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Habitat Use and Movement Patterns of Northern Alligator Lizards (*Elgaria coerulea*) and Western Skinks (*Eumeces skiltonianus*) in Southeastern British Columbia

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Abstract.—Many reptiles have different habitat requirements for different activities (e.g., hibernation and nesting/gestation) that may not be satisfied by a single location. Suitable habitat may not only be limited, but also fragmented, making it difficult for animals to move between sites. In this study, we examine habitat use and movement patterns of Northern Alligator Lizards (*Elgaria coerulea*) and Western Skinks (*Eumeces skiltonianus*). In particular we determine the characteristics of hibernation and summer sites for both species and the extent of movement in both species, particularly whether migration occurs between summer and winter habitats. We used mark-recapture (PIT-tags and toe-clips) to do this. Both species coexisted at many of the same study sites, although some sites had only one of the species, and individuals were found in approximately the same locations in spring, summer, and fall. Thus, hibernation apparently occurs in the same habitat where lizards are active during the summer and no seasonal migration occurs. In fact, individuals of either species were recaptured on average within 10 m of a previous capture. Both species were rarely found in the open and more often under rocks than in vegetation or under logs; they also remained close to shrubs and forest edges. Roads apparently are not a major hazard for either species because they have high site-fidelity and do not make long-distance movements between hibernation or summer sites. Their requirement for cover means that any disturbance or removal of rocks from their habitats would be detrimental to both species.

Animals often have different habitat requirements for different activities. These habitats may be spatially separated, necessitating movement between them. This issue is significant on two fronts: (1) Availability of suitable habitat in a favorable spatial configuration may be a key factor limiting the distribution and abundance of species; and (2) Manipulation of habitat is a potentially important technique in conservation and management. Furthermore, habitat fragmentation, as a result of human activities, makes this a serious issue in wildlife conservation. In reptiles, particularly at higher latitudes, two major habitats are hibernation sites and incubation/gestation sites (Etheridge et al., 1983; Gregory, 1984; Burger and Zappalorti, 1986; Burger et al., 1988; Brown and Brooks, 1994; Prior and Weatherhead, 1996; Litzgus et al., 1999). In some northern populations of reptiles, suitable summer and winter sites are so far apart that long-distance migration is a regular feature of their annual cycle (Weintraub, 1966; Gregory and Stewart, 1975; Brown and Parker, 1976; Brown and Brooks, 1994).

The requirements of squamates for hibernation and incubation/gestation are quite different. Hibernation sites must be structurally stable, below the frost-line, and sufficiently humid to prevent overwinter dehydration. Incubation/gestation, by contrast, requires nest sites that provide high temperatures and sufficient moisture content for developing embryos and must also be a refuge from predators. Nest sites that fit these criteria may be limiting (Cooper et al., 1983; Hecnar, 1994), particularly for reptiles living in cooler climates. Choice of basking sites is important for gravid viviparous females because basking by gravid females may increase the risk of predation (Huey and Slatkin, 1976; Shine, 1980; Madsen, 1987) caused by their reduced mobility (Vitt and Congdon, 1978; Bauwens and Thoen, 1981; Seigel et al., 1987; Sinervo et al., 1991).

Most studies of movements between habitats by squamates have been done on snakes (reviewed in Gregory et al., 1987), which are often amenable to radiotelemetry (reviewed in Fitch, 1987). However, we have little understanding of seasonal habitat use and movement patterns of small lizards. The consequences of different movement patterns have important implications, both in theory and applied management. For example, extensive movement may foster higher levels of gene flow, compared to the more isolated populations of less mobile species. Extensive movements may carry greater risks of exposure to agents of mortality such as predators. In hu-

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man-influenced areas, roads may cause extensive mortality in animals that are hit by vehicles as they attempt to cross, although roads may also act as barriers that isolate and deter movements (Trombulak and Frissell, 2000). In snakes, roads may also be attractive as temporary basking sites, further increasing the risk of mortality (Bernardino and Dalrymple, 1992; Ashley and Robinson, 1996). If lizards have similar seasonal movement patterns to snakes, they likely face the same risks and barriers.

