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# Post-breeding season movements of Columbia spotted frogs (*Rana luteiventris*) in northeastern Oregon

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# POST-BREEDING SEASON MOVEMENTS OF COLUMBIA SPOTTED FROGS (*RANA LUTEIVENTRIS*) IN NORTHEASTERN OREGON

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ABSTRACT.—Movements of Columbia spotted frogs (*Rana luteiventris*) were determined after breeding to provide managers with information on habitat requirements. We radio-tagged 47 adults and observed movements occurring with 22 frogs. Eleven frogs remained in breeding ponds, and 11 moved to other ponds or river stretches during spring and summer 1998. Distances frogs traveled to other water bodies ranged from 15 to 560 m. Movements appeared to be influenced by availability of habitat and aquatic conditions. Eleven of 16 frogs located within 100 m of other permanent water sources moved, while no frogs at an isolated breeding pond moved. Frogs moved to river stretches in July where water temperatures averaged 5.6°C cooler than ponds. Knowledge of Columbia spotted frog movements and habitat use in summer enables land managers to make decisions on activities that affect aquatic sites, vegetation, and stream structures that may influence frog populations.

*Key words: Columbia spotted frog, movements, northeastern Oregon,* Rana luteiventris, *ranid.*

The global decline of many amphibians has created a crucial need for a comprehensive understanding of their ecology. For the Columbia spotted frog (*Rana luteiventris*), information on habitat requirements, movements, and activities during summer and overwintering is especially sparse, and no data are available for any population in Oregon. Considerable data exist for breeding sites of some *R. luteiventris* populations (Morris and Tanner 1969, Nussbaum et al. 1983, Hovingh 1993), but few of these data provide insights about activities outside the breeding season. In a classic mark-recapture study, Turner (1960) reported seasonal movements of marked *R. luteiventris* in Yellowstone National Park. In an unpublished study with radio-tagged spotted frogs in Idaho, movements of substantial distances (>1 km) away from breeding sites in summer, particularly by females, have been observed (David Pilliod, Idaho State University, Pocatello, personal communication). A further complication of determining movements is that despite the recent partitioning of spotted frogs into 2 species, *R. luteiventris* may conceal as many as 3 cryptic species (Green et al. 1997), which may exhibit different movement patterns.

*Rana luteiventris* in northeastern Oregon exists in ecosystems influenced by a suite of management activities including timber harvest, grazing, mining, and stream-altering activities (Bull and Hayes 2000). Without knowledge of *R. luteiventris* movements, unintentional damage can be done to important habitat through these management activities. For this reason we focused on determining movements and the pattern of habitat use of *R. luteiventris* during spring and summer in northeastern Oregon.

## METHODS

We monitored movements of radio-tagged *R. luteiventris* between April and November 1998 in northeastern Oregon. Frogs were captured during egg deposition, or shortly after, in 6 permanent ponds used as breeding sites. All 6 ponds are in the upper Grande Ronde River watershed and are within 20 km of each other. Two ponds (ponds 1 and 2) are spring-fed and are surrounded by grassland grazed by cattle. Three of the ponds (ponds 3–5) were formed by mine tailings, are supplied with water from the hyporheic zone, have no grazing, and have little ground vegetation surrounding them because of cobble from the tailings. The last pond (pond 6), a spring-fed reservoir constructed for placer mining, is on a ridge with sparse ground vegetation surrounding the pond; no livestock grazing occurred here. Characteristics of the ponds vary (Table 1).

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Pond depth changes by <25 cm during summer. Dates of egg deposition are variable, with deposition at higher-elevation ponds occurring at later dates (Table 1). The ponds are in, or adjacent to, mixed-coniferous forest habitats in Union County, and 5 ponds (ponds 1–5) are within 100 m of the Grande Ronde River (Table 1). No ponds contain fish, although rainbow trout (*Oncorhynchus mykiss*) occur in the Grande Ronde River.

