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Age-Related Seasonal Variation in Captures of Stream-Borne Boreal Toads (*Bufo boreas boreas*, Bufonidae) in Western Montana

Michael K. Young[1] and David A. Schmetterling[2]

Like many species of amphibians, Boreal Toads (*Bufo boreas boreas*, Bufonidae) are declining throughout portions of their range. Recent efforts have focused on describing the ecology of this species, yet few studies have evaluated demographic characteristics that may influence the persistence of Boreal Toad populations. Because Boreal Toads often convey themselves down valleys via stream channels in some areas, we set upstream-facing hoop nets in early to late summer in several first- to third-order tributaries in two western Montana river basins to assess the sizes of individuals using streams and examine temporal and spatial variation in captures. We made 923 captures of juvenile and adult Boreal Toads. Adult females were up to 125 mm snout–vent length, whereas males never exceeded 105 mm. Females tended to be heavier than males and female weights were significantly more variable. Early-summer captures were dominated by juvenile toads <40 mm, late summer catches were largely of individuals >70 mm, and toads of intermediate size were rare throughout. In tributaries of one river basin, captures of toads were more widely distributed in late summer than in early summer, whereas in tributaries of the other basin catches were similarly distributed in both periods. We infer from these patterns that frequent and perhaps far-ranging movements by juveniles and adults are typical of Boreal Toads in this region. We contend that netting streams in summer represents a useful complement to breeding site surveys for understanding the demographics and distribution of Boreal Toads, and perhaps other non-breeding amphibians near streams.

GLOBALLY, populations of many species of amphibians are declining, and these declines have been attributed to a number of factors (Alford et al., 2001; Green, 2003; McCallum, 2007). Biek et al. (2002) noted the need for performing life-stage-specific analyses of amphibians to identify those stage transitions that are most likely to contribute to negative population growth rates. Yet vital rates of many amphibians are difficult to estimate because fundamental life history parameters, such as growth, size class distributions, and length–weight relations, have rarely been described. Detailed demographic studies may also be rare in part because many amphibians are difficult to locate away from their breeding sites (Hammerson, 1999). Moreover, amphibians at breeding sites may be unrepresentative of populations as a whole (e.g., for Columbia Spotted Frogs [*Rana luteiventris*]; Pilliod et al., 2002).

The Boreal Toad (*Bufo boreas boreas*) in the western United States is exemplary in many of these respects. Perhaps as early as the 1970s, Boreal Toads in the southern and central Rocky Mountains of the U.S. began to wane, and many once-abundant populations have been extirpated in this region (Goettl, 1998). Disease, ultraviolet radiation, pollution, and predation have been implicated, although identifying the factors responsible for the loss of particular populations has proven challenging (Muths and Nanjappa, 2005). In the Pacific Northwest and northern Rocky Mountains, however, toad populations remain relatively robust (Corn et al., 2005; Muths and Nanjappa, 2005), although there is evidence for reductions in some areas (Wind and Dupuis, 2002; Davis and Gregory, 2003; Maxell et al., 2003). The cause of this geographic variation in population persistence remains unknown.

Furthermore, quantitative descriptions of the life history characteristics of Boreal Toads are few. Carey et al. (2005) provided some of this information for Boreal Toads from three high-elevation breeding areas in western Colorado (one of which no longer harbors this species), and Olson et al. (1986) reported size-class data for Boreal Toads collected at three breeding sites in Oregon, but the paucity of supplementary data remains a concern because demographic patterns vary geographically among anurans. For example, Labanick and Schlueter (1976) and Kellner and Green (1995) reported that the growth rates and adult size of Fowler's Toads (*Bufo fowleri*) appeared to follow a latitudinal cline, and maximum size in Boreal Toad adults was related to elevation in Oregon (Olson et al., 1986). Furthermore, growing season length can be critical to consistent recruitment in Boreal Toads because tadpoles at high-elevation sites often fail to metamorphose before the onset of winter, and such year classes are assumed to fail (Jones and Goettl, 1998; Jones, 2000). Recognizing range-wide variation in life histories will be necessary to gauge how changes in vital rates influence population persistence.