Our first objective was to determine the characteristics of hibernation and summer sites for Northern Alligator Lizards (*Elgaria coerulea*) and Western Skinks (*Eumeces skiltonianus*). Our second objective was to determine the extent of movement in both species, particularly whether migration occurs between summer and winter habitats. We also discuss the extent to which both species coexist in southeastern British Columbia. We used mark-recapture (PIT-tags and toe-clips) to do this. In addition to addressing fundamental questions about the biology of these animals, our results also have important implications for their management.

Materials and Methods

Study Site.—The two study species are found in the western United States and reach the northern limits of their distribution in southern British Columbia (Stebbins, 1966). Although they are both diurnal and sometimes found in the same habitat, they differ in one respect that is potentially important for this study: the northern alligator lizard is viviparous and the western skink is oviparous.

We conducted this study during the summers of 1996–1998 from mid-April to mid-September on the west side of the Creston Valley, 10 km west of Creston, British Columbia, Canada (49°6′N, 116°31′W; elevation 597 m). Mean daily maximum air temperatures from April to September 1996 ranged from 6.5°C to 35.0°C. Mean daily minimum air temperatures in the same period ranged from −0.6°C to 18.3°C (Environment Canada).

For mark-recapture, we used four primary study sites (hand capture and trapping; Pat's Hill, Hydro, East Clearing, and Lone Pine Hill) and six secondary sites (hand capture only; Dewdney, Office, Sign Slope, Trail, Junction, and West Creston). In 1998, Pat's Hill was used to track animals with PIT-tag implants. All sites were separated from each other by distances of 500 m or greater.

Mark-Recapture.—On average, the primary sites were visited four times a year, and the secondary sites were visited two times per year over three years (1996–1998). Upon capture we recorded the following data: ground temperature in the open, temperature at the capture site, lizard's capture position (open or under cover), distance to nearest rock > 10 cm in length, distance to nearest shrub > 1 m in base diameter, distance to forest edge (to the nearest 5 m), rock area, and mean rock thickness (cm). Temperatures were measured using a Smart2 precision indoor-outdoor thermometer to the nearest 0.1°C. Ground temperature is the temperature in the open, at ground level, of the nearest site to the captured lizard that was exposed to sun. We gave each rock a unique number to determine whether it was used by more than one lizard over time and to determine whether lizards show site fidelity.

At each primary site, we set up an array of portable traps. All trap numbers, sessions, and duration are averages. In 1997, 12 traps were set for three sessions of three days each. In 1998, 30 traps were set for four sessions of five days each. In both years, traps were checked from one to three times a day depending on the weather.

The traps were made of 0.5 cm wire-mesh. They were tube-shaped, and 34 cm in length and 10.5 cm in diameter. A wire-mesh funnel was sewn into one end using 30 lb braided fishing line. A removable sponge was inserted into the other end. Lizards entered a trap through a 3.5 cm opening in the funnel and were unable to escape. Traps were covered with a cloth in the spring and fall, and a piece of wood in the summer, to provide shade.

PIT-Tags and Mapping.—In 1998, we implanted AVID PIT (passive integrated transponder) tags in 13 Northern Alligator Lizards (three adult male, five adult female, four juvenile male, one juvenile female) and six Western Skinks (five adult male and one adult female) from Pat's Hill. These tags do not appear to affect growth rates or locomotor performance of neonatal snakes (Keck, 1994; Jemison et al., 1995). Although Roark and Dorcas (2000) urged caution in use of PIT tags because of their potential to move through the body and be expelled via the gut, we never captured any PIT-tagged lizards that had lost their tags.

The PIT-tags were 14 mm × 2.1 mm and weighed 0.08 g. They were implanted by making a small incision (2 mm) in the side of a lizard and injecting the tag under the skin, using a specially designed needle and syringe. Animals were left to recover for one day in the laboratory before release. All animals fully recovered, and later recaptures in the field indicated complete healing of the small incision. The tags were read by passing a reader within 18 cm of the animal. Measurements of rock thickness in 1996–1997 indicated that, on average, lizards were under rocks less than 18 cm. Therefore, we expected to be able to scan cover objects and

TABLE 1. Sizes of the 10 study sites and total number of individuals of Northern Alligator Lizards (*Elgaria coerulea*) and Western Skinks (*Eumeces skiltonianus*).

