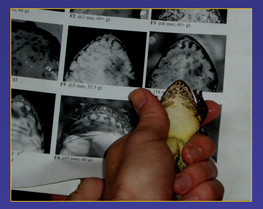
The Grand Dame of the North Fork Feather River: Insights into Longevity from Photographic Identification of Individual Foothill-yellow Legged Frogs (*Rana boylii*) Using Chin Mottling Patterns



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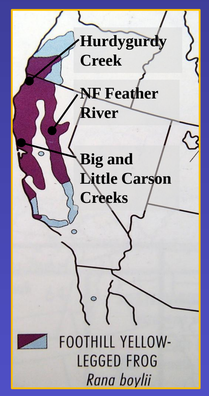

Figure 1. Location of three *R. boylii* field study sites in Northern California (2002-2012). Range map from Stebbins (2003).

INTRODUCTION

Since 2002, we have used mapping of chin mottling patterns to identify individual foothill yellow-legged frogs (*Rana boylii*) by visually matching digital photographs from three separate field studies in California (Figure 1). Over 1,950 individuals have been identified to date from chin photographs collected of adult and subadult frogs from Hurdygurdy Creek (Humboldt Co.; 2002-2004), the North Fork Feather River (NFFR;Butte Co.; 2004-2012), and Little and Big Carson Creeks (Marin Co.; 2008-2012). The pilot study at Hurdygurdy Creek began in 2002 to examine this method for identification of individuals. On the NFFR, chin pattern photographs were collected from 2004 to 2012 during a two-year breeding study (GANDA 2006) and during ongoing *R. boylii* monitoring surveys for Pacific Gas & Electric Company. On Little and Big Carson Creeks, chin photographs have been collected since 2008 during *R. boylii* monitoring surveys for Marin Municipal Water District (MMWD). PIT tags were inserted into a subset of 316 individuals between two of these studies and 84 recaptured PIT-tagged individuals verified that no two individuals had identical markings and that markings did not change with growth.

As with PIT-tagging, pattern recognition of individuals can be used to estimate longevity when used on longer-term studies such as these. Longevity estimates based on length frequency histograms and von Bertalanffy growth model analyses for this species indicate that female *R. boylii* may live **at least 12 years**. During 2012, a female first captured in 2004 and recaptured and photographed over the course of nine years substantiated this estimate for female *R. boylii*.

METHODS

On all three studies, adult and sub-adult frogs were captured, weighed, measured and the chin pattern photographed following methods described by Marlow et al. (2012, *in prep*). Each year on the NFFR and MMWD projects, photos were printed in black and white and labeled with photo number, survey date, and tributary or breeding site. Individual identification was determined by matching pigment shapes and patterns and verified through photo comparisons by several members of each study group. In addition to chin photographs, all frogs captured on Hurdygurdy Creek were PIT-tagged (Wheeler et al 2007) and 48 individuals were PIT-tagged in 2007 on the NFFR in order to further verify that individuals retained unique marks and that no two frogs had identical patterns. PIT tagged females were greater than 50 mm and males greater than 40 mm. Frogs captured on the MMWD project area were not PIT-tagged, but identified only through use of this photographic method.

RESULTS

A total of 2,050 individual FYLF were identified using this method in Hurdygurdy Creek, the NFFR and Big and Little Carson Creek study sites. Of 2,050 individuals, 421 frogs (20.5%) were recaptured over two or more years. A full analysis of longevity data is pending, however, during chin photograph matching analysis in the post 2012 field season, we discovered that a female recaptured in 2012 on the NFFR has been recaptured in six non-consecutive years from 2004 to 2012. Female F72 was captured a total of eight times over the course of nine breeding seasons (Figure 2).

Figure 2. Chin photographs of adult female F72 recaptured multiple years on the NFFR from 2004 to 2012. She was PIT-tagged* in 2007.

RESULTS, cont…

Results from these studies previously verified that females live at least eight years in the wild and may breed for at least five years. However, this 2012 recapture on the NFFR indicates that females can live, and possibly breed, much longer based upon the size at initial capture. Using the Von Bertalanffy Growth Estimate chart (Figure 3), for example, female F72 was 58 mm SUL at initial capture in 2004, a size which likely was reached at approximately 4 years of age, indicating that this female could be at least 12 years old when recaptured in 2012 at 69 mm SUL (Figure 3). Growth of this individual appeared somewhat slower than standard VBGE growth estimates, suggesting that the largest female (80.5 mm SUL) observed on the NFFR in 2004 may have been older than 12 years at the time of capture.