Compounding this problem is that Boreal Toads are rarely observed after the breeding season (Hammerson, 1999; Keinath and McGee, 2005). In addition, results from breeding site surveys may not be representative of Boreal Toad populations because most females and some males forego breeding in consecutive years (Olson, 1992; Muths et al., 2006), counts at breeding sites are male-biased (Olson et al., 1986; Corn et al., 1997), and post-metamorphic juveniles are generally absent from natal sites (Carey et al., 2005). Also, confining observations of Boreal Toads to breeding sites disregards the importance of their post-breeding movements, which appear to be particularly pronounced among adult females (Muths, 2003; Bartelt et al., 2004; Bull, 2006).

Recently, an alternative method for detecting Boreal Toads outside the breeding season has been devised. Adams et al. (2005) and Schmetterling and Young (2008) demonstrated that large numbers of Boreal Toads can be captured in summer by deploying upstream-facing hoop nets in mountain streams. This technique has been successful in

[1] USDA Forest Service, Rocky Mountain Research Station, 800 East Beckwith Avenue, Missoula, Montana 59801; E-mail: mkyoung@fs.fed.us. Send reprint requests to this address.
[2] Montana Fish, Wildlife and Parks, 3201 Spurgin Road, Missoula, Montana 59804; E-mail: schmetterling@mt.gov.
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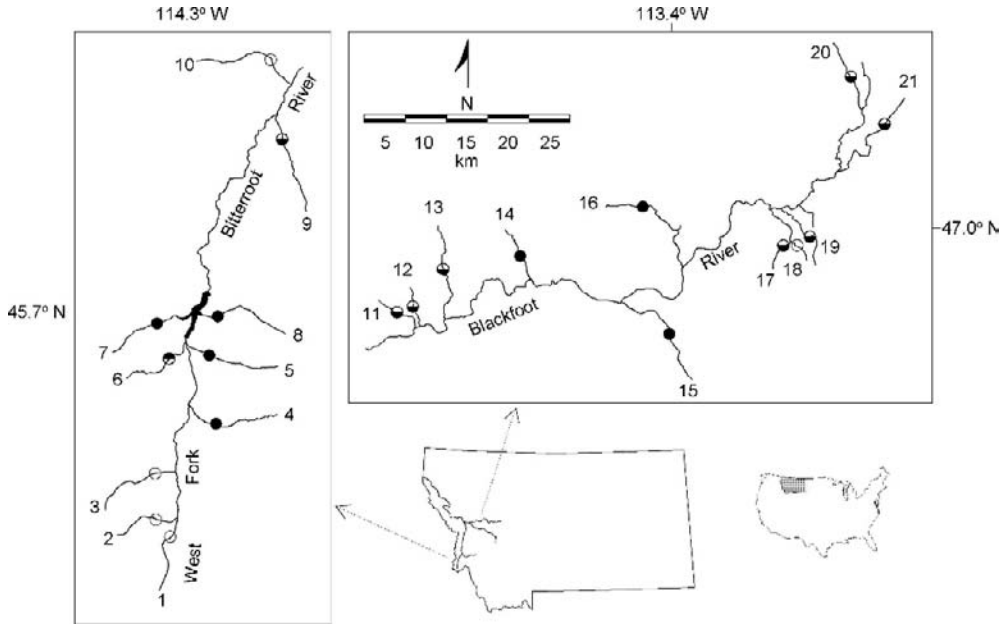

Fig. 1. Streams sampled for the presence of Boreal Toads in western Montana. Open circles denote that no toads were captured, circles filled on the top denote that captures were made only in early summer (June), circles filled at the bottom denote captures were made only in late summer (July–August), and completely filled circles denote captures in both periods. Note that not all streams were sampled both early and late in summer (see Table 1). Stream labels: 1, West Fork Bitterroot River; 2, Beaver Creek; 3, Woods Creek; 4, Hughes Creek; 5, Overwhich Creek; 6, Coal Creek; 7, Little Blue Joint Creek; 8, Slate Creek; 9, Piquett Creek; 10, Trapper Creek; 11, West Twin Creek; 12, East Twin Creek; 13, Gold Creek; 14, Belmont Creek; 15, Elk Creek; 16, Blanchard Creek; 17, Chamberlain Creek; 18, East Fork Chamberlain Creek; 19, Pearson Creek; 20, Dunham Creek; 21, McCabe Creek.

capturing juvenile and adult toads (Adams et al., 2005), and can be more effective than visual encounter surveys for locating Boreal Toads in the non-breeding season (Young et al., 2007). Adams et al. (2005) and Schmetterling and Young (2008) found that captures of juvenile Boreal Toads declined from July to August, whereas trends in adult captures were weak or absent in consecutive years in two Montana streams. In this paper, we extend this analysis by evaluating captures over a larger part of the summer across different years in several additional streams in two western Montana river basins. We also examine the size class distributions of captured toads and assess the length–weight relations of adult females and males.

