State of California
The Resources Agency
Department of Fish and Game

OVIPOSITION SITE SELECTION, MOVEMENT, AND SPATIAL ECOLOGY OF THE FOOTHILL YELLOW-LEGGED FROG (*RANA BOYLII*)

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June, 2006

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by

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and

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ABSTRACT

The foothill yellow-legged frog (*Rana boylii*) is a medium-sized (37-71 mm SUL) frog that occurs in rivers and streams of Oregon and California (Stebbins 2003; CDFG Special Animals List http://www.dfg.ca.gov/whdab/pdfs/SPAnimals.pdf). It has been designated as a California State Species of Special Concern (Jennings and Hayes 1994). It has been recognized that there is a lack of information regarding the ecology of the species. The purpose of this study was to add to our understanding of foothill yellow-legged frog oviposition habitat requirements, spatial ecology and movement behavior in relation to reproductive activities. We collected microhabitat data for oviposition and random sites to examine site selection. We used mark-recapture and radio-telemetry to study breeding site fidelity, spatial ecology, and post-breeding movement patterns. Our results indicate that stream flow and water depth influence oviposition site selection. We found that individual frogs have breeding site fidelity. Males used breeding habitats more and non-breeding habitats less than available during the breeding and non-breeding seasons and females used breeding habitats more than available only during the breeding season. Our radio-telemetry and mark-recapture results show that males move away from the immediate area used for reproduction but may remain within vicinity of the breeding area following the cessation of reproductive activity. Based on our results we recommend that streams should be managed properly in order to maintain areas that provide suitable conditions for oviposition and breeding activity and we suggest

management of breeding and non-breeding habitats and protection of these habitats both during and outside of the breeding season.

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INTRODUCTION

The foothill yellow-legged frog (*Rana boylii*) is a medium-sized (37-71 mm SUL) frog that occurs in rivers and streams of Oregon and California (Stebbins 2003) and is one of a few stream breeding ranid frogs in the United States. It is well documented these frogs primarily utilize gravel bars for reproduction and select low water velocity microhabitats for oviposition (Lind et al. 1996, Kupferberg 1996, Lind 2005). Frogs aggregate to these areas containing suitable oviposition habitat when environmental conditions such as stream velocity and water depth are favorable. Egg masses are directly attached to stream bottom substrates within the stream margin. The use of stream habitats for foraging and over-wintering and extent of terrestrial habitat use are still poorly understood. This species inhabits and breeds in streams with both snow and rain influenced watersheds, making it challenging to fully understand its specific habitat requirements.

The foothill yellow-legged frog has been designated as a California State Species of Special Concern (Jennings and Hayes 1994). As with many other California amphibians, especially ranid frogs, there have been significant declines in foothill yellow-legged frog populations across its known distribution (Hayes and Jennings 1986, Jennings and Hayes 1994). One major threat to *Rana boylii* populations is the artificial regulation of stream flows in dammed river systems. Improperly managed flows can have both direct (i.e. scouring and stranding of egg masses) and indirect (elimination of suitable breeding habitat) effects on foothill yellow-legged frogs (Lind et al. 1996). Historically, the foothill yellow-legged frog occurred in nearly all major Pacific river drainages in California (Jennings and Hayes 1994). A number of previous studies were directed towards understanding the influence of hydrologic and geomorphic factors (Kupferberg 1996, Yarnell 2000) and the effects of artificial water flows (Lind et al. 1996), on *Rana boylii*. It is likely that much of its population declines are a result of hydroelectric projects.

In response to the declining status of the foothill yellow-legged frog, the Forest Service (R5) is preparing a conservation assessment for the species. The main objectives of the assessment are to summarize existing research on the species and to identify information gaps that are vital to conservation and management efforts. Numerous recent studies have emerged as a result of recognizing a lack of information regarding the species ecology. A recent dissertation (Lind

2005) addressed the potential causes of population declines, examined the genetic structure and habitat associations and presented an approach to species reintroduction. The success of reintroductions is influenced by many factors, including a comprehensive knowledge of the species ecology. The purpose of this study was to add to our understanding of foothill yellow-legged frog oviposition habitat requirements, spatial ecology and movement behavior in relation to reproductive activities.

The reproductive ecology of the foothill yellow-legged frog has not been fully described and documented. Previous observations suggest that males congregate at particular sites offering suitable breeding habitat and may defend calling sites within these breeding areas (*personal observation*). Females then may be selecting mates, initiating amplexus and the process of fertilization. Due to the proximity of the deposition of numerous egg masses in small, localized portions of a stream, and the paucity of such sites, populations may basically be "laying all their eggs in one or a few baskets." If these frogs have a propensity to aggregate at these "hot spot" sites for oviposition, the availability of these specific areas throughout the entire breeding season is extremely important. Data from this study will provide information on oviposition site selection and breeding site fidelity in an un-dammed site, Hurdygurdy Creek, Del Norte County.

The seasonal movement patterns of the foothill yellow-legged frog are essentially unknown (Jennings and Hayes 1994). A mark-recapture study (Van Wagner 1996) examined the maximum distances moved and maximum movement rates of the foothill yellow-legged frog at a site in Nevada County. Van Wagner assessed the differences between pre-breeding/breeding and non-breeding seasonal movement and patterns of upstream or downstream movement. However, spatial ecology and movement behavior as they relate to breeding activity have not yet been fully investigated.