Ponds were surveyed for frogs and egg masses twice a week for a month following ice-melt. Number of egg masses was recorded and, when possible, adult frogs were captured. Thirty-eight frogs were captured during the breeding season, and 9 were captured after. Frogs were sexed, measured (snout-vent length [SVL]), weighed, and fitted with a radio transmitter (model BD-2G, Holohil Systems Inc., Ontario, Canada). Each frog was identified by a 3-digit number preceded by M or F designating sex. Transmitters weighed 1.8 g, lasted 6 months, and had a range of 200–300 m. Each transmitter was glued to a 6-mm-wide satin ribbon that was fitted around the waist of the frog (Bull 2000).

We located the frogs once a week from April until November 1998, or until a frog slipped the harness, the signal could not be detected, or the harness was removed because of abrasions. We recorded date, type of site (temporary or permanent pond or river), water temperature, and vegetation at each frog location. Each frog location was mapped to determine the distance it traveled between successive locations. Pond size or river/stream width, maximum water depth, elevation, distance to the river, distance to the nearest permanent pond, and dominant vegetation were recorded at each pond or river stretch where frogs were located.

Paired *t* tests (Snedecor and Cochran 1980) were used to compare water temperatures at frog locations between the river and adjacent ponds. Using a Spearman's rank correlation (Conover 1980), we determined the relationship between pond size and percent of frogs leaving the breeding ponds. A significance level of $P < 0.05$ was used.

## RESULTS

We obtained 353 locations of 47 radio-tagged frogs, 72% of which were in breeding ponds, 13% in other permanent ponds, 9% in river stretches, and 6% in temporary ponds. Twenty-six females ranged from 59 to 91 mm SVL and from 35 to 84 g; 21 males ranged from 58 to 74 mm SVL and from 22 to 41 g. Twenty-two (16 females, 6 males) of 47 frogs were monitored for at least 28 days and up to 215 days, with a mean of 83 days. Of the remaining frogs, 2 were not detected after initial capture, 1 died, 1 was killed by a predator, 5 had transmitters removed due to abrasions, and 16 slipped their transmitters. Predominance of females being monitored resulted from more males slipping transmitters or having their transmitters removed because of abrasions.

A portion of the frogs left each of the 5 breeding ponds that were within 100 m of other permanent ponds or the river (ponds 1–5), while no frogs left pond 6. Pond 6 was isolated from other permanent water and was larger than the other ponds (Table 1). Of 22 frogs monitored 28 days or longer, 11 (8 females, 3 males) remained in breeding ponds for the summer, and 11 (8 females, 3 males) moved to other sites. Of the frogs that left breeding ponds, 3 females moved to permanent ponds, 4 females moved to the Grande Ronde River or a tributary, 1 male moved to both ponds and the river, and 3 frogs (1 female, 2 males) moved to temporary ponds. All frogs that moved to temporary ponds slipped transmitters before the ponds dried, so their final locations were unknown (Table 2). A higher proportion of radio-tagged frogs left the smaller breeding ponds (and left sooner after egg deposition) than left the larger ones (Table 1), although the relationship was not statistically significant.

Six of 7 frogs that moved left ponds 3–5 and traveled 22–434 m to 5 other ponds. Four of these 5 ponds were formed by mine tailings and did not appear to have been used for breeding based on an absence of eggs in the spring and of larvae in July as determined in a previous study by Bull and Hayes (2000). Ponds to which the frogs moved were 100–250 $m^2$ in size and 40–100 cm deep, which was within the size range of ponds they left (Table 1). However, breeding sites were dominated by duckweed (*Lemna minor*), pondweed (*Potamogeton* sp.), and buttercup (*Ranunculus* sp.), while ponds to which the frogs moved were dominated by sedge (*Carex* spp.), mare's-tail (*Hippuris vulgaris*), or cattail (*Typha* sp.). Ponds

TABLE 1. Characteristics of 6 breeding ponds where *Rana luteiventris* were radio-tagged in northeastern Oregon, 1998.