MATERIALS AND METHODS

In the summers of 2002, 2003, and 2004, we sampled first- to third-order montane streams in portions of the Bitterroot and Blackfoot River basins in western Montana (Fig. 1, Table 1). Discharge in these streams followed a similar pattern among years: flows peaked from mid- to late May and declined to near summer base flows by mid- to late July (U.S. Geological Survey records for Laird Creek [Bitterroot River basin] and North Fork Blackfoot River, unpubl. data). Temperature patterns were also similar, with average monthly highs of 22–24°C in June, 29–32°C in July, and 24–31°C in August (National Climatic Data Center records for Sula and Potomac, Montana, unpubl. data).

All Boreal Toads were taken in upstream-facing hoop nets that captured downstream-moving individuals (Fig. 2). These hoop nets were placed in the thalweg, where the bulk of the flow is found, and anchored to the stream bottom with reinforcement bar. Each net was 2.0 m long, had a single 5.0–7.5-cm throat, four 30–38-cm-diameter hoops, two 1–2-m leads, and a mesh of multifilament nylon netting (0.6-cm bar length). The throat of each net was submerged, but portions of the leads, hoops, and the cod end extended above the water to intercept toads traveling near the surface and to permit toads to remain out of the water after capture. On average, hoop nets (width range, 0.7–1.5 m) spanned 39% of the stream channel (width range, 0.7–12.2 m) at a site and their lower edges were not embedded in the streambed (except in 2002 when the entire water column was blocked from bank to bank during fish movement studies; Young and Schmetterling, 2004); hence, not all passing toads would be captured at a particular location.

The distribution and number of nets varied by year and location (Table 1). In 2002, we monitored eight nets in Little Blue Joint and Slate Creeks from 11 July to 16 August. Nets were 0.2–1.0 km apart. In 2003, sampling was done in two phases. Initially, we tallied captures from two nets ≥1.0 km apart in 19 streams from 18 to 27 June. From 8 July to 19 August, we placed 12 nets at 333-m intervals in Little Blue Joint and Slate Creeks. In 2004, we again put in 2–4 nets at least 1.0 km apart in 20 streams, most in the same locations used in June 2003, although we added two streams (to increase sample size) and removed another (because of low discharge) in the Blackfoot River basin. Sampling in the Blackfoot River basin was from 27 July to 6 August, and in the Bitterroot River basin from 3 to 13 August. Not all nets were effective throughout the sampling periods because of theft, damage from captured mammals or fallen trees, inundation by Beaver (*Castor canadensis*) ponds, or clogging from floating debris, but all streams were sampled for at least a portion of each interval.

All nets were checked daily. For most captured toads, we measured snout–vent length (SVL, mm) with a rule (2002) or calipers (2003 and 2004) and weight (g) with a spring scale. In addition to SVL, we also measured snout–urostyle length (SUL) of some toads collected in 2004. In 2003 and 2004, we

Table 1. Study Streams from the Blackfoot and Bitterroot River Basins in Western Montana, Sampling Effort (Number of Nets in Each Stream and Number of Nights Nets Were Deployed), Net Site Elevation, Sample Years, and Captures of Boreal Toads of Different Ages and Sexes. Period sampled: Early, June; Late, July–August. x denotes occurrence of sampling.

