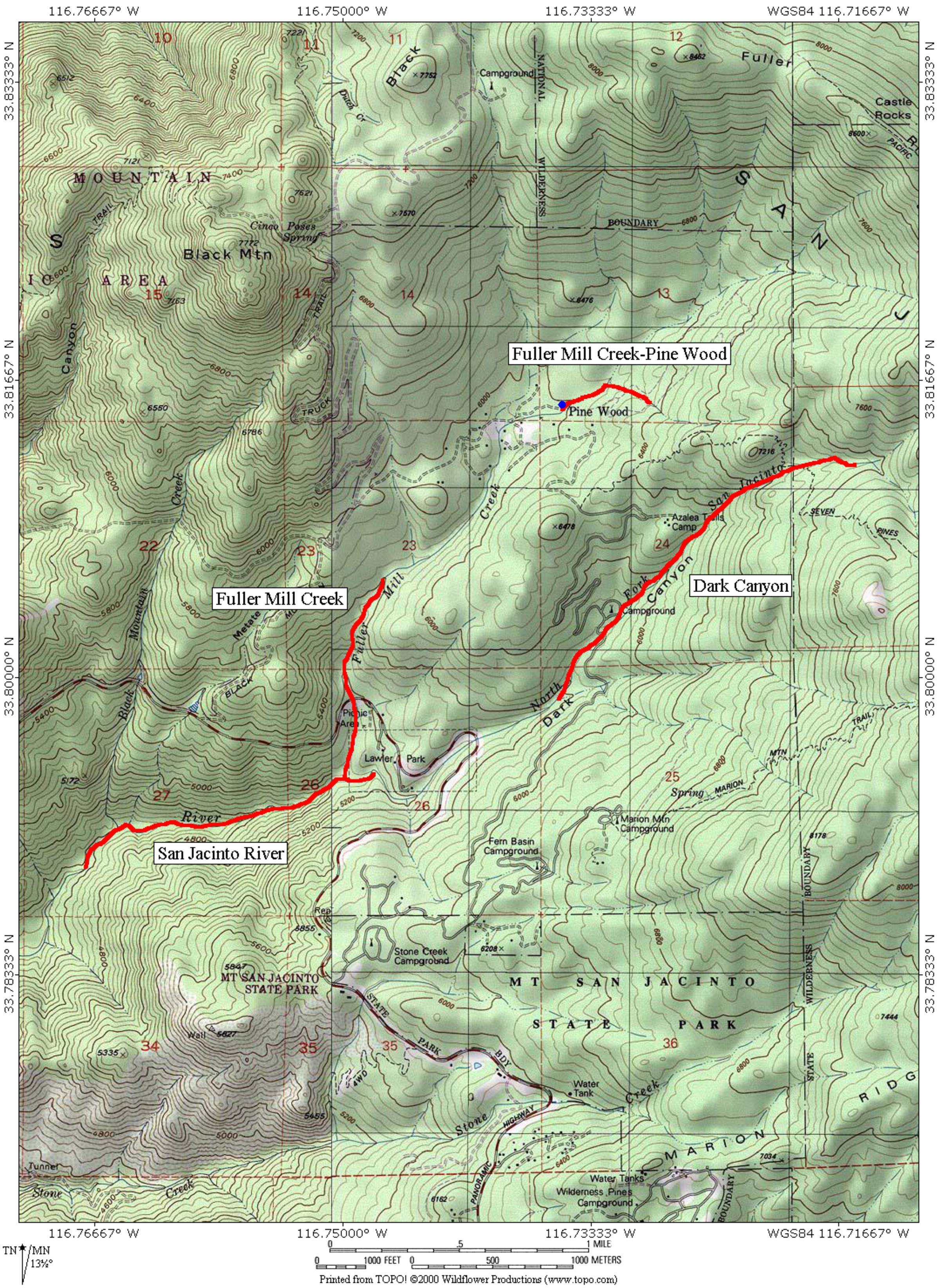

117.01667° W
117.00000° W
WGS84 116.98333° W
34.13333° N
34.11667° N
34.10000° N
34.08333° N
Green Canyon
Mountain Home Creek
Thomas Hunting Grounds
Constance Peak
Mountain Home Peak
Thurman Flats Picnic Area
Mountain Home Village
Mill Creek Campgrounds
Gravel Pit
Yucaipa Ridge
Allen Peak
Yucaipa
Canyon
Creek
Ridge
AQUEDUCT
FIREBREAK
NATIONAL FOREST BDY
TN / MN 13½°
0 1 MILE
0 1000 FEET 0 500 1000 METERS
Printed from TOPO! ©2000 Wildflower Productions (www.topo.com)
Survey reach
MYLF larvae
MYLF adult/juvenile

Figure 8.



Survey reach
MYLF larvae
MYLF adult/juvenile

Figure 9.



Survey reach

MYLF larvae

MYLF adult/juvenile

Figure 10.