The longest lived male observed among these three studies was captured on the NFFR initially in 2008 and not captured again until 2012, four years later. He was 47 mm SUL at initial capture and did not increase in length between captures. VBGE suggests he had reached approximately three years of age in 2005, indicating he was at least seven years of age when recaptured in 2012.

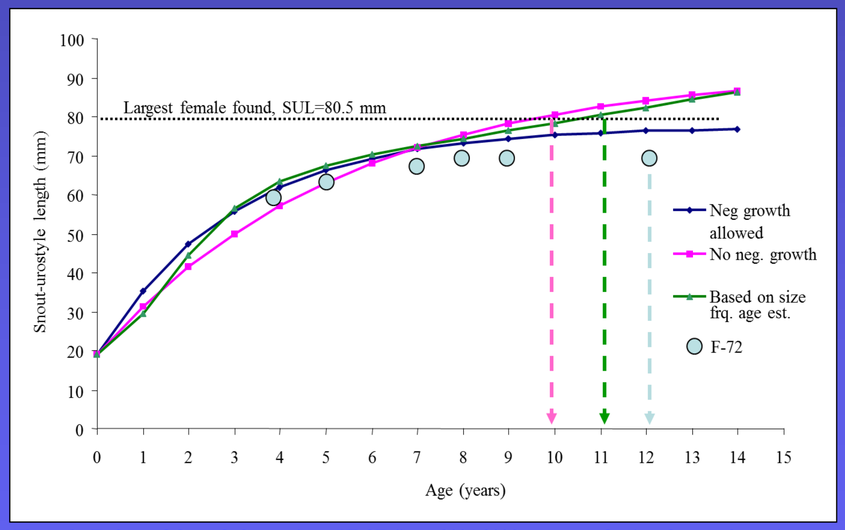

Figure 3. Estimated Growth Curves from VBGE (from 2004-2006 recapture data) and age estimate for Female F72 captured over nine years.

In addition to determining longevity, this method continues to prove beneficial for determining movement and breeding patterns of *R. boylii* in this long-term study. Figure 4 demonstrates the movement patterns of F72 from 2004 to 2012 on the NFFR. Specific movement can be determined for this female in 2007 when she moved a minimum distance of 185 m from the breeding site to the tributary. Further, it can be assumed that she has moved at least twice that distance, and likely farther, between the breeding site and her home range in each breeding season.

Among eight captures of Female F72, she was found in gravid condition three times, twice at the breeding site and once on the tributary. She was found in spent condition five other times, all on the tributary (Figure 4). Once back on the tributary in spent condition, it can be assumed that she had bred that season, however, females were considered to have bred only if observed both in a gravid and spent condition during the breeding period of a given year. Breeding for female F72 was confirmed in 2007 when she was found in gravid condition on the river breeding site on April 20 and in spent condition on the tributary on May 24—34 days later (Figure 4).

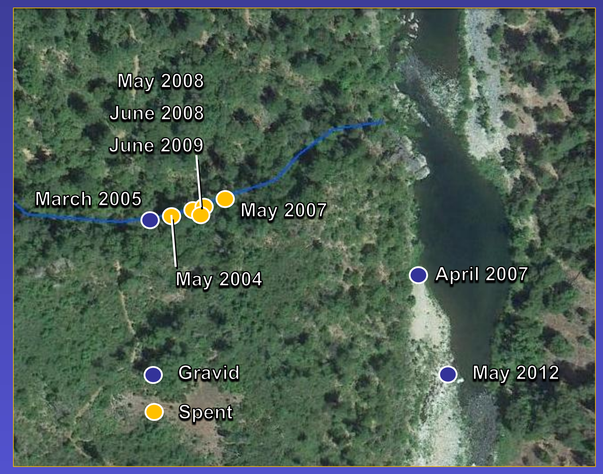

Figure 4. Capture locations for Female F72 shows movement patterns from her home range on the tributary to a breeding site on the NFFR within a nine year period (2004-2012).

DISCUSSION

This method continues to be a reliable, non-invasive way to conduct mark-recapture studies on *R. boylii*, and has proven beneficial for determining estimates of longevity as well as movement and breeding patterns over multiple years. Future longevity data analysis is intended, however, recapture of this individual female in 2012 substantiates that female *R. boylii* can live at least 12 years and the largest female found (80.5 mm SUL) suggests that the species may live up to perhaps 15 years.

Based on these results, this method of pattern recognition holds promise for studies on other ranid species such *R. sierrae*, *R. cascadae*, *R. pretiosa*, *and R. luteiventris*. In light of declining amphibian populations, this is a useful method for monitoring and gaining more information about small populations of *R. boylii* and potentially for other Western North American ranids.

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