Site	Size (m^2)	*E. coerulea* (*N*)	*E. coerulea* (%)	*E. skiltonianus* (*N*)	*E. skiltonianus* (%)	Total
Primary						
Pat's Hill	22 500	61	61	39	39	100
Hydro	60 000	51	93	4	7	55
East Clearing	30 000	50	100	0	0	50
Lone Pine Hill	52 500	65	100	0	0	65
Secondary						
Dewdney	70 000	36	59	25	41	61
Office	90 000	47	94	3	6	50
Sign Slope	10 000	3	75	1	25	4
Trail	2 500	6	100	0	0	6
Junction	1 250	4	67	2	33	6
West Creston	22 500	7	21	27	79	34
Total		334	100	100	100	435

identify animals sitting under them without disturbing the animals.

We implanted PIT-tags from 4–7 May and 14–17 June. In May, we scanned for 480 min over three days, but only one (of seven) northern alligator lizards were detected and two (of five) western skinks were detected. Therefore, scanning during the remaining three visits to the site was done opportunistically, rather than on a formal schedule.

We used a tape measure and compass to construct detailed fine-scale maps of the rock locations at each site. We used R (Ihaka and Gentleman, 1996) for all statistical analyses. R is a project which is similar to the S language and environment for statistical computing and graphics.

RESULTS

Species Coexistence.—Northern alligator lizards and Western Skinks coexisted at seven of 10 of the sites (Table 1). The Northern Alligator Lizard was the only species that occurred at the other three sites. At four sites where the species coexisted, Northern Alligator Lizards were predominant. The two species coexisted in approximately equal numbers at two sites, and Western Skinks predominated at only one site.

At the seven sites where the two species coexisted there was no difference in location, and they were frequently found using the same rocks, although at different times. In fact, for either species, we found only copulating lizards or newborn (presumed to be from the same litter) together under a single rock at the same time.

Hibernation and Summer Sites.—We categorized all capture sites of lizards made before April 30 and after September 1 to be hibernation sites. We were present at the study site before lizards emerged from hibernation in the spring. Weather was typically cool, and some snow cover was common until the end of April. Temperatures began to decline in early September, although snow was not present at this time. Northern Alligator Lizards captured at hibernation sites were near captures made during the summer at the four primary study sites (Fig. 1). A similar pattern existed in Western Skinks at the only primary study site (Pat's Hill) where they were abundant.

Given that both species were found in the same location throughout the year we pooled all data from hibernation site and summer site captures to look for differences in habitat use between the two lizard species. Most lizards of both species were found under rocks (Table 2). Using ANOVA, we compared proximity to cover and cover object size among three categories of lizards: (1) Northern Alligator Lizards when they were the only lizard present at a site; (2) Northern Alligator Lizards when they were syntopic with Western Skinks; and (3) Western Skinks when they were syntopic with Northern Alligator Lizards. Note that there were no sites that contained only Western Skinks. Rock area ($F = 3.92$, df = 2,335, $P = 0.02$), rock thickness ($F = 7.28$, df = 2, 336, $P < 0.001$), and distance to the nearest forest edge ($F = 6.99$, df = 2,488, $P = 0.001$) all differed among the three categories of lizards. The distance to the nearest rock ($F = 2.72$, df = 2,491, $P = 0.18$) and the distance to the nearest shrub ($F = 2.72$, df = 2,489, $P = 0.07$) did not differ among the three categories ($F = 1.70$, df = 2,491, $P = 0.18$; Fig. 2). Pairwise *t*-tests revealed that Northern Alligator Lizards were under larger, thicker rocks than western skinks, at sites where they are syntopic with western skinks. Both lizard species were found