				Period sampled				Toads captured			
Stream	Nets	Net-nights	Elevation (m)	2002 Late	2003 Early	2003 Late	2004 Late	Juvenile	Female	Male	Unknown adult
Blackfoot River											
Belmont	1–2	37	1098–1118		x		x	1	1	2	0
Blanchard	2	44	1214–1370		x		x	12	3	2	0
Chamberlain	2	44	1264–1304		x		x	0	1	2	0
E. Fk. Chamberlain	2	22	1269–1281		x			0	0	0	0
Dunham	2	22	1270–1321				x	0	2	0	0
Elk	2	43	1177–1258		x		x	9	2	6	0
Gold	1–2	31	1231–1321		x		x	0	2	0	0
McCabe	2	22	1269–1452				x	0	2	0	0
Pearson	2	44	1239–1312		x		x	0	0	4	0
E. Twin	1–2	34	1046–1150		x		x	1	0	1	0
W. Twin	2	43	1048–1106		x		x	0	1	0	0
Bitterroot River											
Beaver	2	43	1706–1764		x		x	0	0	0	0
W. Fk. Bitterroot	2	41	1701–1745		x		x	0	0	0	0
Coal	2	44	1483–1623		x		x	2	0	0	0
Hughes	1–2	32	1543–1587		x		x	11	3	0	0
Little Blue Joint	4–12	861	1456–1620	x	x	x	x	252	17	50	41
Overwhich	2	38	1488–1538		x		x	0	4	2	0
Piquett	2	40	1312–1360		x		x	0	1	2	0
Slate	4–12	812	1446–1537	x	x	x	x	88	41	44	87
Trapper	1–2	25	1365–1387		x		x	0	0	0	0
Woods	2	44	1610–1644		x		x	0	0	0	0

determined sex based on whether a toad vocalized while being grasped behind the front legs from above (simulating amplexus) and whether darkened nuptial pads were present on the inner toes of the front legs (Campbell, 1970; Hammerson, 1999). In 2003 and 2004, all toads were given a mark (either a toe clip, PIT tag, or both) that enabled us to recognize previously captured individuals, but in 2002 marks were not given to all toads. After processing, each toad was released downstream of the site of capture.

We used literature accounts from this region (Black, 1970; Olson et al., 1986; Werner et al., 2004; Carey et al., 2005; Bull, 2006) and our interpretations of length–frequency diagrams to determine what constituted an adult toad of either sex. Range-wide summaries of length at sexual maturity (Muths and Nanjappa, 2005) suggested that males may reach adulthood at 55 mm SVL, but Black (1970) found that the smallest mature males from west-central Montana were 68 mm SVL. In our sample, no individuals recognized as males were less than 66 mm SVL, thus we deemed this the lower bound for adult males. Because female Boreal Toads mature at larger sizes than do males, we considered females ≥70 mm SVL to be adults (Black, 1970; Carey et al., 2005; Bull, 2006). These minimum lengths-at-maturity were also comparable to those observed at a large breeding site in the Blackfoot River basin (B. Hossack and S. Corn, U.S. Geological Survey, unpubl. data).

For length–frequency analysis, lengths of individuals were summed in 5-mm categories. We used chi-square tests to assess differences between juvenile and adult captures among June, July, and August. The possibility for among-year variation led us to analyze captures in three ways: 1) among the three months in 2003 for Little Blue Joint and Slate Creeks, the two streams producing the most captures; 2) among all streams in June 2003 and July and August 2004; and 3) among all streams over the three months irrespective of year. The results of the first two analyses were very similar to those using the entire data set, thus we report only the results from the pooled analysis. This approach was also supported because previous studies (Adams et al., 2005; Schmetterling and Young, 2008) found similar patterns in captures between years and because climatic and hydrologic conditions were comparable among years. We attempted to include each toad only once in each analysis; however, in 2002 some unmarked toads were probably recaptured and represented more than once in the totals. Because adults tend to be recaptured more often than juveniles (Schmetterling and Young, 2008), this would positively bias the proportion of adults in a sample, but not alter overall trends in captures. We also used chi-square tests to assess differences between male and female captures among the three months. For these male–female comparisons, only data from 2003 and 2004 were used and both years were pooled to achieve adequate sample sizes for the three months.

Length–weight regressions were developed based on measurements of 113 males and 76 females. These relations were largely derived from toads captured in 2003 and 2004 because we determined sex for few individuals in 2002. Power equations provided the best fit to these data for both sexes. The equations were log-log transformed, and differences between them were evaluated with analysis of covariance. These analyses revealed that length–weight

Fig. 2. An upstream-facing hoop net in West Fork Bitterroot River.

equations differed between toads in the Bitterroot (n = 162) and Blackfoot (n = 27) River basins, thus we restricted length–weight comparisons between sexes to toads from the Bitterroot River basin because of the larger sample size. All analyses were performed in SAS 9.1.