The objectives of this study are: 1) to provide preliminary information about oviposition site selection and breeding site fidelity and 2) to provide preliminary information about the post-breeding movement patterns and spatial ecology of these frogs. The primary intention of this project is to gain a better understanding of several critical aspects of natural history: the reproductive ecology, movement patterns and spatial ecology of, *Rana boylii* in an un-dammed

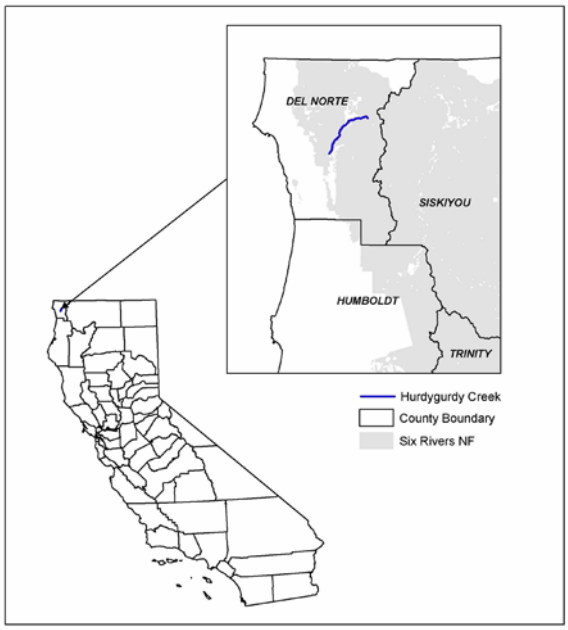
stream system. Data resulting from this study will be crucial to making informed recommendations for modification of current land and water management practices in the interest of species conservation. In addition, this information will be important in the development of a species conservation strategy involving reintroductions; these data may be mandatory for the success of such projects. The information obtained will be important to many state and federal agencies, private consulting firms and land managers utilizing resources that may affect foothill yellow-legged frogs.

STUDY AREA

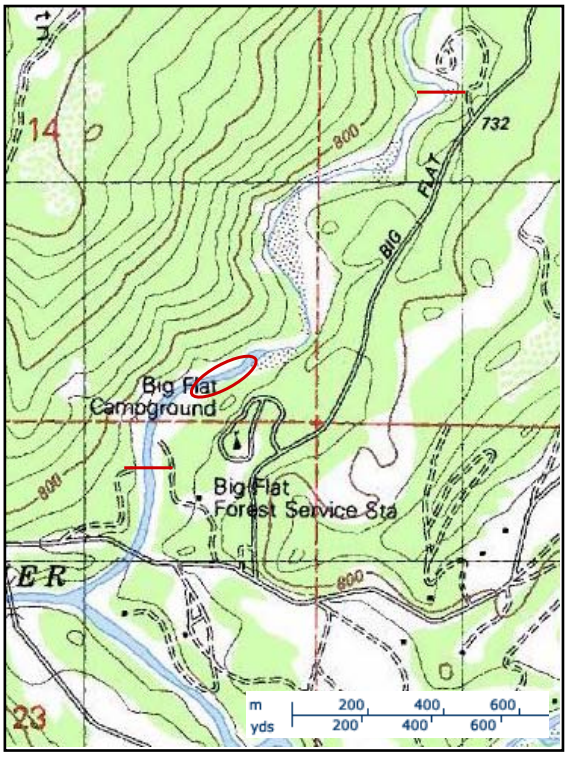
Field work was conducted on the lower 2 km (1.24 mi) of Hurdygurdy Creek, Del Norte County, northwestern California, USA (Fig. 1a), a tributary to the South Fork Smith River. Oviposition site selection and site fidelity data were collected at a heavily used breeding site located ca. 877 m (0.54 mi) upstream from the confluence (Fig. 1b). The study location is in mixed hardwood/Douglas-fir (*Pseudotsuga menziesii*) forest with decided cool wet winter and warm dry summer seasons. Rainfall at the nearest gauging station (Gasquet Ranger Station, Smith River National Recreation Area, eleven air miles north) averages 280 cm (110.2 in) annually [range 152-330 cm (59.84-129.90 in)]. Ambient temperatures during the study ranged from 6 to 30°C (42.8 to 86.0°F) and water temperatures ranged from 6 to 18°C (42.8 to 64.4°F). Stream width ranges from 10 to 15 m (32.81 to 49.21 ft), and the channel contains the full range of lotic mesohabitats associated with a typical mountain stream (riffles, run, pools, cascades, etc.), with deep pools [>3 m (9.84 ft) in depth] (for definitions and descriptions of all possible mesohabitat types see McCain et al. 1990). In terms of natural disturbance regimes (Montgomery 1999), Hurdygurdy Creek shows evidence of annual debris flows, flooding, and some braided channel migrations, but with major mesohabitat types along the reach consistently maintained from year to year. Stream flow varies from an average of 100 cubic meters per second (CMS) [(3,531 cubic feet per second (CFS)] in the winter, with ten year flood events documented to 140 CMS (4,944 CFS) (D. Fuller, Bureau of Land Management, personal communication.), down to one CMS (35.31 CFS) in the summer (M. McCain, USFS Gasquet Ranger District, personal communication). During high water from late fall until early spring the usually clear water becomes more turbid, and the current is often too strong to be safely crossed by humans.

Figure 1.

a) Location of Hurdygurdy Creek in Del Norte County, northwestern California.



b) Location of study reach along Hurdygurdy Creek. The red ellipse represents the location of the primary breeding site studied. The solid red lines represent the beginning and end of the survey reach.