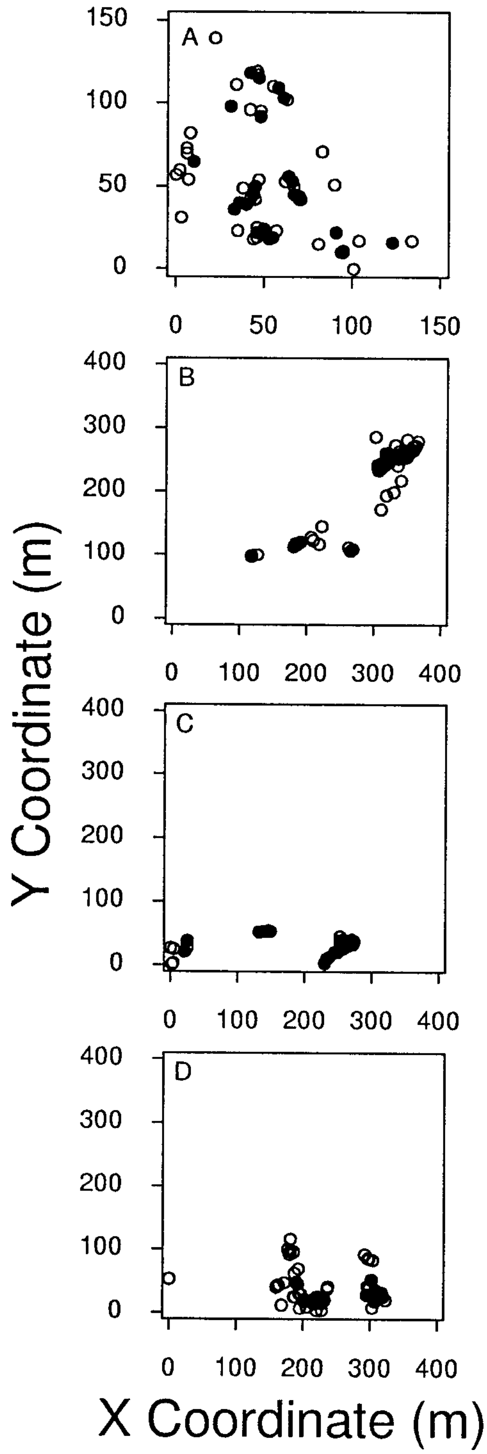

FIG. 1. Hibernation (closed circle) and summer sites (open circle) for Northern Alligator Lizards (*Elgaria coerulea*) at four primary sites: (A) Pat's Hill; (B) Balance Rock (Hydro); (C) Balance Rock (East Clearing); and (D) Lone Pine Hill. All capture sites of lizards captured before 30 April and after 1 September are hibernation sites; all other capture sites are summer sites.

TABLE 2. Locations of all captured (including recaptures) and sighted (not captured) lizards. Data include both hibernation site and summer site captures.

Northern Alligator Lizards (*Elgaria coerulea*)						
	Captured		Sighted		Total	
Location	(*N*)	(%)	(*N*)	(%)	(*N*)	(%)
Under rock	271	61	47	34	318	55
In vegetation	59	13	21	15	80	14
On dirt/rock	27	6	24	18	51	9
Under log	4	1	1	1	5	1
On road	2	0.5	0	0	2	0.3
Unknown	79	18	42	31	121	21
Total	442	100	137	100	579	100

Western Skinks (*Eumeces skiltonianus*)						
	Captured		Sighted		Total	
Location	(*N*)	(%)	(*N*)	(%)	(*N*)	(%)
Under rock	112	83	55	60	167	74
In vegetation	2	1	5	5	7	3
On dirt/rock	1	1	2	1	3	1
Unknown	19	14	29	32	48	21
Total	135	100	91	100	226	100

at similar distances from rocks, shrubs, or forest edges. Northern Alligator Lizards were under larger, thicker rocks and further from shrubs and forest edges (but not rocks) when they were syntopic with western skinks, than when they were allotopic.

We compared the species of shrub that was nearest to the lizard when it was found, between the two lizard species at the two sites where they were abundant (Pat's Hill and Dewdney). The five most common shrub species were compared at Pat's Hill and the top three at Dewdney using Chi-square analysis. Both lizard species were associated with similar shrub species (Pat's Hill: $\chi^2 = 2.75$, df = 4, $P = 0.60$; Dewdney: $\chi^2 = 1.40$, df = 2, $P = 0.50$). Most lizards were found near Mallow Nine Bark (*Physocarpus malvaceus*), Ocean Spray (*Holodiscus discolor*), Mock Orange (*Philadelphus lewsii*), and Snowberry (*Symphorocarpos albus*).

Similarly, we compared the associations with the immediately surrounding substrate (e.g., soil, grass, moss, leaf litter, etc.) of the two species at Pat's Hill. Both lizard species were associated with similar surrounding substrate ($\chi^2 = 3.55$, df = 2, $P = 0.17$); most lizards associated with grass and moss.