RESULTS

We made 923 captures of up to 699 toads—376 juveniles, 80 females, 115 males, and (from 2002) 128 unknown adults—in 16 of 21 sampled streams from 2002 to 2004 (Fig. 1, Table 1). Most captures were in 2003 (106 early, 514 late), with fewer captures in 2002 (233) and 2004 (70). Daily capture rates at those sites with Boreal Toads averaged 0.4 toads/net/d, but variation in capture rates was high, even among locations within individual streams (range, 0–15 toads/net/d). Estimates of the distribution of Boreal Toads based on stream netting varied with respect to month. Early summer netting typically detected toads in fewer streams compared to netting in late summer (Fig. 1). With only one exception, if toads were captured in a stream in early summer, they were also collected there in late summer.

Length–frequency histograms (Fig. 3) illustrated the seasonal differences in the size class distribution of Boreal Toads found in these streams. In June, most captures were of toads <40 mm (modal length 25 mm), which were presumed to be juvenile toads that had metamorphosed the previous year (age 1). August catches were dominated by adult toads with a modal length of 95 mm. July catches represented a more even mix of both groups. The number of juveniles and adults captured differed among months (X^2 = 120.4, df = 2, $P < 0.001$). The juvenile:adult ratio was 5.7:1 in June, 1.4:1 in July, and 0.3:1 in August. Overall, relatively few captured toads were 40–70 mm. Among adults, captures of males outnumbered those of females (1.6 males:1 female). Although the influence of month on captures of a particular sex was marginally non-significant (X^2 = 5.8, df = 2, P = 0.054), captures in June and August seemed to be less male-biased (1.1–1.5 males:1 female) than those in July (2.5 males:1 female).

Length–weight relations differed between basins and between sexes (Fig. 4). Both males and females tended to be heavier for a given length in the Bitterroot River basin than in the Blackfoot River basin (ANCOVA of the log-log model of weight and length; main effect of basin: $F_{2,110}$ = 15.39, $P < 0.001$ for males; $F_{2,73}$ = 15.11, $P < 0.001$ for females). Within the Bitterroot River basin, females were heavier than males (ANCOVA of the log-log model of weight and length; main effect of sex: $F_{2,159}$ = 19.59, $P < 0.001$). For females, the best-fit regression between weight and length was $g = 0.00534(SVL)^{2.2289}$ ($P < 0.001$, $r^2 = 0.61$), for males, $g = 0.00151(SVL)^{2.4746}$ ($P < 0.001$, $r^2 = 0.67$), and for juveniles, $g = 0.0000294(SVL)^{3.3859}$ ($P < 0.001$, $r^2 = 0.78$). Female weights were more variable than those of males (mean residual from length–weight regression: 21 v. 11; t-test, t = 5.36, $P < 0.001$). Also, males did not attain lengths greater than 105 mm, whereas the largest female was 125 mm. For toads measured in 2004 (SVL range, 33–122 mm), the relation between SUL and SVL was described by SUL = 0.892(SVL) + 0.6 ($P < 0.001$, $r^2 = 0.96$, $n = 40$).

