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Observations of Boreal Toad (*Bufo boreas*) Breeding Populations in Northwestern Utah

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From 1999 to 2003, the Utah Division of Wildlife Resources studied Boreal Toad (Western Toad; *Bufo boreas*) breeding populations in northwestern Utah. I report several apparently unique characteristics related to movement, elevation, habitat, and timing of breeding.

Six breeding ponds were monitored in the Grouse Creek Mountains, elevation 1690–2070 m, Great Salt Lake Desert Drainage Basin (mean annual precipitation of 23 cm), in Utah (Fig. 1). Boreal Toad breeding occurred in springs which had been dredged and bermed in the 1950s to create small ponds (surface area 30–900 m^2; maximum depth 0.5–2.5 m) for livestock watering. Emergent vegetation was dominated by rushes (*Juncus* spp.), sedges (*Carex* spp.), Hardstem Bullrush (*Scirpus acutus*), Cattail (*Typha latifolia*), and Teasel (*Dipsacus fullonum*). The upland vegetation community was Single-leaf Pinyon (*Pinus monophylla*)-juniper (*Juniperus* spp.)/sagebrush (*Artemisia* spp.).

Visual searching and dipnetting was conducted at breeding sites once a week during a six to eight week period (Thomas et al. 1997). New eggs strands were counted, and if not distinguishable, the minimum number of egg strands was estimated. An egg strand was considered a pair of egg strings in a gelatinous strand, so counts likely approximated the number of clutches. Small, fragmented egg strands were not counted, as these strands were a result of strands that were not continuously deposited. Adults were caught by hand or dip net from breeding aggregations. Passive Integrated Transponder (PIT) tags (10 x 2.1 mm) were used to individually mark toads (Corn et al. 1997; Muths et al. 2003). A small incision was made with sterile scissors horizontal to the mid-dorsal line, a sterilized PIT tag was implanted subcutaneously, and the tag was worked to the posterior of the toad to prevent it from being expelled before the small wound healed. Only *B. boreas* ≥ 50 mm snout–vent length were tagged. For two consecutive years per site, population sizes with 95% confidence limits were estimated with the closed captures model from the Program MARK (White and Burnham 1999). This model assumes no births, deaths, immigration, or emigration.

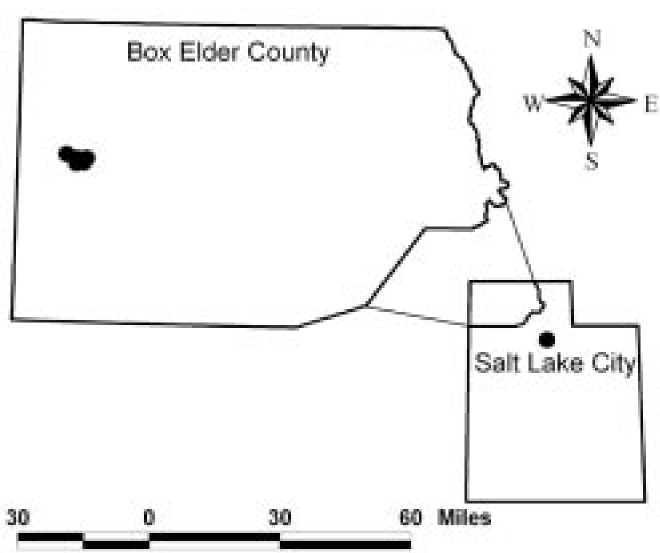

FIG. 1. Locations of six *Bufo boreas* breeding sites monitored in northwestern Utah.

Breeding consistently occurred in late March at two sites and in early May at the remaining four ponds. The earlier sites were fed by 12 and 17ºC warm springs, while the other four breeding ponds were 6–8ºC in early April. Boreal Toads did not breed synchronously; the breeding period ranged from two to six weeks, likely due to variable spring weather, and averaged four weeks per site. Initiation of *B. boreas* breeding appears to be correlated with the onset of warming weather and snowmelt (Blaustein et al. 2001; Blaustein et al. 2003; Campbell 1972; Corn 2003; Corn and Muths 2002; Olson 1988; Olson et al. 1986), however, breeding at the two warm springs was initiated when as much as 0.5 m of snow remained on the ground and the breeding ponds at the other four sites typically were frozen. Boreal Toads remained active year round at one warm spring. A covered spring box kept the water temperature in the box near 15°C during the winter of 2003 and a site visit in January 2003 resulted in the capture of 35 active adult toads.