All sites were located on forest edges, but the predominant tree species in the nearest forest edge differed between sites. At Pat's Hill, where Northern Alligator Lizards and Western Skinks were equally abundant, there was no difference between the two lizard species in their occurrences near either tree species ($\chi^2 = 0.18$, df = 1, $P = 0.67$). The two most common tree species

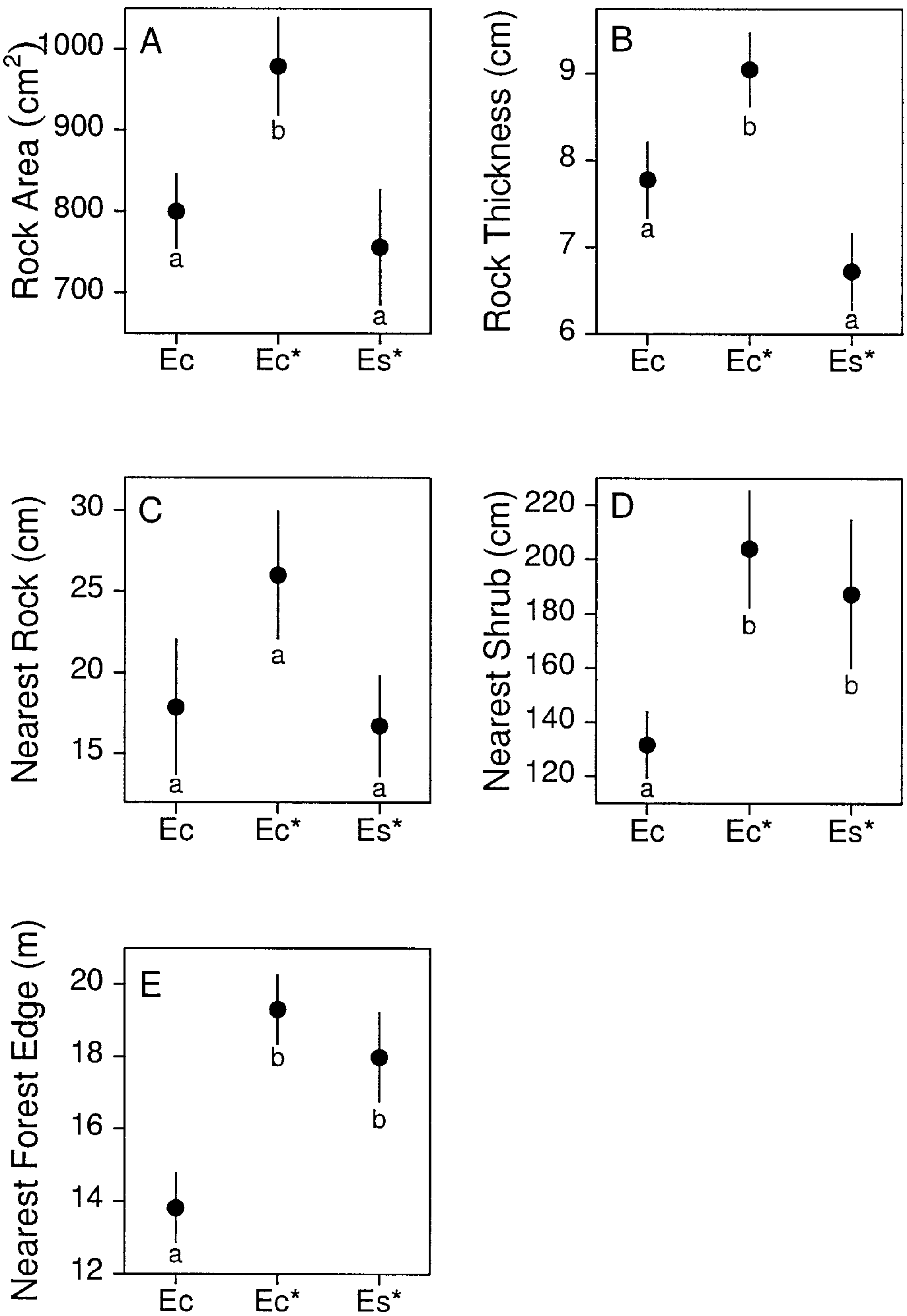

FIG. 2. Comparisons of proximity to cover and cover object size for three categories of lizards: (1) Northern Alligator Lizards (EC) when they were the only lizard present at a site; (2) Northern Alligator Lizards (EC*) when they were syntopic with Western Skinks (ES); and (3) Western Skinks (ES*) when they were syntopic with Northern Alligator Lizards. Categories that do not differ at *P* less than or equal to 0.05 are shown with the same letter.