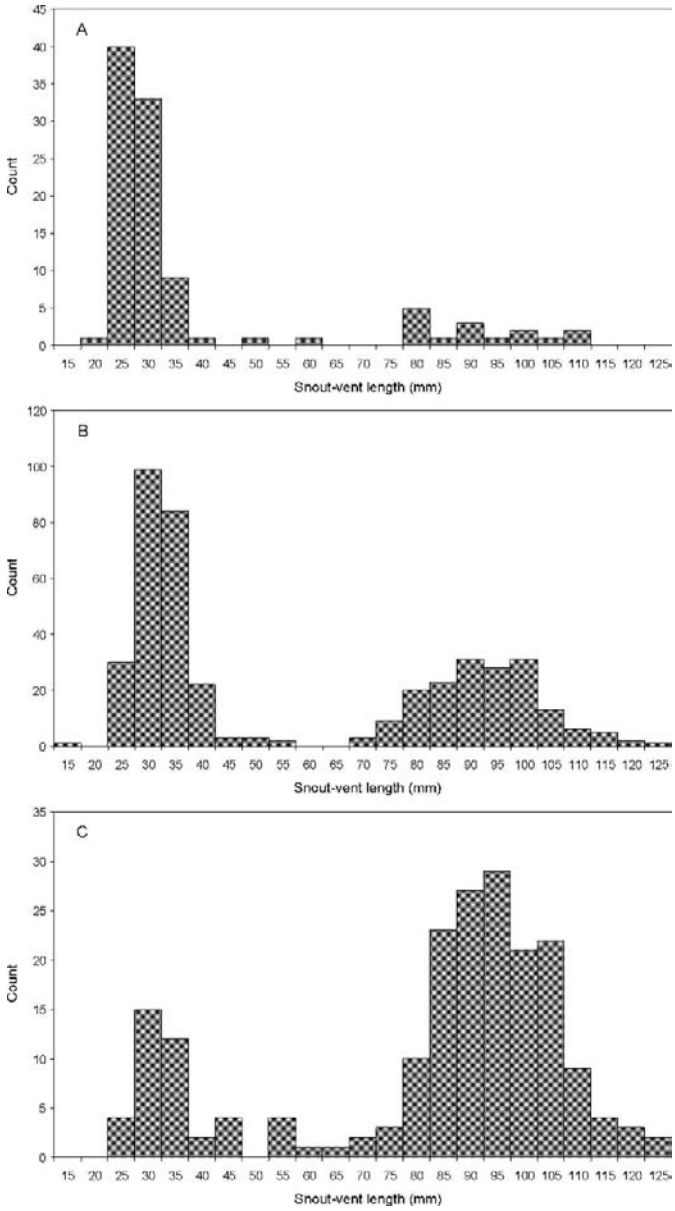

Fig. 3. Length–frequency histograms of Boreal Toads captured in streams in (A) June, (B) July, and (C) August.

DISCUSSION

There was a substantial difference in the age of toads captured during different months. As was noted previously (Adams et al., 2005; Schmetterling and Young, 2008), captures of age-1 toads peaked in early to mid-summer and substantially declined later in the season, whereas captures of adults were uncommon in June but much more prevalent later in summer. We lack data on the immediate post-breeding and pre-hibernation movements of Boreal Toads in this area, but evidence from elsewhere suggests that adult movement at those times can be substantial (Muths, 2003; Bartelt et al., 2004; Bull, 2006). Therefore, it appears that portions of the Boreal Toad populations in this area may be moving throughout much of the growing season, which contrasts with other accounts of the behavior of this species (Hammerson, 1999). Although this is probably partly attributable to the availability of streams as transportation corridors, it may also reflect the difficulty in detecting the activities of Boreal Toads away from breeding sites, or that individuals sampled in streams exhibit a different movement strategy than do recently spawned toads captured at breeding sites.

Variability in capture rates and an experimental approach that did not enable us to estimate detectability (*sensu* Bailey et al., 2004) preclude us from estimating the true distribution of Boreal Toads in the study areas. Nevertheless, we captured adults in all but one of the sampled streams (and in 18 of 22 sites) in the Blackfoot River basin. If the presence of age-1 juveniles in streams is indicative of the proximity of breeding sites (Pilliod et al., 2002), it would suggest that adults are relatively far-ranging. This is somewhat in contrast to the pattern observed in the Bitterroot River basin, where adults and juveniles were not captured in all streams and captures of both tended to be in the same locations. Nevertheless, median adult movement in two of these watersheds in mid-summer exceeded 2 km (Schmetterling and Young, 2008), implying that complex, large-scale movements may be typical of Boreal Toads in this region.

Greater netting efficiency may also be responsible for some of the increases in adult captures in summer. Netting in June coincided with relatively high flows resulting from snowmelt runoff, which led to a relatively small portion of the flow being directed through a net. By late summer, flows had declined to the point that nets sometimes nearly spanned the entire channel. This potential difference in netting efficiency may also explain why toads were detected in fewer streams in early summer. Nevertheless, different periods of in-stream movement by these age classes appears to be a consistent phenomenon; limited sampling in Little Blue Joint and Slate Creeks in June 2007, a period of unseasonably low flows, produced captures solely of juvenile toads (M. Young and D. Schmetterling, unpubl. data).

The influence of season on the sex ratio of captured toads was inconclusive. Previously, we observed a positive correlation in the number of captures of male and female Boreal toads in two of the study streams (Schmetterling and Young, 2008), and the results from examining all streams indicate that large numbers of individuals of each sex are traveling from mid- to late summer. Nevertheless, more comprehensive sampling will be necessary to address this issue.