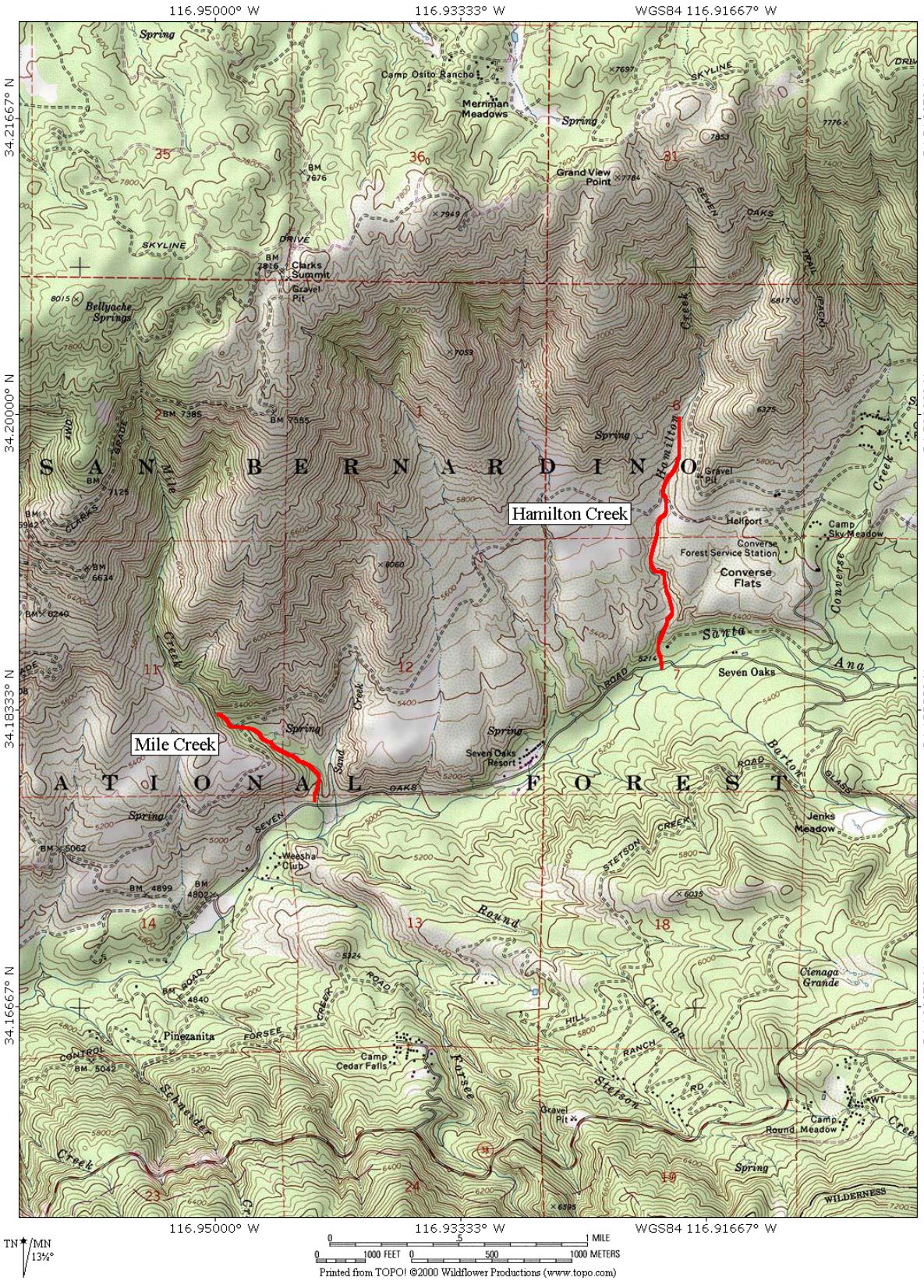

116.95000° W
116.93333° W
WGS84 116.91667° W
34.21667° N
34.20000° N
34.18333° N
34.16667° N
Hamilton Creek
Mile Creek
Survey reach
MYLF larvae
MYLF adult/juvenile
Printed from TOPO! ©2000 Wildflower Productions (www.topo.com)

Figure 11.

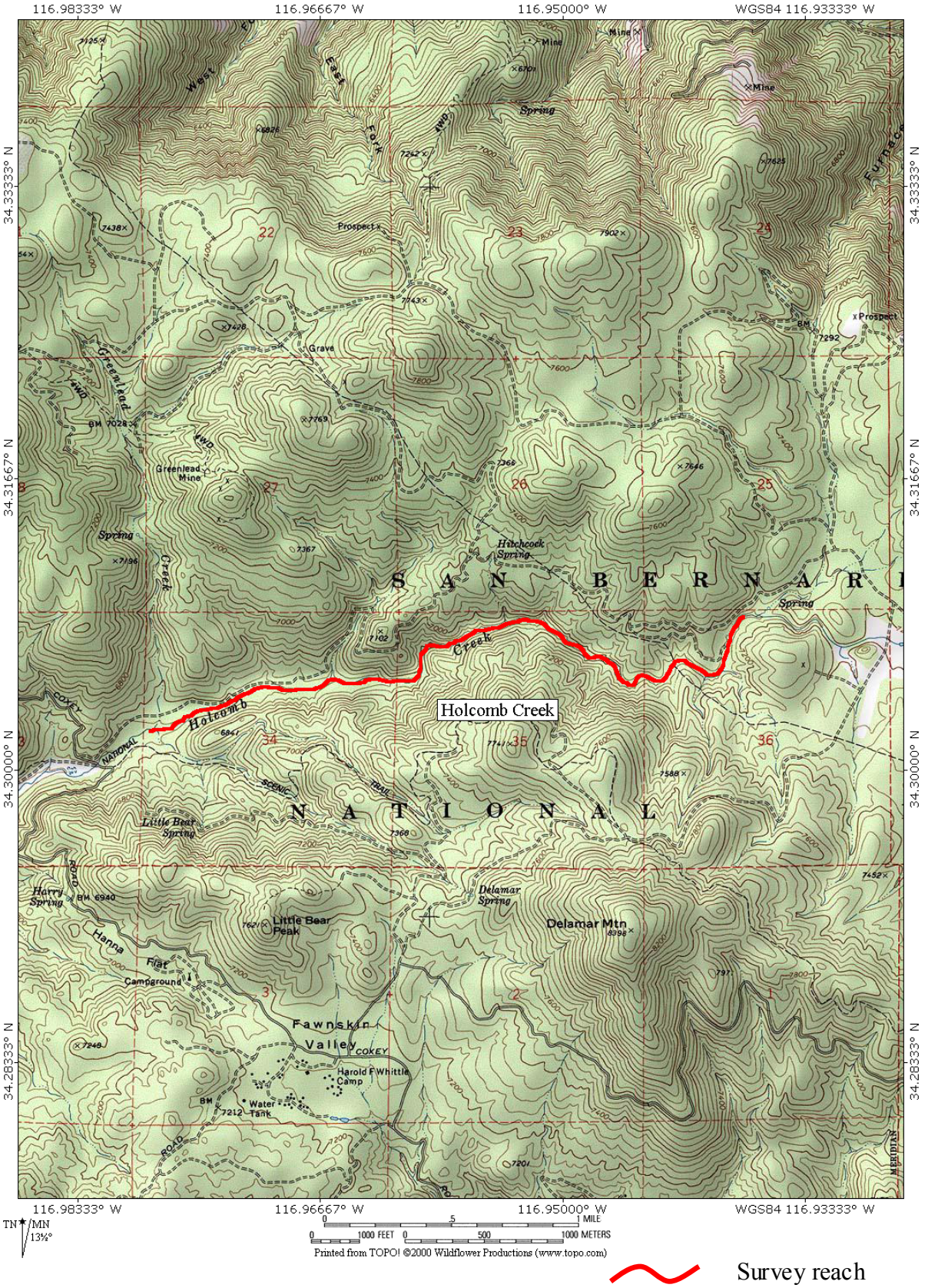

116.98333° W
116.96667° W
116.95000° W
WGS84 116.93333° W
34.33333° N
34.31667° N
34.30000° N
34.28333° N
Holcomb Creek
S A N B E R N A R
N A T I O N A L
Fawnskin
Valley
Delamar Mtn
Little Bear Peak
Harold F Whittle Camp
Water Tank
Hatchcock Spring
Delamar Spring
Little Bear Spring
Harry Spring
Hanna Flat Campground
Greenlead Mine
Prospect
Mine
Grave
Spring
Survey reach
MYLF larvae
MYLF adult/juvenile
Printed from TOPO! ©2000 Wildflower Productions (www.topo.com)

Figure 12.