METHODS

Oviposition Site Selection

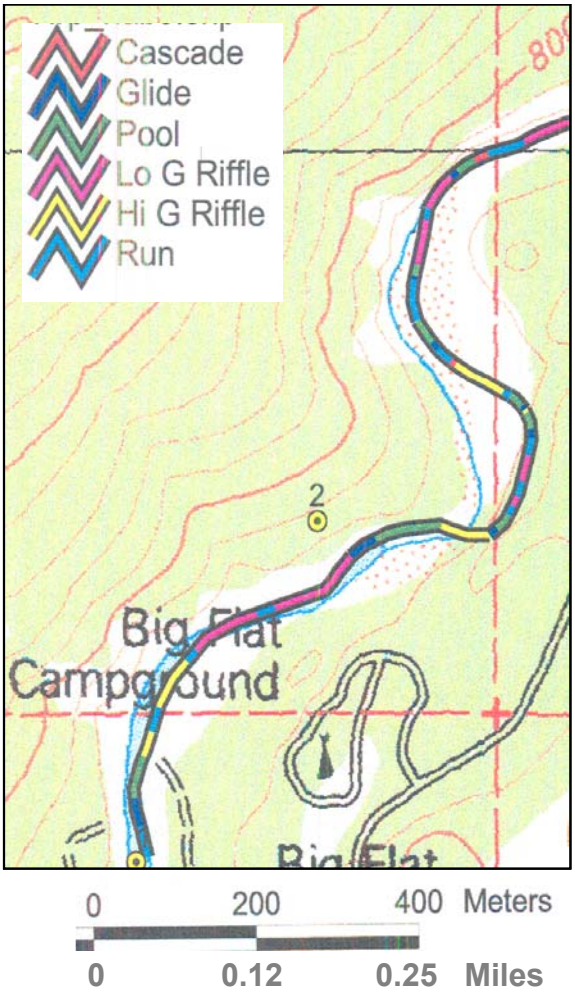
During the 2003 and 2004 breeding seasons, substrate type, water temperature, water depth and water flow measurements were collected for oviposition sites within 24 hours of deposition as well as randomly selected sites at one of the breeding areas along the creek. Random sites were selected using a randomly generated distance [1-20 m (3.28-65.6 ft)] and direction (1-360 degrees) from each oviposition site. Twenty meters was used as the maximum distance in order to remain within a reasonable area [the breeding area is approximately 40 m^2 (430.6 ft^2)]. Data for the two years were combined. We used paired t-tests or Wilcoxon rank tests, depending on data normality, to establish which variables are influencing oviposition site selection. We used ANOVA or chi-square tests to examine the differences in variance between oviposition and random sites.

Movement Patterns and Spatial Ecology

During the 2002, 2003 and 2004 breeding seasons, surveys of a 1,560 m (0.97 mi) creek reach at Hurdygurdy Creek were conducted during active breeding, and several times following the cessation of breeding activity. Frogs larger than 40 mm (1.58 in), were weighed, sexed, and measured (snout-to-urostyle length). They were then marked using passive integrated transponders (PIT tags) as described in Pope (1999). Data on substrate type, water depth, distance to water, location and stream habitat type at the site of capture were recorded. Location data were based on a map of the reach that consisted of stream mesohabitat types and length of habitat units (McCain et al. 1990) (Fig. 2). Mesohabitats included glides, runs, low and high gradient riffles, cascades and pools. Habitat units ranged from 3.96 to 86.97 meters (13.0 to 285.3 ft) in length. Data from these surveys provided information on the distribution and the movement of adult frogs along the creek, both during, and outside of, the breeding period. Distances moved were calculated by determining the length in meters between the nearest upstream or downstream edge of the habitat unit of each location in order to acquire the most conservative, or minimum distance. Movement distance was determined for frogs that were recaptured within the same year or frogs that were captured in the late fall and recaptured the following spring. We used recapture event as the sampling unit. Frogs recaptured in habitat units immediately upstream or downstream from the previous capture unit were eliminated from

analysis (N=3). We used chi-square proportions analyses to test if adult frogs were seasonally (breeding and non-breeding) distributed differently along the creek relative to observed breeding areas (defined as those habitat units in which at least one egg mass was observed in any of the study years, 2002-2004), testing the hypothesis that frogs use breeding site habitats more than non-breeding habitats during the breeding season (March-June) and that frogs use breeding sites less than non-breeding habitats during the post-breeding season. Only survey data were used for habitat selection analysis and we used individual captures as the sampling unit. We were not able to conduct statistical tests on movement data from the mark-recapture study because of low sample size.

Figure 2. A section of the study reach along Hurdygurdy Creek illustrating the mesohabitat units used as location data for captured frogs.



During the 2004 breeding season, the primary breeding site was visited 23 days during the months of March, April and May. All frogs observed at the breeding site were captured, weighed, sexed, measured, identified and pit-tagged, if necessary. Radio-tracking was conducted at the end of breeding activity in order to examine post-breeding movement. Only seven male frogs were large enough (≥13 g) for radio attachment at the breeding site late in the breeding season. These frogs were captured and fitted with radios on May 19-20. Initial capture location was recorded. We tracked animals over a period of 26 days (May 20-June 14). The signal from two of the radio-tagged frogs could not be detected the day following radio attachment. After pursuing the signals a distance upstream and downstream of the breeding area, we concluded that these frogs were likely predated on by an avian or mammalian predator. During the 2005 breeding season, the breeding site was visited 13 days during the months of April, May and June. Frogs were processed the same as previous years. Radio-tracking was conducted during and at the end of breeding activity in order to examine post-breeding movement. Only six male frogs were large enough for radio attachment at the breeding site late in the breeding season. These frogs were captured and fitted with radios on May 23-26 and one on June 2. We tracked animals over a period of 25 days (May 24-June 17). In both years, distances moved were determined from a reference point within the breeding area. All initial captures were within or near the breeding area. Long distance movements were determined similar to mark-recapture movements as described above. We plotted the distances moved by frogs against tracking day to examine the movement patterns away from the breeding site over time.

RESULTS

Oviposition Site Selection

During the 2003 breeding season we collected data for 36 oviposition sites and 36 randomly selected sites at the primary breeding site (Fig. 3). During the 2004 breeding season, we collected data for nine oviposition sites and nine randomly selected sites (Table 1). Tests results indicate that water depth and water velocity influence oviposition site selection with oviposition sites having significantly lower water depth and lower water velocity than random sites (Table 1). Variance tests indicate that random sites also have greater variance in water depth and water flow (Table 1). Water temperature was not significantly different between oviposition and random sites (Table 1).

Figure 3. Representative foothill yellow-legged frog breeding site on Hurdygurdy Creek.

Table 1. Results of foothill yellow-legged frog oviposition site selection.