During the five breeding seasons, tadpoles were observed on three occasions when egg strands had not been detected during prior visits; a minimum of one egg strand was assigned in these cases. Dense emergent vegetation likely hampered detection of egg strands at the two sites where egg strands were missed. During the five-year period, the total number of egg strands observed per year at all six breeding sites ranged from 28 to 45, with the largest number at a single site being 14 (Table 1). Variation among years in egg strand production was observed at all sites. Olson (1991) observed that half of female *B. boreas* skipped one year between breeding and 30% of them skipped 2–3 years, which might explain some of this variation. Another explanation might be loss of breeding habitat, a result of a drought that northwestern Utah experienced during 2000–2003. Sites 4 and 6 experienced an apparent decline in breeding activity (Table 1) and the breeding habitat at these sites was reduced by 50–100% compared to the available habitat in 1999.

PIT-tags were implanted in 981 toads. High recapture rates at breeding ponds indicated that few tags were expelled; 39–84% of the *B. boreas* tagged were encountered on at least one subsequent visit. Population estimates were obtained for two years at five of six sites; a population estimate was not obtained at one site because too few *B. boreas* were captured during that year. Breeding population estimates ranged from 40 to 243 adult toads and, in general, the estimates remained consistent between the two years (Table 2). Although the populations may not have been closed, I feel that little movement occurred at these sites while *B. boreas* were breeding. Toads tended to aggregate 1–2 weeks prior to breeding and tagging was discontinued 1–2 weeks following the last egg strand deposition. In general, sex ratios of breeding adult *B. boreas* were male biased (Table 2), with similar ratios to those

Table 1. Number of egg strands per breeding site.

Site	Year 1999	2000	2001	2002	2003
1	12	10	12	8	12
2	5	5	1	5	7
3	3	7	4	4	0
4	6	1	1	0	0
5	5	8	15	11	8
6	14	0	4	5	1
Total	45	31	37	33	28

observed at breeding sites in Oregon (Olson et al. 1986; Olson 1988; Samollow 1980).

Fifteen toads (5 females, 10 males) moved between breeding ponds during the mark-recapture study. The movements were between 0.9 and 5.0 km. Male *B. boreas* are not believed to travel long distances from a breeding site (Loeffler 1998). Muths (2003) and Bartelt (2000) observed post-breeding movements by male *B. boreas* of up to 1 km. I observed two male *B. boreas* that moved longer distances following breeding. One male toad moved 5.0 km between two springs in the summer/fall of 2002 during a severe drought. A wet corridor does not exist between the two springs. This toad was initially tagged in June of 2002 and recaptured in January of 2003 at a warm spring. Another male toad moved 1.3 km between May 2000 and May 2001. In June 2002, this toad was found back at the original breeding locality.

Boreal Toads in the southern Rocky Mountains (New Mexico, Colorado, Utah, southeastern Wyoming, and southeastern Idaho) generally occur above 2500 m in elevation and are restricted to mountain habitats (Hammerson 1999). Campbell (1970) and Livo and Yeakely (1997) describe *B. boreas* populations in Colorado at elevations ranging from 2164 to 3640 m. I found that the population of *B. boreas* in northwestern Utah occupied habitats at considerably lower elevations in a desert environment with pinyon-juniper/sagebrush upland habitats. The six breeding populations in this study were at elevations ranging from 1690 to 2070 m and another breeding location in this region was documented at 1570 m. The lowest elevation of any other known *B. boreas* breeding location in Utah is 2010 m. The dredging and berming habitat alterations in the 1950s may have improved breeding habitat quality for boreal toads in northwestern Utah low elevation areas by increasing water permanency. Continued monitoring of these locations is warranted given their apparently unique characteristics and potential regional instability.

Table 2. Population structure of six Boreal Toad breeding populations in northwestern Utah.