| Characteristic | Pond 1 | Pond 2 | Pond 3 | Pond 4 | Pond 5 | Pond 6 |
|---|---|---|---|---|---|---|
| Pond size ($m^2$) | 4132 | 630 | 86 | 224 | 264 | 28,526 |
| Pond depth (m) | 0.9 | 0.9 | 1.0 | 0.6 | 2.0 | 3.0 |
| Vegetation[a] | L | L,P | L | R | L | P,T,E |
| Distance to river (m) | 90 | 27 | 12 | 30 | 55 | 1600 |
| Distance to pond (m)[b] | 720 | 2240 | 16 | 18 | 13 | 3600 |
| Elevation (m) | 1001 | 1240 | 1380 | 1380 | 1380 | 1810 |
| Number of egg masses | 39 | 8 | 4 | 3 | 8 | 25 |
| Egg laying initiation | 30 Mar | 18Apr | 18 Apr | 27 Apr | 18 Apr | 11 May |
| Number of females[c] | 5 | 2 | 1 | 0 | 3 | 4 |
| Number of males[c] | 1 | 0 | 1 | 1 | 2 | 2 |
| % females left pond[d] | 40 | 100 | 100 | — | 100 | 0 |
| % males left pond[d] | 0 | — | 100 | 100 | 50 | 0 |
| % all frogs left pond[d] | 33 | 100 | 100 | 100 | 80 | 0 |

[a]Dominant vegetation at the ponds was duckweed (L), pondweed (P), buttercup (R), cattail (T), and spike-rush (*Eleocharis palustris*) (E).
[b]Distance between breeding ponds and nearest adjacent permanent pond.
[c]Number of female and male frogs monitored for ≥28 days at each pond.
[d]Percent of radio-tagged females, males, and all frogs that left the breeding ponds.

to which the frogs moved lacked shallow water sites with high solar radiation used as oviposition sites.

The 5 frogs that went to the Grande Ronde River or a tributary traveled 60–560 m from ponds 1–5. Sites to which frogs moved along the river and tributary had cobble substrates, no aquatic vegetation, and rapid water flow. All these sites were 8–15 m wide and 30–100 cm deep, while the tributary was <1 m wide and 5–30 cm deep. Water temperatures at frog locations on the river from July until September were significantly lower ($\bar{x}$ = 14.8, $s$ = 3.66) than those in the nearest breeding ponds at the same time ($\bar{x}$ = 20.4, $s$ = 4.28; $t$ = –10.30, 22 df, $P < 0.01$).

Frogs that left ponds 2–5 could travel along a riparian corridor. One frog that left pond 1 traveled overland 400 m through relatively dry land in the floodplain covered in grasses that had been grazed. Areas surrounding all breeding ponds had low ground vegetation, so frog movement was probably unhindered.

Timing of movements away from breeding ponds varied with respect to the pond and final frog location (Table 2). Frogs that went to other ponds typically left breeding ponds between late April and late May. Four of 5 frogs that went to the river did so between 7 and 16 July. One frog went to a terrestrial bank site next to the river in April for 2 weeks; her signal was not detected again.

Only 1 frog that left a breeding pond returned to that pond (in mid-July). Three frogs moved back toward their respective breeding ponds on 10 August, 31 August, and 28 September and were within 200 m of the breeding ponds when their transmitters failed. Only 1 frog that left the breeding pond was monitored into November, and she did not return to that pond.

## DISCUSSION

In this study frog movement appeared to be associated with proximity to the river or the nearest permanent pond, and with pond size. Frogs in ponds 3–5 were within 55 m of both the river and other permanent ponds, and we observed these frogs moving to the river and other ponds. The frogs at ponds 1 and 2 were within 90 m of the river but >600 m from other permanent ponds; thus, these frogs moved to the river or stayed in the breeding pond. The largest ponds (ponds 1 and 6) had highest percentages of frogs remaining in the breeding pond. However, opportunities for dispersal in pond 6 were limited because the nearest body of permanent water was 1600 m away through dense forest with an elevation drop of 280 m. Larger ponds may provide adequate resources for frogs to remain all year.