In contrast, there is some evidence that sampling location can have a pronounced effect on sex ratios and juvenile: adult ratios. The two streams with the largest sample sizes, Little Blue Joint and Slate Creeks, yielded different sex ratios among captured toads in 2003 and 2004—2.9 males v. 1.3 males per female—despite their proximity. Moreover, juveniles constituted 70% of the catch in Little Blue Joint Creek yet only 34% in Slate Creek. Although individual toads have been observed moving between each of these streams (Schmetterling and Young, 2008), the disparity in population structure implies that these watersheds represent different kinds of habitat to Boreal Toads. This may reflect recent disturbance history, because the sampled portion of Little Blue Joint Creek burned in 2000 whereas Slate Creek remained forested, and fire is believed to influence Boreal Toad habitat use (Hossack and Corn, 2007).

The size and apparent growth rate of Boreal Toads in this study offer other insights into the demographics of this species. Carey et al. (2005) argued that a continuum of sizes in Boreal Toad populations from the southern Rocky Mountains was evidence of annual recruitment. Although the many captures of age-1 Boreal Toads in 2002, 2003, and

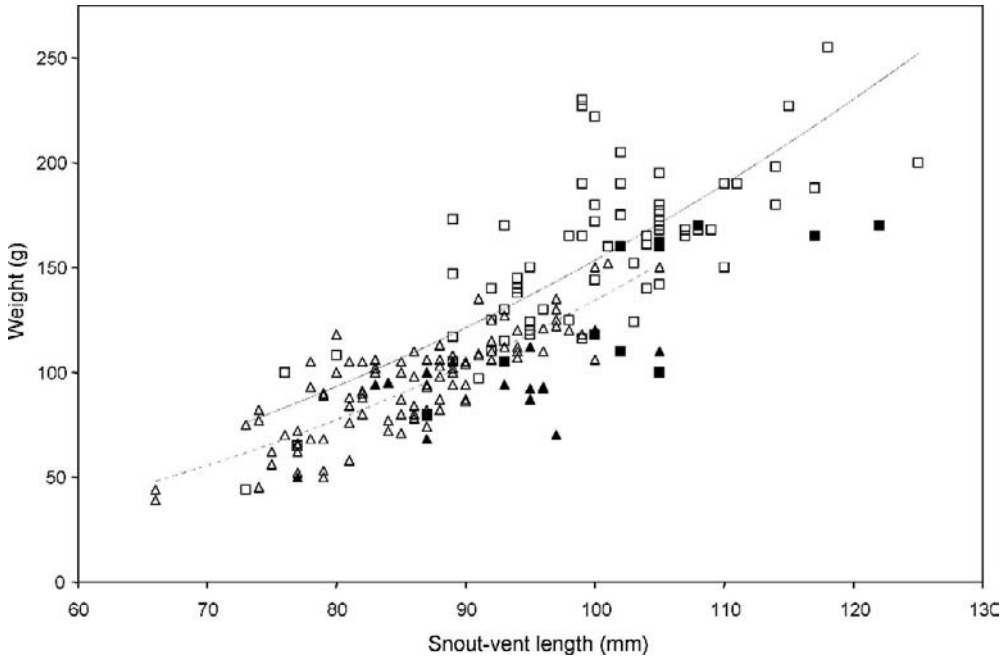

Fig. 4. Lengths and weights for female (squares) and male (triangles) Boreal Toads from the Bitterroot (open markers) and Blackfoot (filled markers) River basins. The best-fit regression lines are for toads in the Bitterroot River basin (females, solid line; males, dashed line).

2004 in Slate and Little Blue Joint creeks provide evidence for consistent recruitment, we found distinct modes in length–frequency histograms. This pattern could arise under at least two scenarios. First, there may be rapid growth of Boreal Toads in their first two years of life. If correct, in mid-summer of the year following metamorphosis, most toads were 25–40 mm SVL, and one year later were over 70 mm SVL. Although second-year growth rates of this magnitude seem large, other anurans exhibit comparatively rapid growth (up to 0.36 mm/d; Labanick and Schlueter, 1976) before reaching maturity (Halliday and Verrell, 1988), and the growing season in this region may extend from June to September. Such fast growth implies that toads could mature at relatively young ages in these basins (Maxell et al., 2002). Another explanation for the absence of toads 40–70 mm SVL from our sample is that these immature individuals largely remain in upland habitats for 1–2 additional years and are not detectable by most surveying methods. This is consistent with other interpretations of juvenile behavior (Carey et al., 2005; Keinath and McGee, 2005), but these are based largely on the absence of observations of juvenile toads rather than on confirmation of this behavior. Reliable skeletochronologies of Boreal Toads in this area could resolve this issue, but these require validation studies employing known-age individuals that address the uncertainties in aging (Eden et al., 2007).