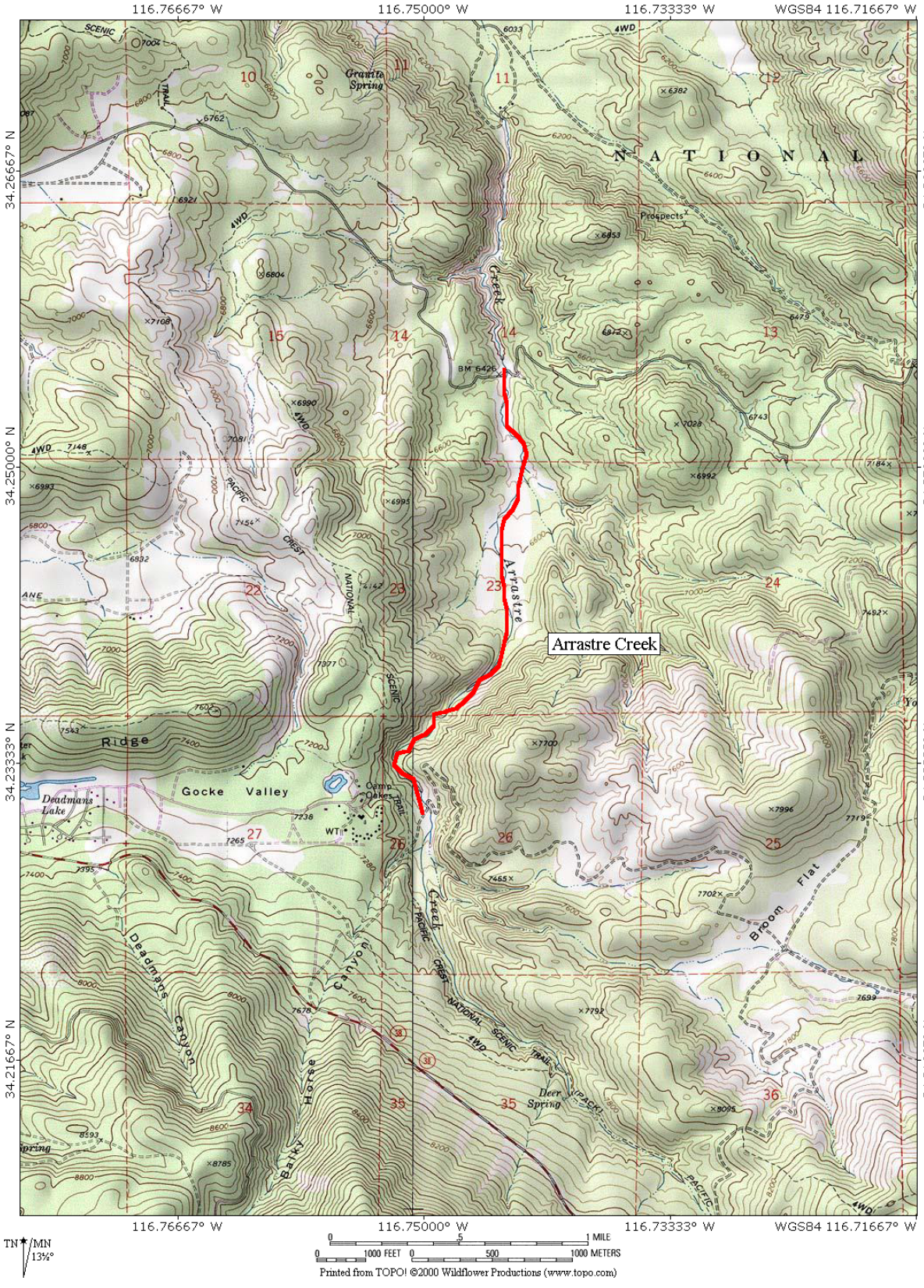

116.76667° W
116.75000° W
116.73333° W
WGS84 116.71667° W
34.26667° N
34.25000° N
34.23333° N
34.21667° N
Arrastre Creek
Survey reach
MYLF larvae
MYLF adult/juvenile
Printed from TOPO! ©2000 Wildflower Productions (www.topo.com)

Figure 13.

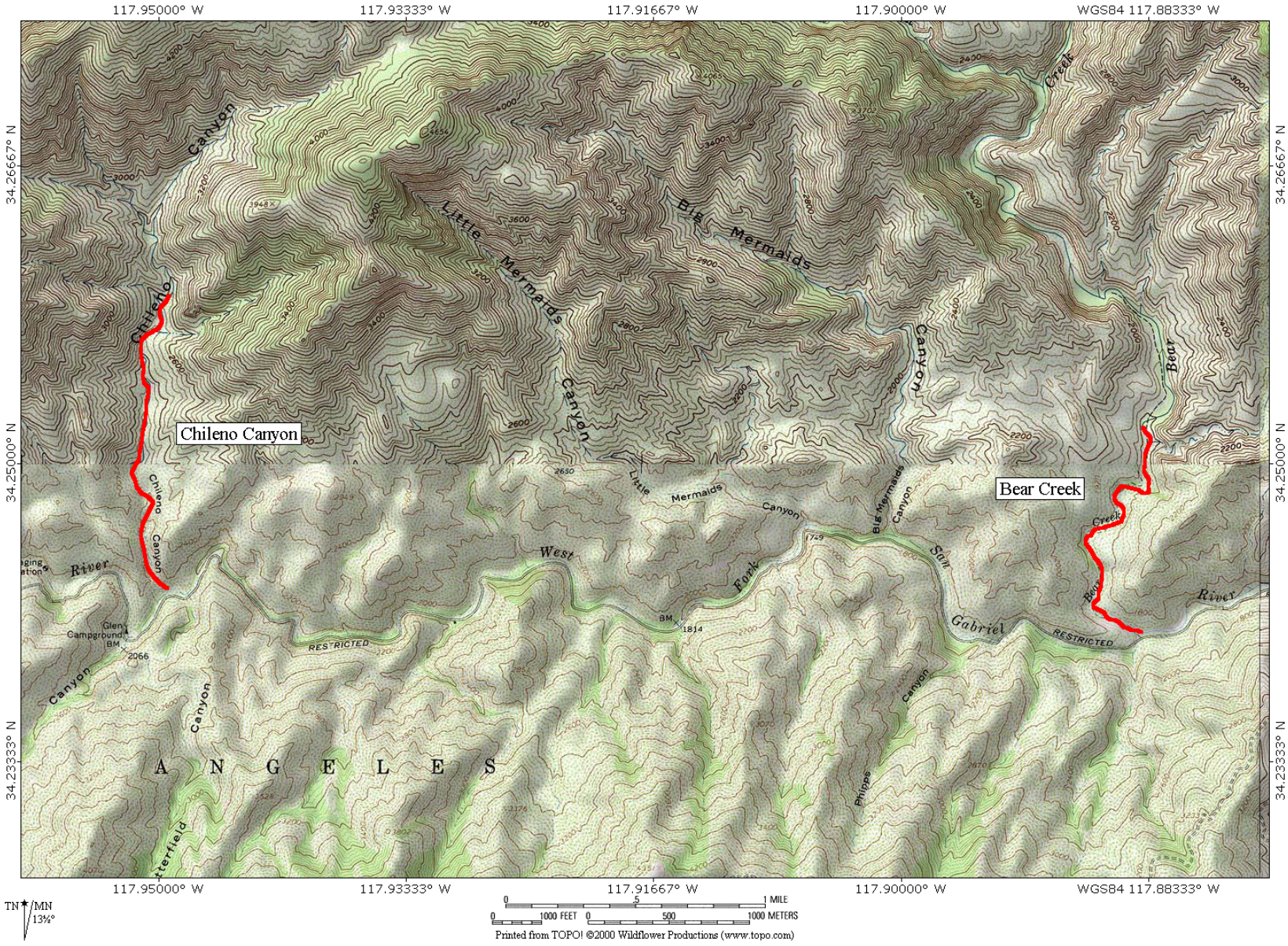

117.95000° W
117.93333° W
117.91667° W
117.90000° W
WGS84 117.88333° W
34.26667° N
34.25000° N
34.23333° N
Chileno Canyon
Bear Creek
Little Mermaids Canyon
Big Mermaids Canyon
West Fork Sun Gabriel River
Glen Campground BM 2066
BM 1814
RESTRICTED
A N G E L E S
TN 13½° MN
0 1 MILE
0 1000 FEET 0 500 1000 METERS
Printed from TOPO! ©2000 Wildflower Productions (www.topo.com)
Survey reach
MYLF larvae
MYLF adult/juvenile

Figure 14.