Variable	N	Occupied or Random	Mean	Min	Max	Variance	Test Statistic	P	Variance Test Statistic	P
Water Depth in cm (inches)	45	R	27.2 (10.7)	5.0 (2.0)	57 (22.4)	226.21	t=-4.04	<0.001	F-ratio=16.85	<0.0001
	45	O	17.8 (7.0)	8.0 (3.2)	28.0 (11.0)	12.29				
Water Velocity in m/s (ft/s)	42	R	0.4 (1.3)	0.0 (0.0)	1.7 (5.6)	0.11	z=4.01	<0.0001	$\chi 2$=26.69	<0.0001
	42	O	0.1 (0.3)	0.0 (0.0)	0.8 (2.6)	0.05				
Water Temperature in °C (°F)	45	R	12.5 (54.5)	10.0 (50.0)	15.5 (59.9)	1.88	t=-1.64	0.11	F-ratio=0.36	0.55
	45	O	12.4 (54.3)	10.0 (50.0)	15.0 (59.0)	1.61				

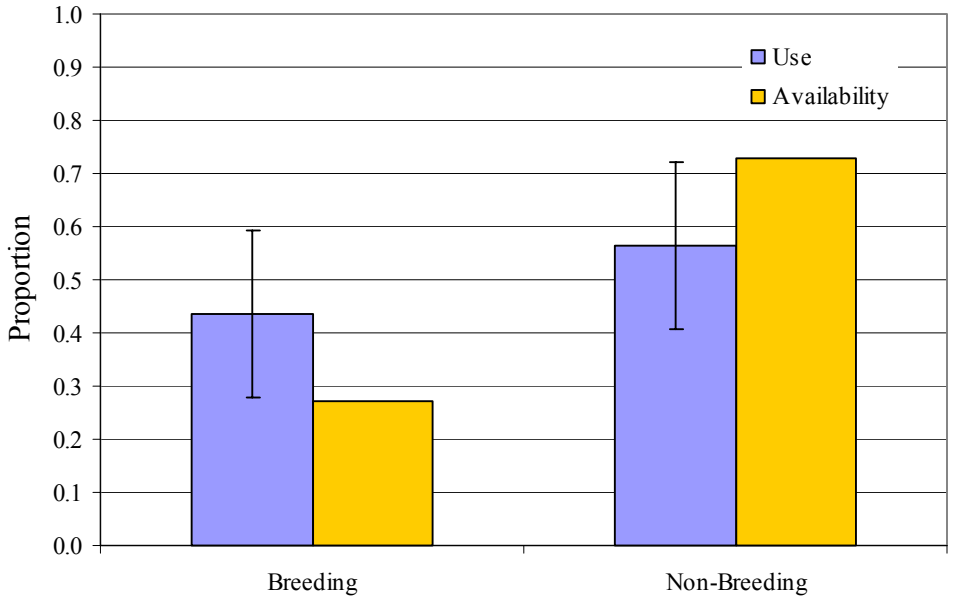
Movement Patterns and Spatial Ecology

The total number of male frogs observed at the primary breeding site was 27, 32, 35, and 35 in 2002, 2003, 2004, and 2005, respectively. In 2003, 10 of the male frogs captured were recaptures from 2002. In 2004, 14 of the male frogs captured were recaptures from 2003. Four male frogs were observed in all three years. We observed a total of 34 females at the primary breeding site within the four breeding seasons, with only four females returning to the site in a subsequent year and one captured in 2003 and recaptured in 2005.

We captured a total of 101 frogs during the breeding season and 122 frogs in the post-breeding months along the study reach in 2002, 2003 and 2004. Test results indicate that adult female frogs use breeding site habitats more than non-breeding habitats during the breeding season, but use habitats in proportion to their availability during the non-breeding season ($\chi^2 = 6.69$, df = 1, P =0.02, N=39; $\chi^2 = 0.88$, df = 1, P =0.51, N=34; and Figs. 4 a & b, respectively). Adult male frogs use breeding site habitats more than non-breeding habitats during the breeding season and non-breeding seasons ($\chi^2 = 88.75$, df = 1, P <0.0001, N=54; $\chi^2 = 17.66$, df = 1, P <0.0001, N=43; and Figs. 5 a & b, respectively). In addition, four subadults, (two identified as a females, two unknown gender [<40 mm (1.58 in) SUL]), were observed in breeding habitats during the breeding season. Four subadults (one female, three unknown gender), were observed in non-breeding habitats during the non-breeding season. We observed 16 subadults (8 females, 8 unknown gender) in breeding habitats during the non-breeding season and 29 subadults (16 females, 13 unknown gender) in non-breeding habitats during the non-breeding season. We did not test differences statistically because of low number of observations of subadults during the breeding season.

Figure 4.

a) Adult female foothill yellow-legged frog use of breeding habitat and non-breeding habitat and habitat availability during the breeding season (March-June). Bars represent confidence intervals.



b) Adult female foothill yellow-legged frog use of breeding habitat and non-breeding habitat and habitat availability during the non-breeding season (July-November). Bars represent confidence intervals.