(that individual lizards were captured nearest) were Ponderosa Pine *Pinus ponderosa* (Northern Alligator Lizards: 63% of captures; western skinks: 57% of captures) and Douglas-fir *Pseudotsuga menziesii* (Northern Alligator Lizards: 37% of captures; Western Skinks: 42% of captures). We were not able to test the differences between the lizard species at the other site where both lizard species were commonly found (Dewdney), but a similar pattern existed. The predominant tree species was Douglas-fir (Northern Alligator Lizards: 91% of captures; Western Skinks: 100% of captures), which also predominated at the four sites where Northern Alligator Lizards were most abundant (Hydro: 100% of captures; Office: 100% of captures; East Clearing: 100% of captures and Lone Pine Hill: 99% of captures). The most common tree species at the one site where Western Skinks were most abundant was Trembling Aspen *Populus tremuloides* (Northern Alligator Lizards: 71% of captures; Western Skinks: 96% of captures).

Neither lizard species was commonly found on roads, even though six of the 10 sites were bordered on one side by a road.

Distances between Capture Locations.—Minimum distances moved were not corrected for time between captures because there was no relationship between distance moved and days between captures for Northern Alligator Lizards (t = 0.94, df = 88, P = 0.35) or Western Skinks (t = −0.85, df = 23, P = 0.40). Therefore, raw straight-line distance was used as the measure of the distance between capture sites.

Twenty-seven percent (90 of 334) of all marked Northern Alligator Lizards were recaptured over the three years, and 25% (25 of 101) of all Western Skinks were recaptured. Of these recaptures, neither Northern Alligator Lizards nor Western Skinks was caught far from a previous capture location (Northern Alligator Lizards: mean = 16.1 m, SE = 5.56, N = 90; Western Skinks: mean = 8.0 m, SE = 2.67, N = 25). Only one Northern Alligator Lizard that was recaptured moved from one study site to another over the three-year study, approximately 750 m away. No individual Western Skinks were detected at a second site, although neither of the two main Western Skink sites were within one km of another skink site.

We compared distances between capture locations within the same year (1996, 1997, or 1998) to those between capture years (1996 to 1997, 1997 to 1998, and 1996 to 1998) using ANOVA. There was no significant difference in the distances regardless of how far apart in time Northern Alligator Lizards ($F_{5,84}$ = 0.62, P = 0.68) or Western Skinks ($F_{5,19)}$ = 0.54, P = 0.74) were captured.

Northern Alligator Lizards were as likely to

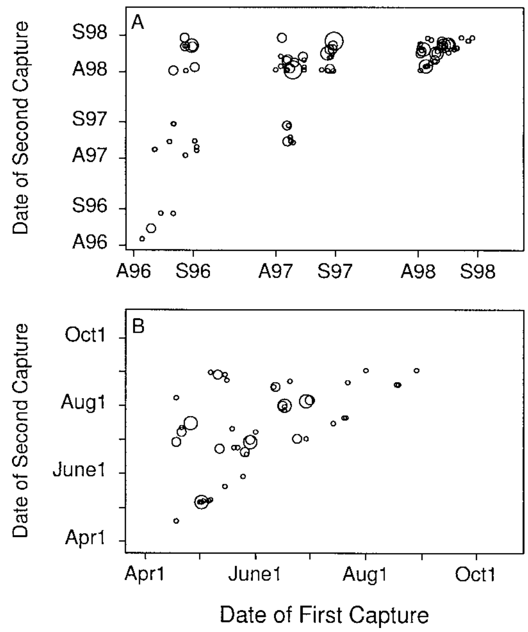

FIG. 3. Distance between locations of first and second captures for (A) 1996–1998 and (B) within 1998 for Northern Alligator Lizards from CVWMA, Creston, British Columbia collected in 1996–1998. Distances traveled between capture locations are in four categories that correspond to dot size: < 10 m, 10–25 m, 26–50 m and > 50 m (A = April S = September).

make both short- or long-distance moves within or between seasons (Fig. 3A). This is particularly evident for the 1998 data, as the movement study was more intensive that year. A similar plot of only the within-season data shows that lizards did not make long-distance moves from hibernation sites to summer sites (Fig. 3B). Western Skinks showed similar movement patterns, both within and between seasons.