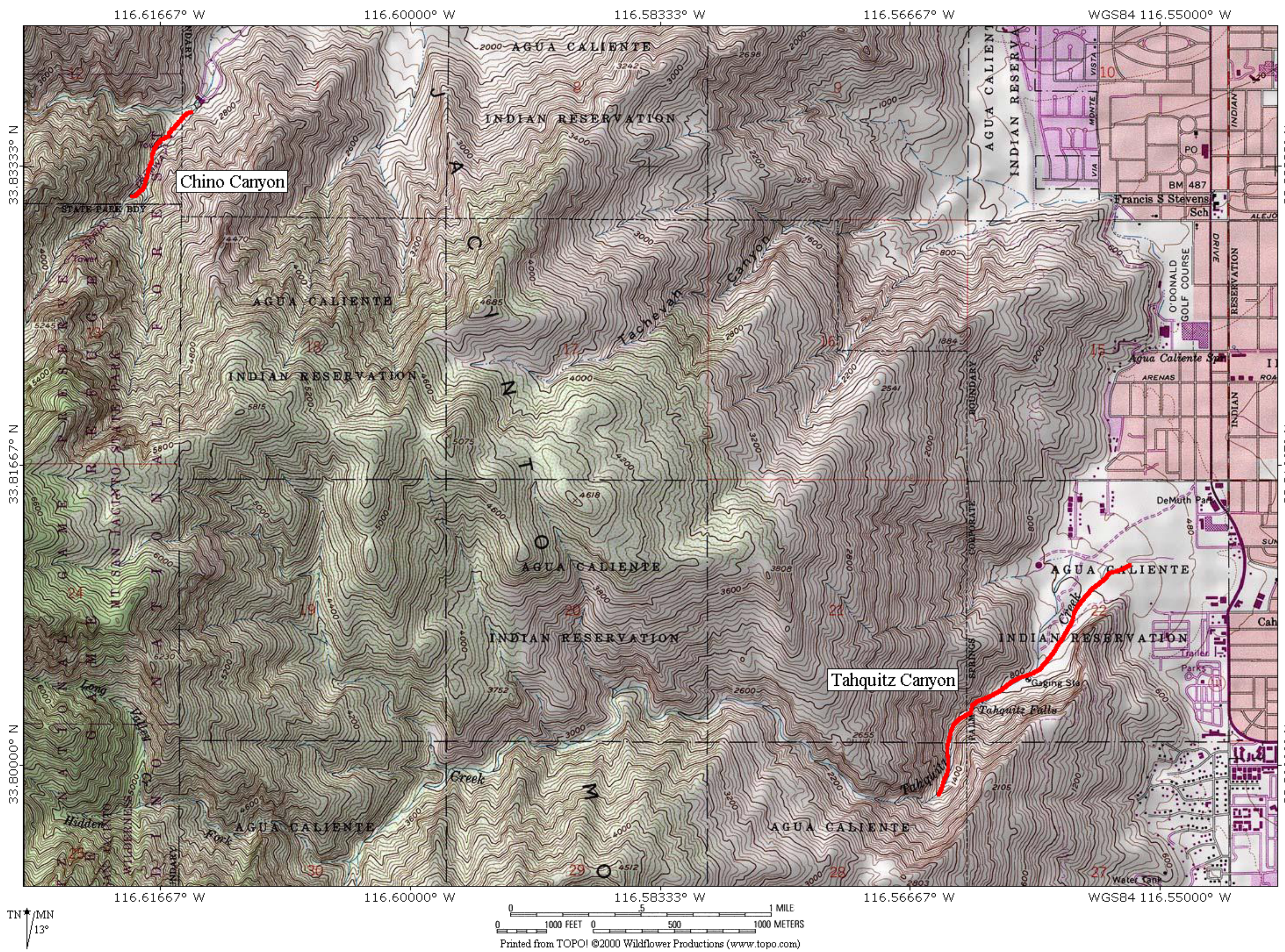


Figure 15.