Site	Year	Population Estimate	(95% CI)	Standard Error	Sex Ratio (Male/Female)
1	1999	243	(185–347)	40.04	3.8
	2000	110	(102–125)	5.57	2.0
2	1999	141	(126–167)	10.23	4.7
	2000	81	(71–102)	7.61	2.4
3	1999	124	(116–141)	5.97	3.4
	2000	173	(168–183)	3.63	4.0
4	1999	116	(105–137)	7.74	4.1
	2000		N/A	N/A	1.2
5	2001	63	(61–72)	2.40	1.4
	2002	110	(109–116)	1.24	3.1
6	2001	53	(49–63)	3.14	1.6
	2002	40	(39–46)	1.30	1.3

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Overwintering California Tiger Salamander (*Ambystoma californiense*) Larvae

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In California, overwintering in larval salamanders is known for three ambystomatid species. Northwestern Salamander (*Ambystoma gracile*) and Long-toed Salamander (*A. macrodactylum*) larvae overwinter in areas where ambient and water temperatures are cold (Stebbins 1985; Stebbins and Cohen 1995; Zug 1993). Introduced Tiger Salamanders (*A. tigrinum*) also may overwinter as larvae (Sexton and Bizer 1978; Riley et al., *in press*). Stebbins and Cohen (1995) and Storer (1925) reported that larvae of a fourth ambystomatid, the California Tiger Salamander (*A. californiense*), do not overwinter; however, B. Shaffer (Univ. California, Davis; pers. comm.) found one larval *A. californiense* in late fall 1993, in Monterey County. I report observations of *A. californiense* larvae overwintering in the Los Vaqueros Watershed, Contra Costa County, California.

Of the 90 managed stock ponds in the Los Vaqueros Watershed, 63 are perennial and 27 seasonal. California tiger salamanders were observed in 66 ponds (45 perennial, 21 seasonal) between 1998 and 2002. Within three perennial stock ponds in the upper Kellogg Creek drainage (eastern Contra Costa County, California), *A. californiese* larvae were recorded through the late fall and winter. On 5 November 1998, a perennial stock pond was drained for maintenance and adult and larval *A. californiese* were found at the bottom of the pond. The three larvae captured ranged in size from 71 to 77 mm SVL, and 125 to 135 mm TL. The pond was located in a heavily grazed grassland at the headwaters of Kellogg Creek (533 m elevation). With the exception of a small stand of cattails (*Typha* sp.), the banks of the pond were devoid of emergent vegetation. Tadpoles of *Rana aurora draytonii* also were observed to be overwintering at this location (Fellers et al. 2001).

During October 1998, a second perennial pond was found with *A. californiense* larvae. The pond was located in an area of grazed annual grassland/oak woodland (300 m elevation) and was devoid of emergent vegetation. Salamanders in this pond were monitored through the winter of 1998/1999. During January 1999, 15 adult and 37 larval salamanders were observed. Larvae ranged in size from 58 to 84 mm SVL, and 114 to 144 mm TL (average = 77.6 mm and 127.3 mm, respectively). Freshly laid eggs also were present in the pond. This pond was monitored weekly until 12 March 1999. During that period, young of the year hatched and developed at a rate that was consistent with other ponds in the watershed.

At a third pond in the Los Vaqueros Watershed (440 m elevation), a single *A. californiense* larva was found in mid-January of 2001. This animal measured 97 mm SVL, 126 mm TL. Again the pond was perennial, associated with cattle grazing, and devoid of emergent vegetation.

Tails tips were collected for genetic analysis from *Ambystoma* larvae overwintering in the Los Vaqueros Watershed. Results confirmed that samples came from *A. californiense* with no detectable level of hybridization (H. B. Shaffer, Univ. California, Davis; 3 genes analyzed: 1 mtDNA, 2 nuclear DNA, 20 specimens, 2 sites, August 2003, pers. comm.).

This report is important because the introduced *A. tigrinum* is being recorded in many areas across California. *Ambystoma tigrinum* is known to overwinter and therefore may be incorrectly identified if the presence of overwintering larvae is the sole characteristic used to determine species. In addition, some authors have suggested that *A. californiense* may not occur regularly in perennial pools (Jennings and Hayes 1994; Storer 1925), yet my findings show 45 of 66 (68%) occupied sites were perennial. Finally, management considerations for perennial ponds may need to be re-evaluated if *A. californiense* larvae are found to overwinter throughout their range. The proper management of *A. californiense* should provide for thoughtful consideration of the implications of overwintering in the species.

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