There was no difference in the distance between captures of adult male Northern Alligator Lizards compared to newborns, juveniles or adult females ($F_{3,84}$ = 0.68, P = 0.57). A similar trend was true for male Western Skinks compared to female Western Skinks (t = 0.68, df = 22, P = 0.51). Nonetheless, males of both species had the largest distances between capture locations.

Site Fidelity.—Some captures were made at sites where lizards had been previously caught (Northern Alligator Lizards: 9% of 282 captures; Western Skinks: 10% of 92 captures). Some of these repeat captures were of the same animal recaptured at the same location (Northern Alligator Lizards: seven of the 26, 26.9%, repeat captures; Western Skinks; four of nine, 44.4%, repeat captures). In all other instances, different lizards were captured at different times at the same location.

There was no difference in the surface area or thickness of rocks recorded once versus more than once for either Northern Alligator Lizards (rock area: $t = 0.62$, df = 31.8, $P = 0.55$; rock thickness: $t = 0.67$, df = 27.3, $P = 0.51$) or Western Skinks (rock area: $t = 1.25$, df = 8.8, $P = 0.24$; rock thickness: $t = 1.01$, df = 9.2, $P = 0.34$. Similarly, distance to the next nearest rock for both Northern Alligator Lizards ($t = 0.87$, df = 36.3, $P = 0.39$) and Western Skinks ($t = 0.15$, df = 10.9, $P = 0.88$) did not differ between single-use or multiple-use rocks. Distance to the nearest shrub did not differ between single-use or multiple-use rocks for both Northern Alligator Lizards ($t = 0.29$, df = 26, $P = 0.77$) and Western Skinks ($t = 1.29$, df = 27.6, $P = 0.21$), nor did distance to the nearest forest edge vary between single-use or multiple-use rocks for both Northern Alligator Lizards ($t = 0.84$, df = 32.5, $P = 0.41$) and Western Skinks ($t = 0.74$, df = 11.3, $P = 0.48$).

Response to Disturbance.—Western Skinks were more secretive than Northern Alligator Lizards. A Chi-square test of the capture location frequencies indicated that fewer Western Skinks were seen in the open, either in vegetation or on a hard substrate ($\chi^2 = 43.31$, df = 5, $P < 0.001$). Although Western Skinks were rarely captured or sighted in vegetation compared to Northern Alligator Lizards, when disturbed Western Skinks typically ran towards a shrub for cover. In contrast, Northern Alligator Lizards typically ran to a nearby rock for cover. Only copulating Northern Alligator Lizards were unresponsive to human presence, even tolerating being picked up while they remained together.

Discussion

Northern Alligator Lizards and Western Skinks are frequently found at the same sites in Creston. This pattern of overlap was also reported between Western Skinks and Southern Alligator Lizards (*Elgaria multicarinatus*) in California (Block and Morrison, 1998). Nonetheless, some sites are dominated by one species. Why this should be is not clear. The proximity to cover and cover object size differs for northern alligator lizards when they are allotopic compared to when they are syntopic with western skinks. This may indicate competitive interactions between the two species, but that hypothesis would need to be tested experimentally. Throughout this study, we did not witness any direct interactions between the two species, although we did not perform any experiments to test for the presence and effects of competition. It is possible that the differences in habitat use of Northern Alligator Lizards (syntopic vs. allotopic) may just reflect site differences in habitat structure (i.e., rock sizes, shrub density). If there is no competition between the two species, then perhaps the pattern of site occupation is simply based on historical reasons.

For both Northern Alligator Lizards and Western Skinks, captures at hibernation sites were near captures made during the summer. This suggests that hibernation and reproduction sites are in the same general area. In addition, individuals of either species were recaptured within 10 m (on average) of a previous capture. Both these factors indicate that a population requires a relatively small area. Stewart (1985) also found that most recaptures of individual Northern Alligator Lizards were within a 10-m radius of the original capture point. This is in contrast to a previous study (Vitt, 1973), in which Northern Alligator Lizards were gregarious around localized dens in early April and then from late April through August they were dispersed away from the den sites. Thus, the degree to which we can extrapolate from one population to another is questionable. Presumably, different movement patterns result from the different spatial arrangement of essential resources. We did not measure conditions required for hibernation and other activities, or their availability, but comparisons of such parameters between different habitats might explain different patterns of habitat use.