Survey reach

MYLF larvae

MYLF adult/juvenile

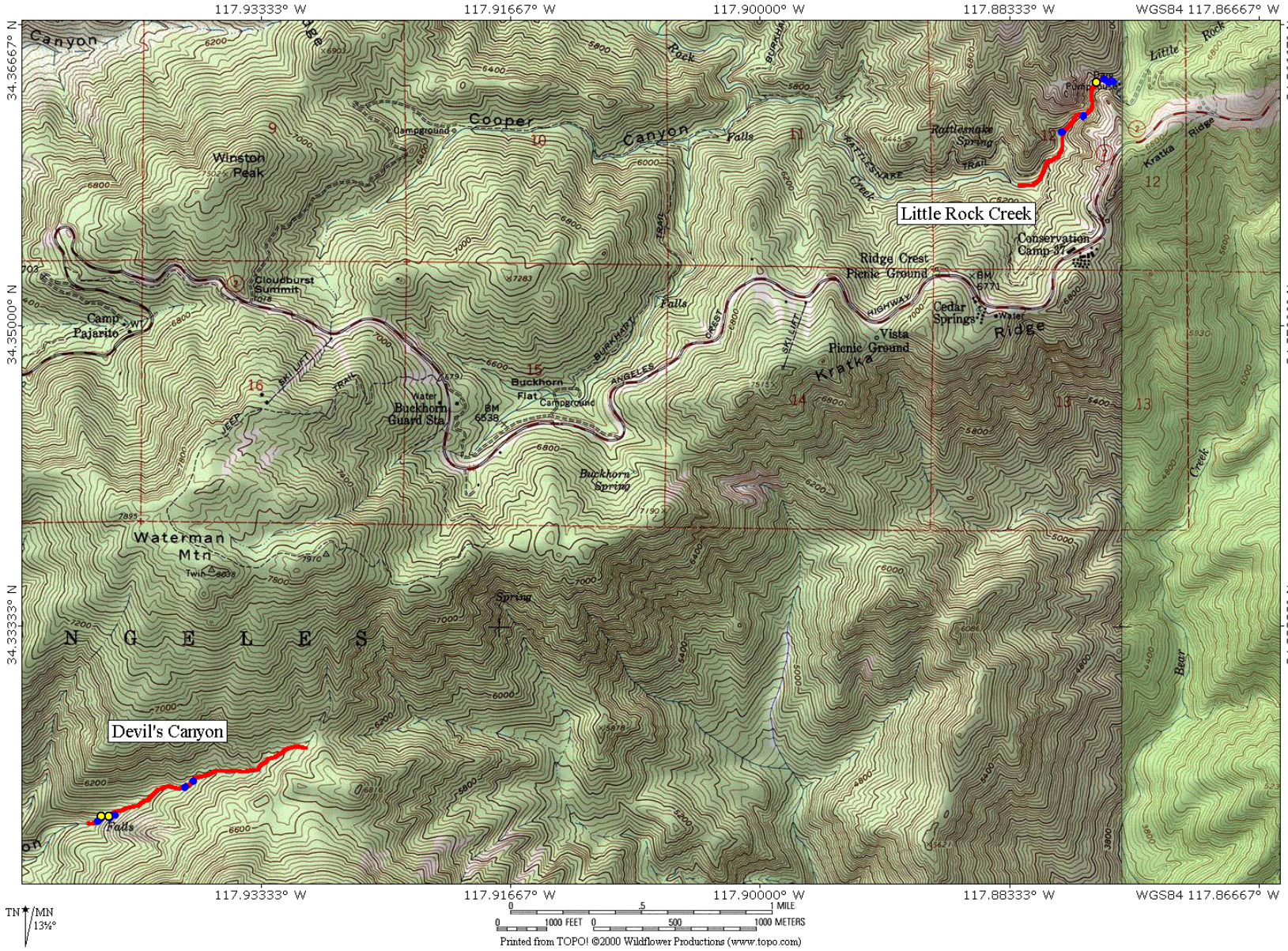

117.93333° W
117.91667° W
117.90000° W
117.88333° W
WGS84 117.86667° W
34.36667° N
34.35000° N
34.33333° N
Little Rock Creek
Devil's Canyon
Cooper Canyon
Winston Peak
Cloudburst Summit
Camp Pajarito
Buckhorn Flat Campground
Buckhorn Guard Sta
Buckhorn Spring
Waterman Mtn
Ridge Crest Picnic Ground
Conservation Camp 37
Cedar Springs
Vista Picnic Ground
Kratka Ridge
Rattlesnake Spring
Rattlesnake Creek
Little Rock Creek
Bear Creek
Falls
Spring
Water
Twin
Trail
Jeep
Ski Lift
Highway
Crest
Burkhart
Angeles
N G E L E S
TN 13½°
MN
0 1000 FEET 0 .5 MILE
0 500 1000 METERS
Printed from TOPO! ©2000 Wildflower Productions (www.topo.com)
Survey reach
MYLF larvae
MYLF adult/juvenile

Figure 16.

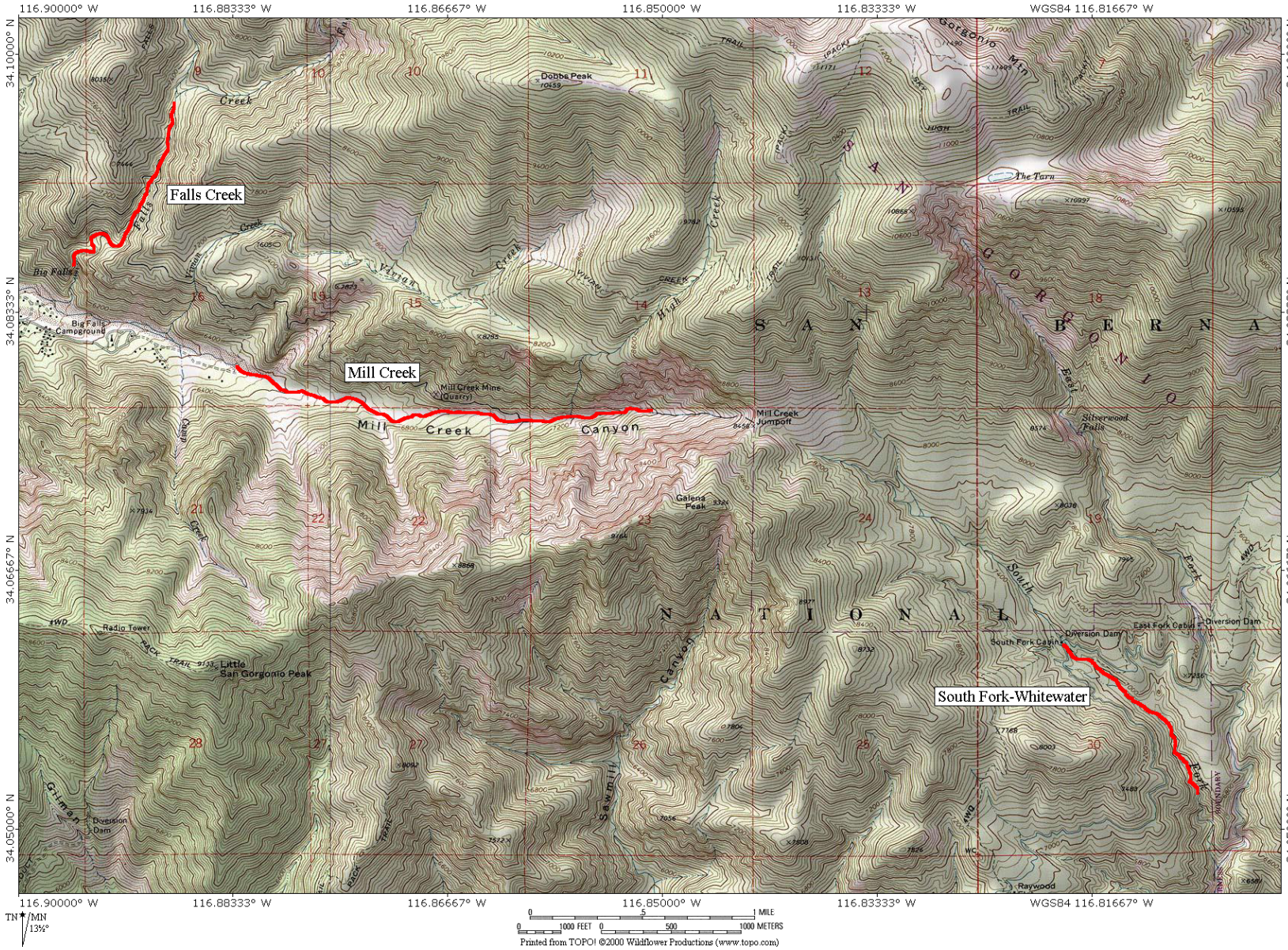

116.90000° W
116.88333° W
116.86667° W
116.85000° W
116.83333° W
WGS84 116.81667° W
34.10000° N
34.08333° N
34.06667° N
34.05000° N
Falls Creek
Mill Creek
South Fork-Whitewater
Dobbe Peak
Big Falls
Big Falls Campground
Mill Creek Mine (Quarry)
Mill Creek Jumpoff
Mill Creek Canyon
Galena Peak
Radio Tower
Little San Gorgonio Peak
Diversion Dam
South Fork Cabin
East Fork Cabin
Silverwood Falls
The Tarn
Gorgonio Mtn
SAN GORGONIO WILDERNESS
NATIONAL
Raywood
TN
MN
13½°
0 1000 FEET 0 500 1000 METERS
0 .5 1 MILE
Printed from TOPO! ©2000 Wildflower Productions (www.topo.com)
Survey reach
MYLF larvae
MYLF adult/juvenile

Figure 17.