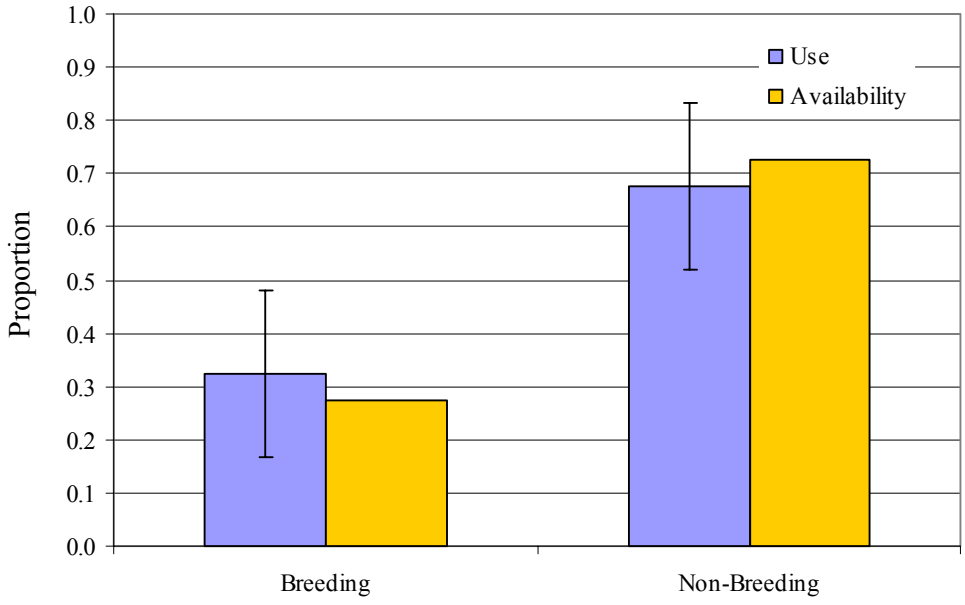
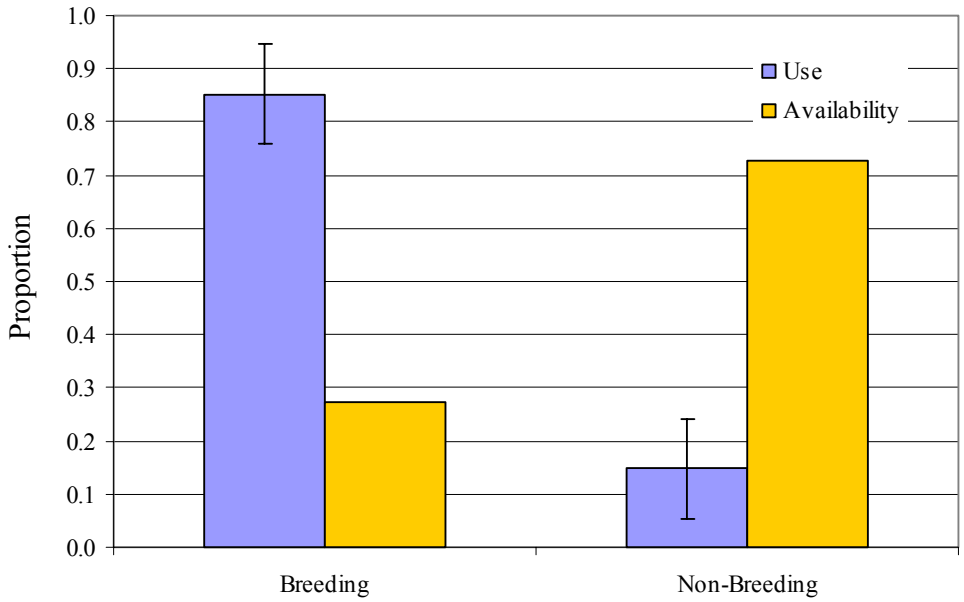
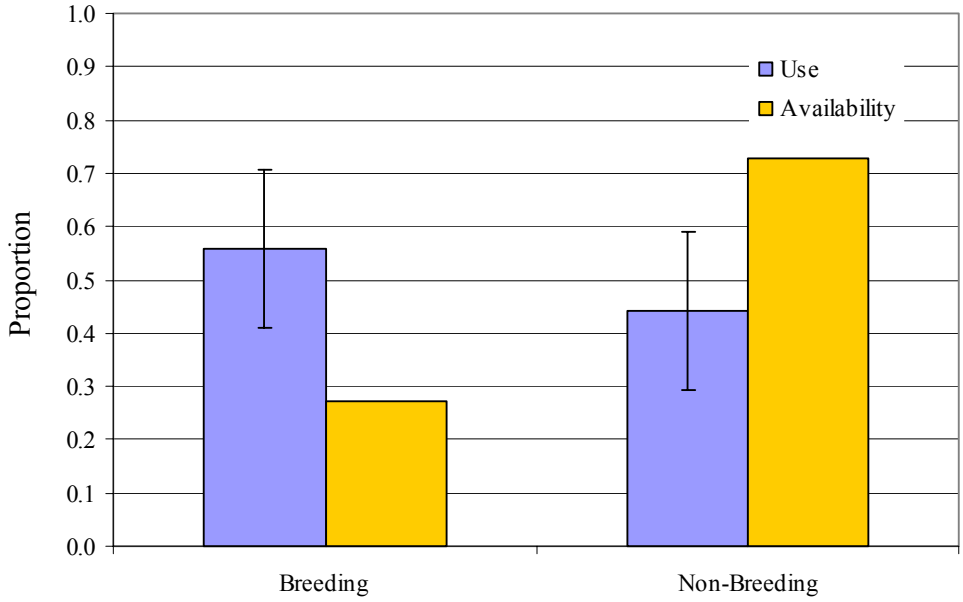


Figure 5.

a) Adult male foothill yellow-legged frog use of breeding habitat and non-breeding habitat and habitat availability during the breeding season (March-June). Bars represent confidence intervals.



b) Adult male foothill yellow-legged frog use of breeding habitat and non-breeding habitat and habitat availability during the non-breeding season (July-November). Bars represent confidence intervals.



At the primary breeding site, during the breeding season, we captured and recaptured (or observed) 10, 24, 12 and 10 males within the same year in 2002, 2003, 2004 and 2005, respectively. This includes individuals with at least 15 days between captures. In contrast, only 1 female was captured and recaptured during the breeding season at the primary breeding site in 2004. We captured and marked a total of 283 frogs along the study reach and at the primary breeding site (93, 111, 46, and 33 in 2002, 2003, 2004, and 2005). We recaptured 52 individuals, 35 males, 17 females in 2003 through 2005. Twenty-eight frogs (23 males and 5 females) were captured in multiple years at the primary breeding site during the breeding season. Two others (1 male and 1 female) were captured at another breeding site and recaptured at the same site the following year during the breeding season. The mean distance moved was 133 meters (436 ft) [ranging 0-446 m (0-1,463 ft)] for females (N=11) and 10 meters (32.81 ft) [ranging 0-560 m (0-1,837 ft)] for males (N=69). Only two male frogs were observed moving within the breeding season. One male moved to another breeding site, the other was observed just upstream of a third breeding site. Movement data are summarized in Table 2.

Table 2. Summary of mark-recapture movement data.