Differences in size between sexes were substantial. For lengths where males and females overlap (70–105 mm SVL), average weights of females from streams in the Bitterroot River basin were 14–19 g heavier than those of males. The difference between males and females is 11–20% of total female mass, which approximates the contribution of the ovarian mass to the total mass of gravid females captured at breeding sites in late spring (Carey et al., 2005; Bull, 2006). Female body weight also showed significantly higher variability than that of males; in several instances, similar length females differed by over 100 g. We suspect this variability results from our sampling of females differing in reproductive condition. Although females are rarely consecutive-year breeders (Olson, 1992; Corn et al., 1997; Carey et al., 2005), the average interval between breeding attempts has not been established for different populations. Thus, our sample may have contained adult females that recently spawned and those destined to spawn in the subsequent or later years.

As noted elsewhere (Olson et al., 1986; Carey et al., 2005), the largest toads in these populations were always female. This suggests that growth or mortality rates differ between sexes. Growth rates of female Boreal Toads may be greater than those of males; their immediate departure from breeding sites after spawning (Jones and Goettl, 1998; Jones, 2000; Bull, 2006) and tendency to travel farther from breeding sites and be more terrestrial may facilitate greater energy uptake (Muths, 2003; Bartelt et al., 2004). This potentially longer growing season, coupled with intervals between breeding lasting two or more years, could yield faster growth. Alternatively, male Boreal Toads may have higher mortality rates. Males tend to mature at younger ages, remain at breeding sites for longer periods, and to return to these sites annually (Corn et al., 1997; Bartelt et al., 2004; Muths et al., 2006). These breeding congregations may attract predators or facilitate the spread of disease (Olson, 1992; Keinath and McGee, 2005; Bull, 2006) and reduce male survival. Additional research on known-age animals will be necessary to identify how much growth and mortality rates contribute to the size dichotomy between male and female Boreal Toads.

Weights of adult toads differed substantially between river basins. For example, 100-mm male and female toads from the Bitterroot River basin were predicted to weigh over 30 g more than their counterparts from the Blackfoot River basin. This was surprising because sampling locations in the Bitterroot River basin tended to be 200 m higher in elevation and presumably had a shorter growing season. Such weight differences between populations within similar river basins in western Montana caution against the

indiscriminant application of length–weight predictions. This also suggests that stage-specific viability models may require population-specific vital rate estimates, or at least address the potential variability in adult weights (and thus female fecundity).

As has been argued elsewhere (Adams et al., 2005; Young et al., 2007), placing hoop nets in streams appears to afford a useful complement to visual encounter surveys of breeding sites for detecting the presence of Boreal Toads. Despite the relative abundance of toads in nets, we rarely encountered individuals during terrestrial forays associated with this sampling, which is consistent with the reduced success of visual encounter surveys conducted after the breeding season (Keinath and McGee, 2005). Moreover, the temporal and spatial variation in juvenile and adult captures may yield insights into the distribution of breeding sites that could be located by more conventional means, as well as indicating the potential importance of seasonal movement in some populations of Boreal Toads. In addition, the capture of large numbers of post-metamorphic juvenile Boreal Toads (which have been notoriously difficult to collect; Davis, 2002; Carey et al., 2005; Muths and Nanjappa, 2005) and of a relatively balanced sex ratio of adult females and males implies that this sampling is more representative of toad populations than the adult-male-biased samples obtained from breeding sites (Olson et al., 1986; Corn et al., 1997). Based on the findings of this and earlier studies, stream netting may be a fruitful approach for obtaining information on Boreal Toads elsewhere in their range, and for capturing other non-breeding amphibians found in or near streams. Including non-traditional methods for sampling amphibians, as well as focusing more attention on the non-breeding season, may provide a more comprehensive understanding of their life histories, identify geographic variation in growth and survival, and locate previously unrecognized breeding sites or populations.

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