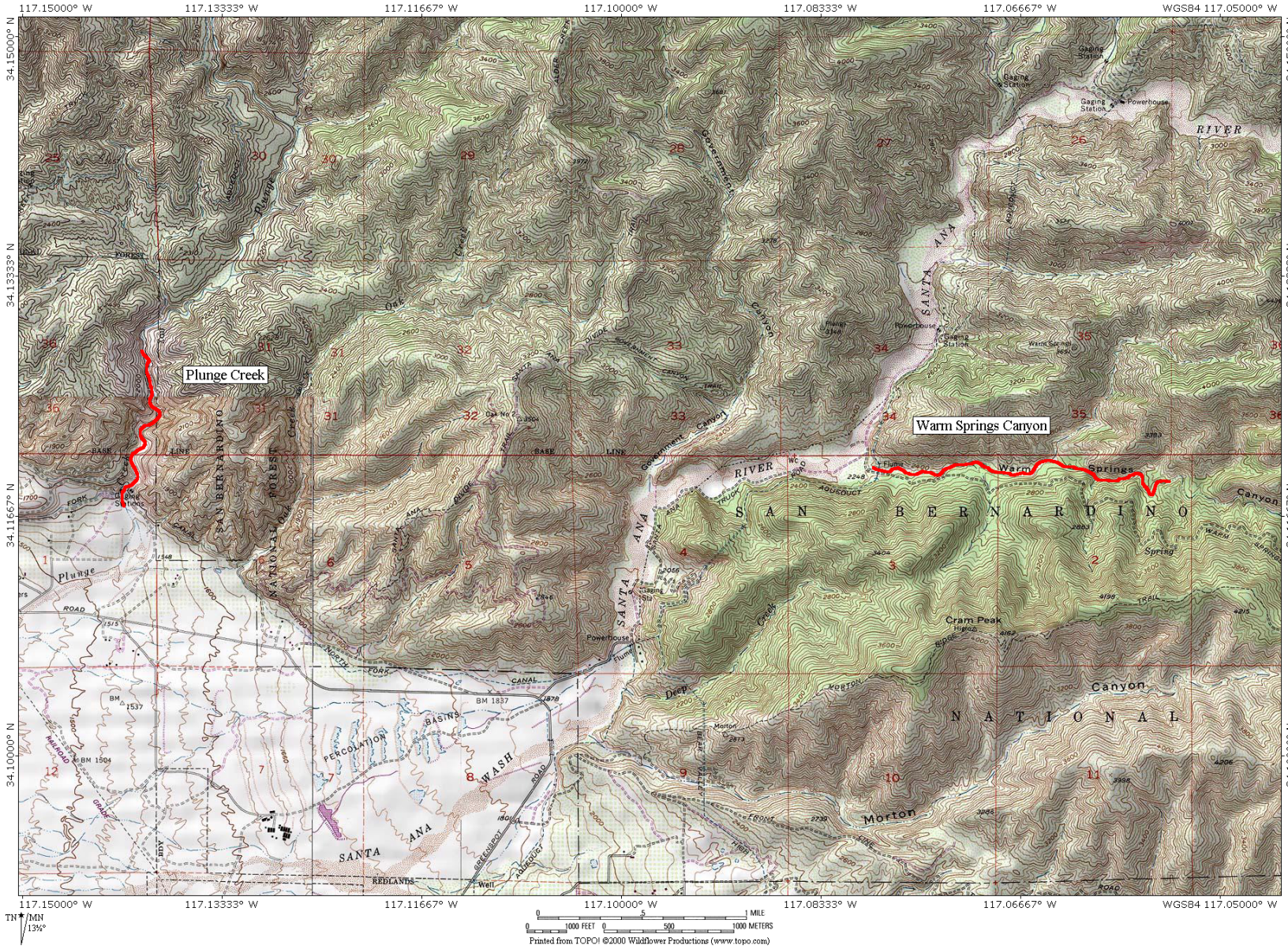

Plunge Creek
Warm Springs Canyon
Survey reach
MYLF larvae
MYLF adult/juvenile

Figure 18.