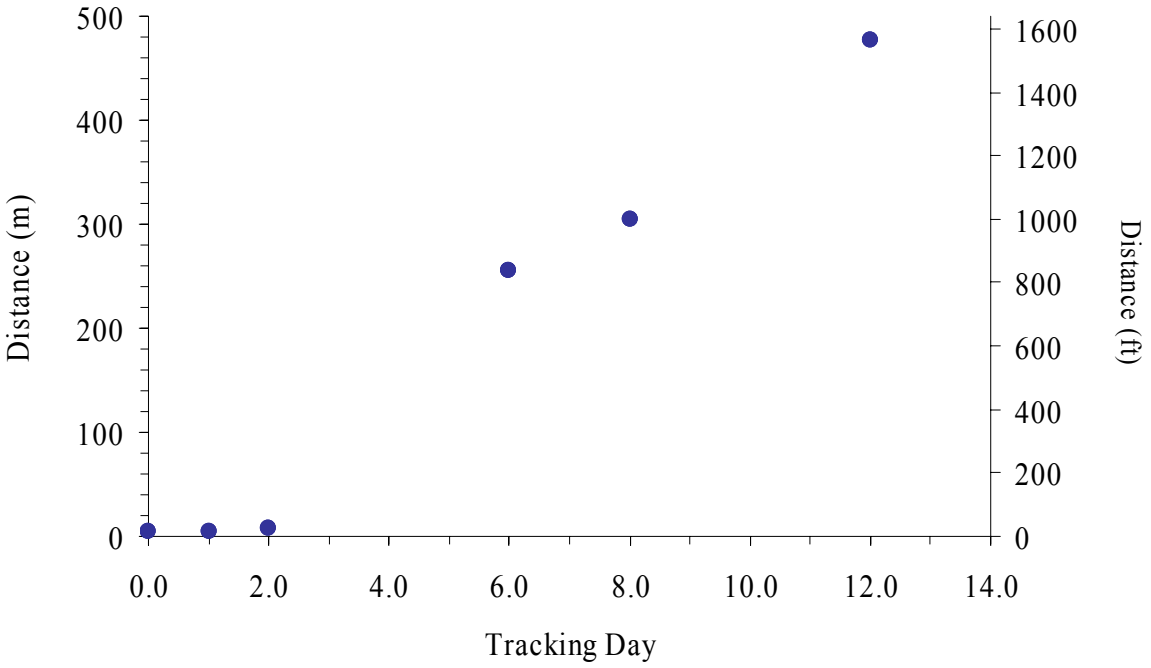
Gender	N	Capture Seasons *	Mean Distance	Min Distance	Max Distance
F	4	B → B	203 m (666 ft)	0	446 m (1,463 ft)
M	59	B → B	11 m (36.1 ft)	0	560 m (1,837 ft)
F	2	B → N	223 m (731.6 ft)	0	446 m (1,463 ft)
M	4	B → N	0 m (0 ft)	0	0 m (0 ft)
F	2	N → B	60 m (196.9 ft)	0	120 m (393.7 ft)
M	2	N → B	0 m (0 ft)	0	0 m (0 ft)
F	3	N → N	29 m (95.1 ft)	0	87 m (285.4 ft)
M	4	N → N	20 m (65.6 ft)	0	79 m (259.2 ft)

* B → B: Captured and recaptured in the same breeding season
B → N: Captured in the breeding season, recaptured in the same year non-breeding season
N → B: Captured in the non-breeding season, recaptured the following year breeding season
N → N: Captured and recaptured in the same non-breeding season

In 2004, two frogs shed their radios before the radio expired. One frog was eaten by an aquatic garter snake (*Thamnophis atratus*). Two frogs retained their radios the entire duration of the radio tracking study. All initial captures were within 6 meters (19.69 ft) from the reference point. All individuals, except for one, remained in the breeding site habitat unit or the adjacent habitat unit. The frog that moved away from the breeding site was captured approximately 477 meters (1,565 ft) upstream from the breeding site after 12 days (Fig. 6a). Sample sizes were too small and statistical power too low for analysis, so we present these patterns graphically only. Two frogs remained within 10 meters (32.81 ft) of the breeding area. Three frogs moved greater than 10 meters from the breeding area, with frogs observed at greater distances away from the breeding area with increasing time (Fig. 6b). In 2005, two frogs shed their radios before the radio expired, while four frogs retained their radios the entire duration of the tracking period. With one exception, all individuals remained in the breeding site habitat unit or the adjacent habitat unit. The last location of the frog that moved away from the breeding site was approximately 287 meters (941.6 ft) downstream from the breeding site after 16 days (Fig. 7a). Three frogs remained within 15 meters (49.21 ft) of the breeding area. Three frogs moved more than 20 meters (65.62 ft) away from the breeding area with increasing distances away from the breeding area over time (Fig. 7b).

Figure 6.

a) Distance moved over time for a radioed individual in 2004.



b) Distance moved over time for radioed frogs in 2004. Each color represents an individual.