Because Northern Alligator Lizards and Western Skinks have high site-fidelity and do not make large movements between hibernation or reproduction sites, they rarely need to cross roads. In addition, they are apparently not attracted to roads as basking locations. Roads may be barriers between populations, limiting gene flow and eliminating colonization of new areas. Although not shown in lizards, this phenomenon has been observed in populations of mammals and carabid beetles (Oxley et al., 1974; Mader, 1984). The impact of habitat fragmentation on these lizards, including the effects of roads, awaits more detailed knowledge of dispersal patterns, especially of young animals.

Both lizard species were rarely found in the open and more often under rocks than in vegetation or under logs. They rarely strayed far from available cover, remaining closest to rocks but typically within 2 m of a shrub. For reptiles, retreat sites can serve as protection from lethal ground temperatures and predators (Huey et al, 1989; Downes and Shine, 1998). In the summer, maximum air temperatures in Creston can reach 35°C with ground temperatures exceeding 40°C, lethal for a reptile in the open in midafternoon (Huey et al., 1989). We know little about their thermal biology, but there are seasonal patterns of cover use (Rutherford and Gregory, in press).

Retreat sites also would provide refuge from predators. The main predators of either lizard species are unknown but Northern Alligator Lizard carcasses have been seen on nearby nest boxes, presumably left by avian predators.

It appears that some retreat sites are more important than others. Although we found no physical differences between these ''preferred'' locations and ''single-use'' locations, it is possible that these ''preferred'' locations had better thermoregulatory properties in addition to their proximity to available cover. Further study would reveal whether lizards are selecting rocks nonrandomly within the habitat by comparing rocks that lizards used to rocks that were not used.

Distances between capture locations indicated site fidelity for both species, although some adult males moved greater distances. Higher activity and longer movements in males have been shown in other lizard species (Marler and Moore, 1988; Parker, 1994) and may be based on mate-seeking behavior. The lesser distances between capture locations of females may be based on the fact that nesting Western Skink females guard their eggs (Shine, 1988) and gravid Northern Alligator Lizards females have reduced mobility (Rutherford and Gregory, in press).

If lizards are dependent on specific retreat sites, it may have broad effects on the population biology of these animals. In areas where other factors are not limiting, the availability of retreat sites may determine the upper limit for species abundance on a local scale (Bustard, 1969; Bustard, 1970). For retreat-site availability to be limiting, retreat sites must be vital to the biology of the animal, and there must be a limit on the number of individual lizards able to use each site simultaneously. Use of a rock by more than one Northern Alligator Lizard or Western Skink was rare in this study, regardless of the size of the rock.

Their necessity for cover means that any disturbance or removal of rocks in the area would be detrimental to both species. Rock collecting is thought to be detrimental to Velvet Geckos (*Oedura lesueurii*; Schlesinger and Shine, 1994) and Broad-Headed Snakes (Shine et al., 1998) in southern Australia. Northern Alligator Lizards and Western Skinks are similar to these reptiles in that they rely heavily on retreat sites and show some site fidelity. Both of these features make them susceptible to retreat-site disturbance.

Although both lizards were most commonly captured under rocks, they also remained quite close to shrubs. In addition, disturbed Western Skinks preferentially ran toward shrubs for cover. Northern Alligator Lizards and Western Skinks were most frequently found nearest four shrub species. Proximity to these shrub species might merely reflect their availability at the site. All four of these shrubs are dense and provide cover close to the ground, allowing the lizards to disappear easily into the vegetation. Both lizard species are insectivores (Gregory and Campbell, 1984) and also may use the shrubs for foraging.

The association of Northern Alligator Lizards and Western Skinks with forests is unclear. All sites were in forest clearings, but the lizards may not have been using the forests themselves. Northern Alligator Lizards sometimes are captured within forests (Gregory and Campbell, 1984), but they are most commonly seen in clearings. This may in part be because of the difficulty of seeing and capturing a lizard in the forest compared to in an open clearing. However, the consistent capture and recapture of both species in the clearings suggests that even if they were venturing into the forests they still returned to the clearing. An intensive movement study would need to be conducted to properly determine their association with forests.

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