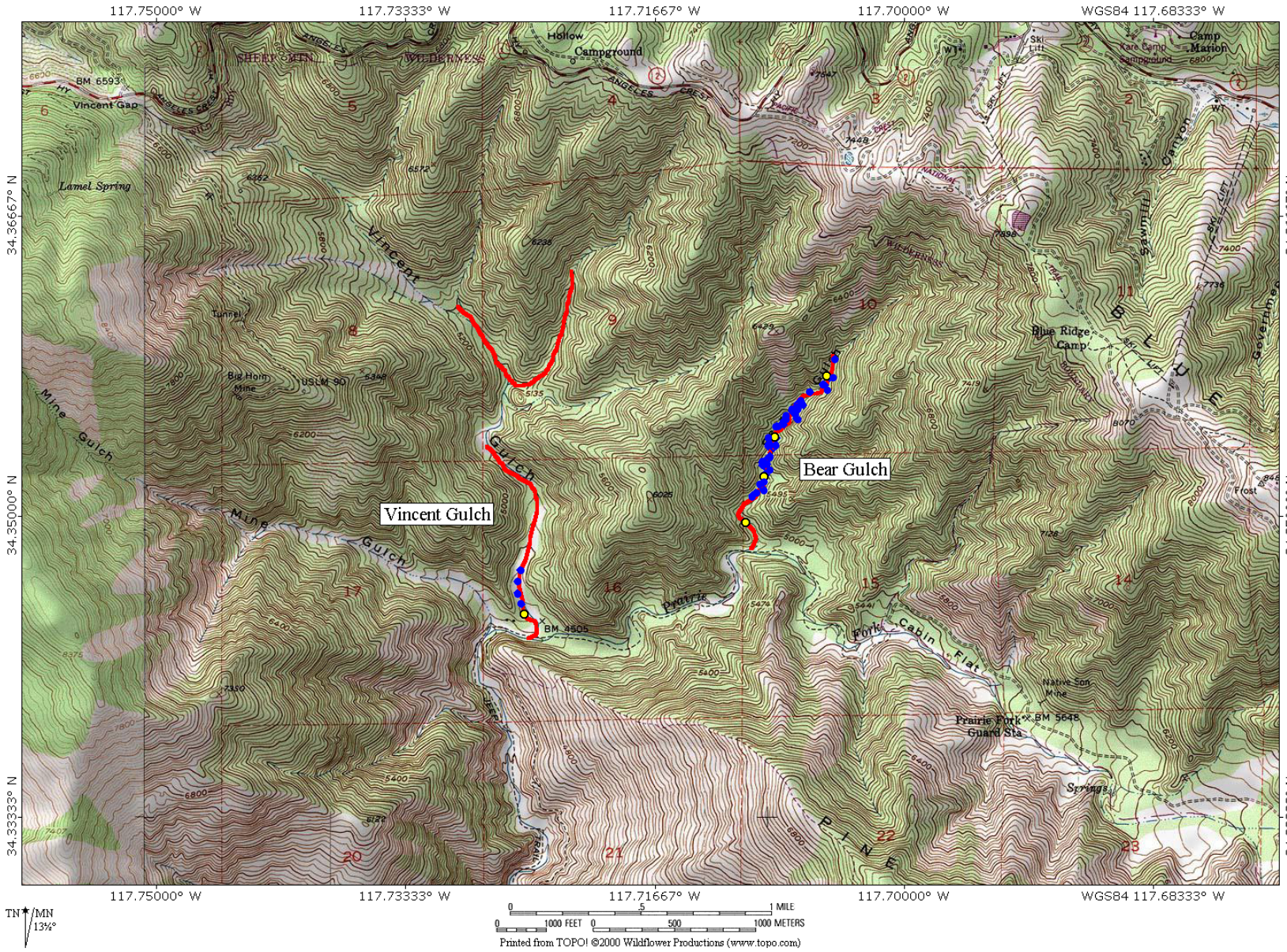

117.75000° W
117.73333° W
117.71667° W
117.70000° W
WGS84 117.68333° W
34.36667° N
34.35000° N
34.33333° N
Vincent Gulch
Bear Gulch
Survey reach
MYLF larvae
MYLF adult/juvenile
Printed from TOPO! ©2000 Wildflower Productions (www.topo.com)

Figure 19.

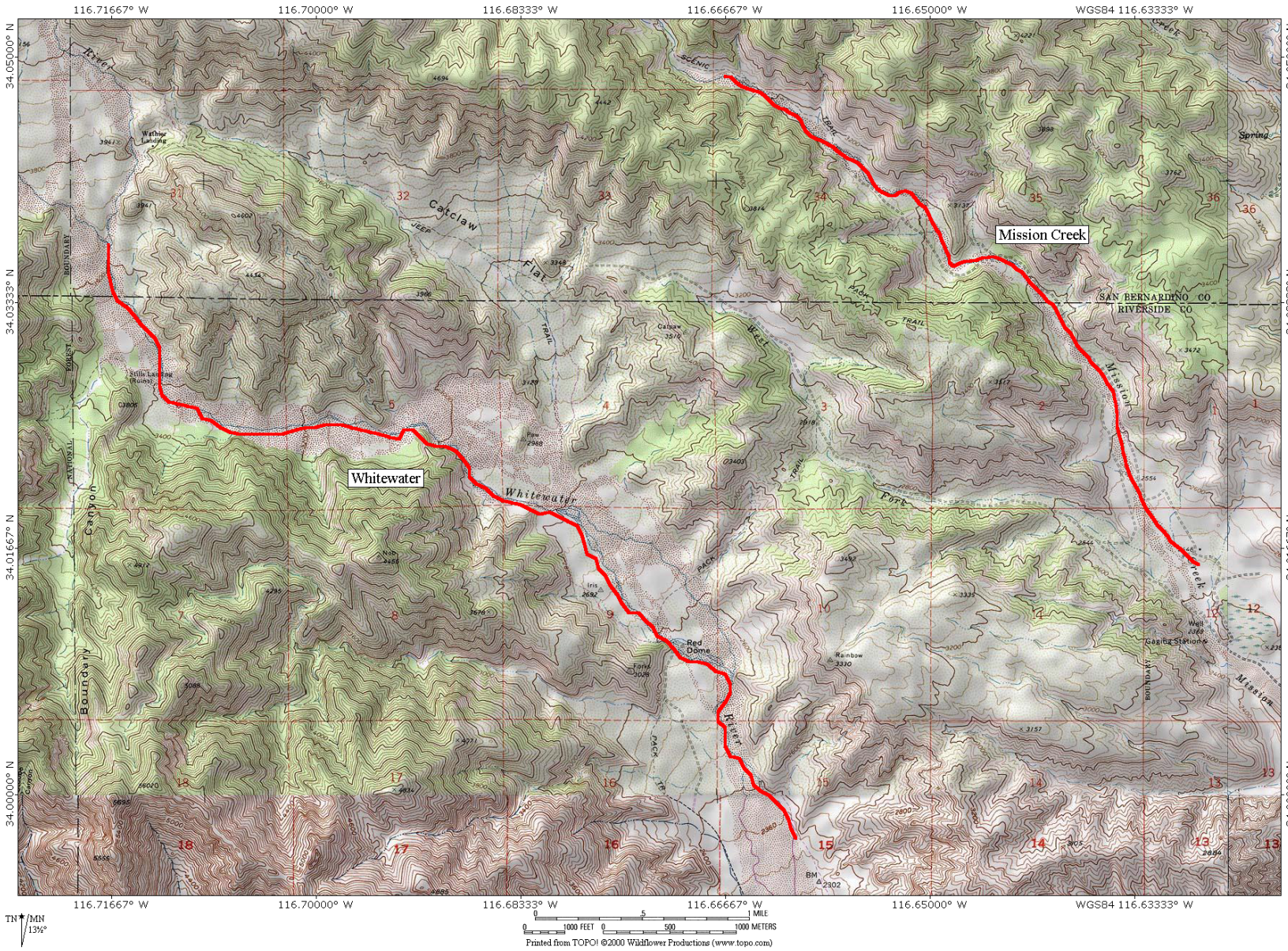


Figure 20.