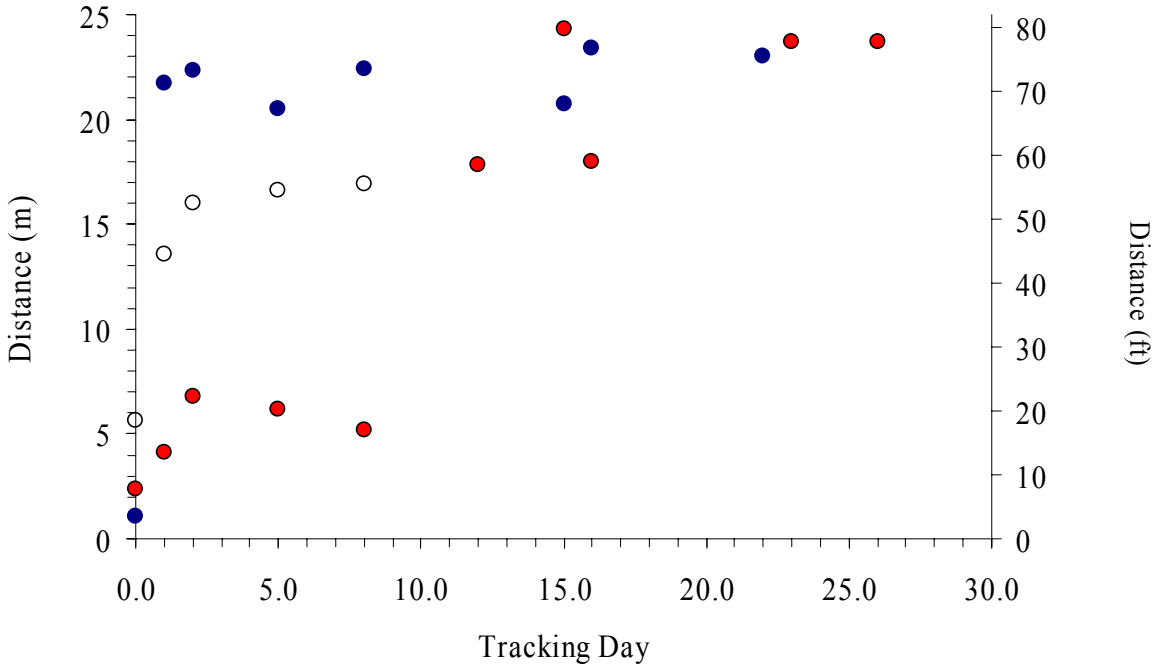
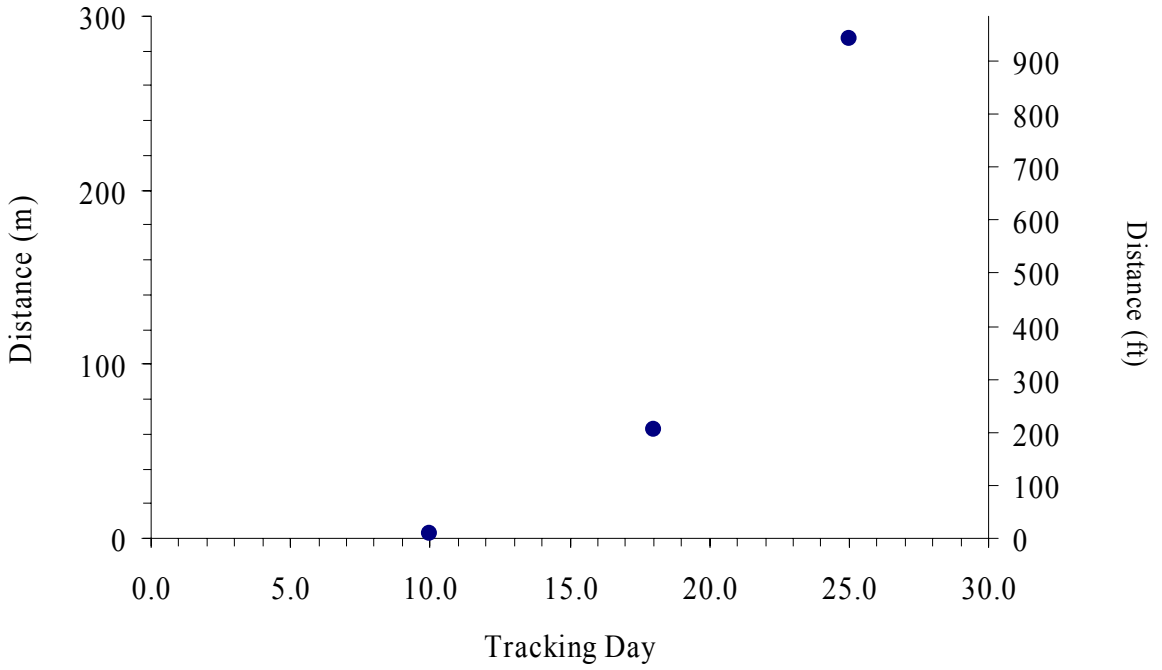
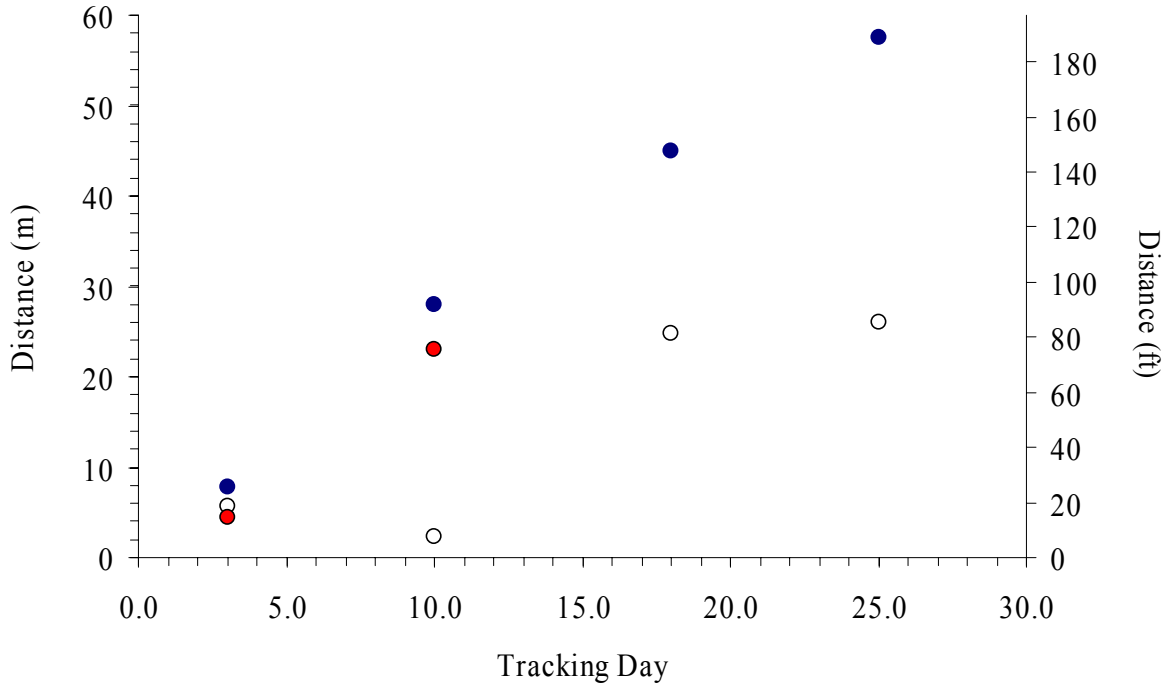


Figure 7.

a) Distance moved over time for a radioed individual in 2005.



b) Distance moved over time for radioed frogs in 2005. Each color represents an individual.