Movements away from breeding sites may result because conditions at breeding sites become unfavorable or conditions away from breeding sites become more favorable. Reasons for leaving the breeding site may include elevated water temperatures, abundance of or

TABLE 2. Date that 11 *Rana luteiventris* moved from their breeding ponds, distance traveled, ultimate site to which frogs traveled, and number of days each frog was monitored in northeastern Oregon, 1998.

| Pond/frog | Date frog left pond | Distance[a] (m) | Ultimate site | Number of days monitored |
|---|---|---|---|---|
| POND 1 | | | | |
| F260 | 23–26 Apr | 480 | Temporary pond | 28 |
| F320 | 28 Apr–5 May | 183 | River | 48 |
| POND 2 | | | | |
| F242 | 30 Jun–6 Jul | 60 | River | 109 |
| F460 | 30 Jun–6 Jul | 110 | River | 131 |
| POND 3 | | | | |
| F420 | 20–21 Apr | 172 | Permanent pond | 53 |
| M301 | 28 Apr–3 May | 65 | Temporary pond | 73 |
| POND 4 | | | | |
| M118 | 28 Apr–3 May | 15 | Temporary pond | 53 |
| POND 5 | | | | |
| F280 | 20–27 May | 24 | Permanent pond | 215 |
| F220 | 20–27 May | 24 | Permanent pond | 115 |
| F100 | 7–15 Jul | 560 | Tributary of river | 140 |
| M380 | 4–10 May | 400 | Ponds and river | 108 |

[a]Straight-line distance between breeding site and the ultimate site to which frogs traveled.

vulnerability to predators, or food supply. Frogs that went to other ponds rather than the river within a month of breeding encountered warmer water than they would have in the river. Frogs that left ponds in July all went to rivers, which had cooler water temperatures (averaged 5.6°C cooler than ponds).

Movement away from breeding sites could provide frogs with a survival advantage if new sites had fewer predators, better protection from predators, more abundant food, or less competition for food resources. Breeding ponds had a predominance of duckweed and submerged vegetation (pondweed and buttercup), while 4 of 5 ponds to which frogs moved had a predominance of emergent vegetation (sedges and cattails). Emergent vegetation may have provided more cover from predators (mammalian, avian, and reptilian) or better food resources than submerged vegetation in breeding ponds. Quantification of predator abundance or food supply would be required to address these hypotheses.

Distances we observed frogs traveling were similar to those reported for *Rana luteiventris* by Hollenbeck (1974) in south central Montana (41–553 m) and by Turner (1960) in Yellowstone National Park (360–450 m). Turner (1960) observed 2 periods of movement: one in May that involved movements to breeding ponds, and another in July when frogs migrated to a creek and other permanent water in response to drying of meadows and temporary ponds. Distances we reported were exceeded only by an individual *R. luteiventris* in Nevada that was recaptured 5 km from the original capture site 1 year later (Reaser 1996). Licht (1969) observed that female western spotted frogs (*R. pretiosa*) moved near breeding sites during fall before winter hibernation in British Columbia. Three frogs in our study moved back near breeding ponds in fall, but we suspect at least some of them moved to breeding sites in spring as reported by Turner (1960).

Movements of *R. luteiventris* that we observed exemplify the need to protect permanent ponds and river and stream habitat within at least 500 m of breeding ponds. We determined that pond size, proximity to other permanent water, and water temperature were associated with frog movements. In particular, additional research is needed to address the importance of predation or food supply in directing post-breeding movements of *R. luteiventris.* In addition, the effects of vegetation manipulation and stream structures (through livestock grazing, beaver [*Castor canadensis*] activity, and human activity) on use of these ponds and streams by *R. luteiventris* during the summer warrant investigation.

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