Survey reach

MYLF larvae

MYLF adult/juvenile

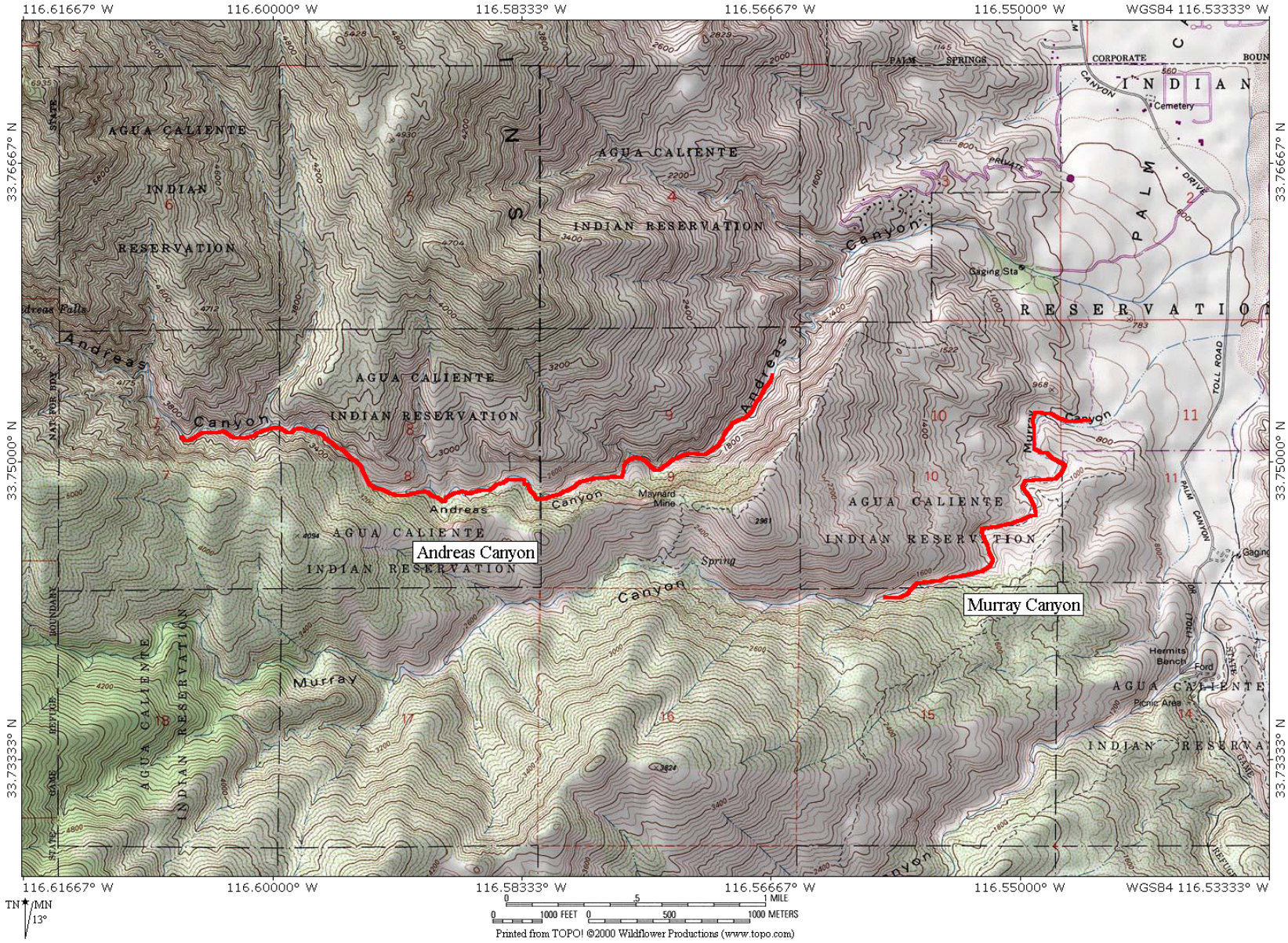
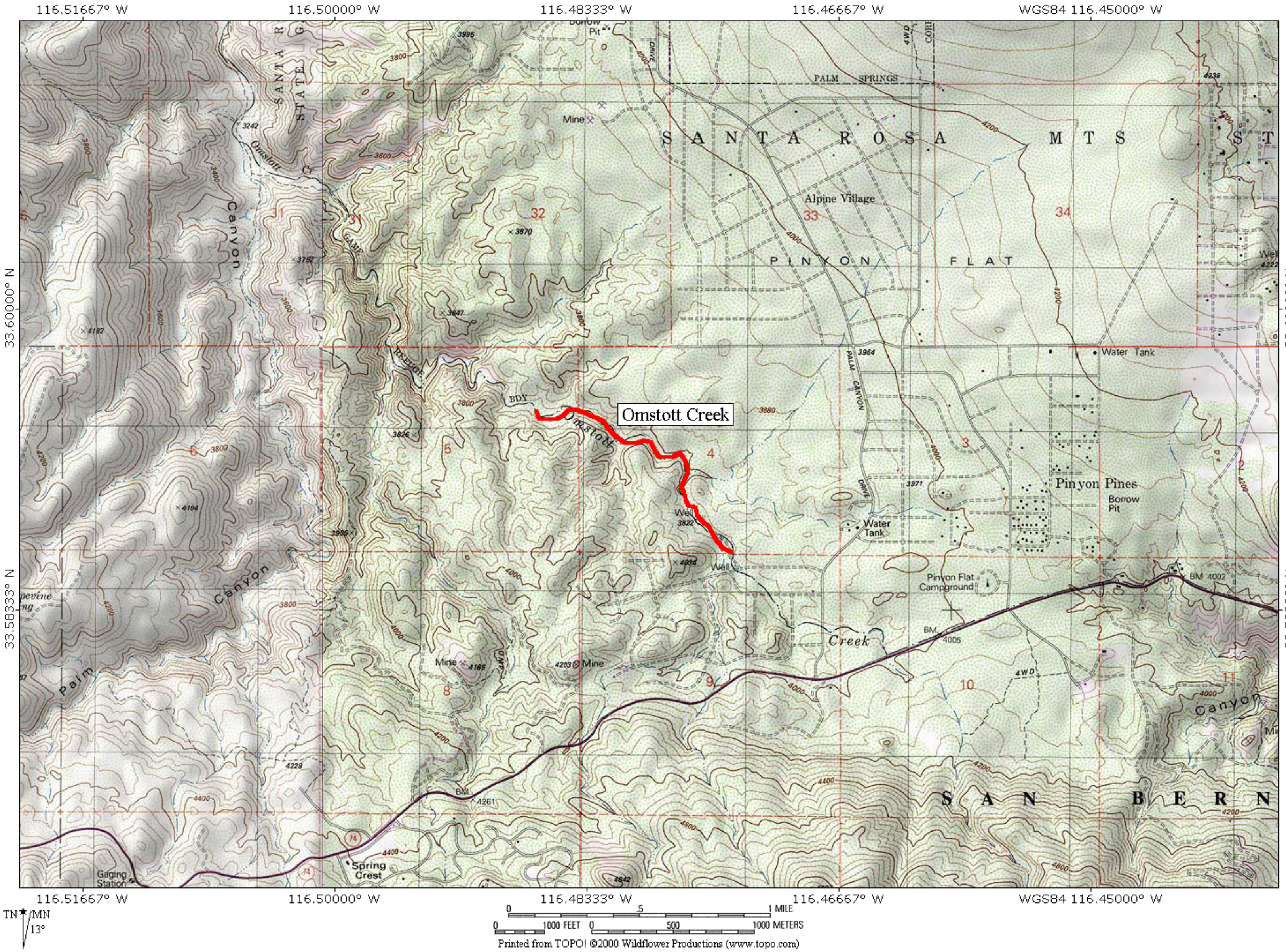

116.61667° W
116.60000° W
116.58333° W
116.56667° W
116.55000° W
WGS84 116.53333° W
33.76667° N
33.75000° N
33.73333° N
Andreas Canyon
Murray Canyon
AGUA CALIENTE INDIAN RESERVATION
Survey reach
MYLF larvae
MYLF adult/juvenile
Printed from TOPO! ©2000 Wildflower Productions (www.topo.com)

Figure 21.



Survey reach

MYLF larvae

MYLF adult/juvenile

Figure 22.