DISCUSSION

Results from previous research have established the importance of suitable breeding sites for the persistence of foothill yellow-legged frogs (Lind 2005, Lind et al. 1996, and Kupferberg 1996). Our results confirm the influence of stream flow and water depth on oviposition site selection, as suggested by these previous studies. Similar to Lind (2005), we found that water flow was lower for oviposition sites than random sites. We also found that variance of water flow was lower for used sites, indicating that frogs are selecting areas with a narrow range of conditions for oviposition sites. However, we did not find any significant difference in water temperatures between used and random sites. This is likely due to the low variance in water temperatures at Hurdygurdy Creek. The mainstem Trinity and South Fork Trinity Rivers are much higher order streams, with a greater range of available temperatures, which likely explains the significant differences in the variances in water temperature between oviposition and random sites in Lind (2005).

Foothill yellow-legged frogs will use the same areas for reproductive activity repeatedly from one year to the next (Fuller and Lind 1992, Kupferberg 1996, Lind 2005). The primary breeding site in this study has been used for at least 18 years (HW, *personal observation*). We found that individual frogs have site fidelity to particular breeding areas, potentially returning to the same site each year. Males appeared to have higher site fidelity than females; however this may be a consequence of differences in detectability. We observed four females (all gravid) that returned to the breeding study area in consecutive years, therefore we have some evidence indicating that females breed every year. However, the number of females captured at the breeding site relative to total number of egg masses observed suggests that the detection probability for females is very low. We observed 8, 13, and 8 females and 49, 39, and 39 egg masses, in 2002, 2003, and 2004, respectively, suggesting only a proportion of actively breeding females were actually detected. Furthermore, our analysis of use of breeding and non-breeding habitats suggests that females utilize breeding habitats less during the breeding season than males.

Although a majority of the male frogs observed at the primary breeding site remained throughout the breeding season, we did document several male frogs possibly utilizing more than one breeding site within a single breeding season. Use of multiple breeding sites suggests that gene

flow is occurring between breeding sites and that single breeding sites do not represent unique populations.

Fidelity to breeding sites can have important management implications. If breeding sites are destroyed or modified, frogs may continue to return to familiar breeding sites regardless of their suitability. Frogs may then refrain from breeding or breed unsuccessfully in unsuitable or low quality habitats, which over time could dramatically reduce population fitness and long-term survival (e.g., Lind et al. 1996).

Our results suggest that there is differential use of breeding and non-breeding habitats and gender-specific movement patterns during and following the breeding season. We found that both males and females used breeding habitats more than non-breeding habitats during the breeding season. Males were also observed using breeding habitats more than non-breeding habitats following the breeding season. However, females were observed in breeding and non-breeding habitats in proportion to their availability in the non-breeding season. We found that in general females moved greater distances than males and that many males remained at the breeding sites following the completion of reproductive activity. Although female use of breeding habitats is greater than non-breeding habitat during the breeding season, the level of significance is less than that for males ($P=0.02$ and $P<0.0001$). This suggests that females are utilizing breeding habitat less during the breeding season which may be explained by a lower annual reproductive effort by individual females. Females that do breed in a given year likely only breed once, departing from the breeding areas shortly following oviposition. Males are able to breed more than once annually and may attend a breeding site for a longer duration in order to increase reproductive success.

Van Wagner (1996) observed no significant differences between distances moved by males and females, and adults moved significantly greater distances in the pre-breeding and breeding seasons than non-breeding season. Contrarily, we found that adult females moved greater distances than adult males and both genders were observed moving long distances within the breeding season and between the breeding and non-breeding seasons. However, we could not test these differences statistically and our contradictory results may be a result of small sample

sizes. Our radio telemetry and mark-recapture results show that males move away from the immediate area used for reproduction but may remain within vicinity of the breeding area following the cessation of reproductive activity. Large male frogs appear to arrive at breeding sites earlier than smaller frogs which may be a result of remaining in close proximity to the breeding areas, and consequently may result in access to more or higher quality females (*personal speculation*). Further study of post-breeding movement is necessary to conclude that males that remain near the breeding site during the months of July through November are not moving along the stream corridor or to tributaries during the wet, winter months.

RECOMMENDATIONS

Based on our results and results from previous studies (Lind et al. 1996, Lind 2005), frogs require microhabitats with suitable conditions with low water flow and water depth for oviposition, conditions that are very sensitive to flow manipulations. In addition, we found that individuals have breeding site fidelity and loss of these familiar suitable habitats can result in numerous years of unsuccessful reproduction or poor recruitment. Streams should be managed to maintain areas that provide these conditions such as gravel and point bars. We recommend more extensive research on site philopatry to examine if frogs return to natal sites. Currently, conservation and management for foothill yellow-legged frogs has primarily been focused on protection of their breeding habitats. Our results suggest that frogs also use areas that are not utilized for reproduction both during and outside of the breeding season. We recommend management of both breeding and non-breeding habitats and protection of these habitats during and following the breeding season. We recommend additional study of post-breeding movement for longer durations in order to examine movement of individuals away from breeding sites to further understand the movement ecology and spatial dynamics of the foothill yellow-legged frog. Because this species has an extensive range and lives in stream systems of varying order, geography, geomorphology, and hydrological regimes (including dammed vs. un-dammed), we recommend further study of movement ecology in different systems. Several other studies on movement ecology of the foothill yellow-legged frog are currently in progress (Garcia and Associates and Ryan Bourque) and we are finding that frogs may be behaving differently in other systems. More research is required to understand the extent of differences in the movement behavior between and among streams with varying structures.

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