Ecography

E5615

Soykan, C. U. and Sabo, J. L. 2009. Spatiotemporal food web dynamics along a desert riparian-upland transition. – Ecography 32: 354–368.

Supplementary material

Appendix S1. Detailed field methods for mammalian carnivores and rodents

Scent station methods

To operate the stations we first poured ~50 ml of diluted scent lure into a perforated plastic bottle with an absorbent sponge and suspended the bottle above the ground with a strong nylon rope attached to a 1.5 m piece of rebar hammered into the ground. We then spread about five kg of finely sieved gypsum powder on the ground in a one-meter circle around the rebar and smoothed it over to produce an unblemished surface. We baited the scent stations during the day and left for two nights, after which time we returned and recorded predator visitation based on tracks left behind in the gypsum powder. Rainfall eliminated all tracks on the gypsum powder, resulting in incomplete sampling for certain months (Nov, Apr) and no scent station data for other months (Feb, July, Aug).

Skunk radio-telemetry methods

We trapped skunks in Havahart live traps (Woodstream Corp, Lititz, PA) and anesthetized them with ketamine hydrochloride (0.1–0.3 ml kg^{-1} body weight). We secured a radio collar (Advanced Telemetry Systems, Isanti, MN) around their necks, and the individuals were released after the effects of the ketamine wore off. While tracking we followed a skunk's radio signal until the skunk was sighted or heard, at which point we recorded a GPS location and data on habitat type. We used a hand-held GPS unit that provided accuracy to within 4 m (Garmin International, Olathe, KS). If it was impossible to locate the individual, but its signal was strong, we assumed proximity to the skunk and recorded a GPS location. To insure temporal independence of the data we recorded spatial locations no more than once per night for each skunk. Monitoring varied from week to week depending on the lead author's schedule. In general, skunks were tracked several times a week during the summer months and a few times a month in September–November and March–April. We also recorded a GPS location and habitat data for uncollared skunks encountered during radio-tracking. A total of 112 skunk locations were used for regression and chi-square analysis. Of these, 11/112 (9.8%) were from uncollared skunks, 52/112 (46.4%) were based on proximity, and 49/112 (43.8%) were from collared skunks that were sighted or heard. The general patterns reported in the result hold, regardless of which data are included in the analysis.

Scat collection and analysis

Scat transects were based on existing roads/paths at two of the four sites described in the methods section (the central two sites – Fig. 1). A stratified design was not possible given the configuration of trails at the study sites (going off trail was difficult due to the dense desert-scrub vegetation, and yielded few scats since predators tend to follow pre-existing paths). Thus, at the upper middle site, one transect included CW habitats, and another included CW, MQ, and NS habitats. At the lower middle site, both transects included MQ and NS habitats, and one included FS habitats. In late May 2003, we cleared the transects of all scats, after which we walked each transect at monthly intervals, individually collecting newly-deposited scats in zipper-seal plastic bags and recording their position with a hand-held GPS unit. We also collected any fresh scats found at miscellaneous locations during the course of the study, but these only accounted for 18/1103 (1.6%) of all scats collected. In the lab we soaked each scat until it softened, put it in a nylon stocking, tied off the end, and agitated it thoroughly in water until the bulk of the soluble material had been removed. A final wash with ethanol sterilized and further cleaned the scat, which we then analyzed for content. We sorted the remaining, insoluble parts of the scat into different prey categories, including fur, feathers, seeds, scales, and exoskeletons.

Rodent trapping

From July to August of 2003 we trapped rodents across a range of sites and habitats using the transect method. For this spatially-extensive rodent trapping we selected three study sites, each separated by >3 km. At each site we selected two sets of locations, separated by >500 m for trapping. We set out four transects at each location, one in each of the following habitats: CW, MQ, NS, and FS, recording the spatial location of each transect using a hand-held GPS unit. Using Sherman live traps baited with a mixture of peanut butter and oats, we set the traps before sunset and processed all captures early the next morning. We set 40 traps per transect and trapped each location once in each of three time periods in early July, late July, and early August for a total of 2880 trap-nights. The traps were spaced about 10m apart, making each transect roughly 400m in total length.

We continued with the spatially-extensive rodent trapping in 2005 – this time with quadrats – selecting four new sites, each separated by >3 km. The change in protocol was intended to better fit with the vegetation sampling scheme begun in 2004 and described in the text under "Litter and vegetation sampling". As in 2003 we trapped in four different habitat types at each of the sites. We trapped two plots per habitat type per site for a total of 32 plots. In each plot we baited and set ten Sherman live traps for a total of 320 trap-nights per season. We conducted the dry-season trapping in June 2005 and the post-monsoon trapping in October 2005.

To complement the spatially-extensive trapping described above, we set up a robust design involving three trapping grids at one of the sites (but separated from the plots mentioned above). The robust design of this trapping scheme allows one to gather information on rodent survival and abundance in the different habitat types (Pollock et al. 1990). One grid was in riparian habitat (CW and MQ), one was in NS, and one was in FS. Each grid contained 120 Sherman live traps arranged in a 12 × 10 trap array, with individual traps separated by ~10 m. We oriented the long axis of the trapping grids perpendicular to the river and trapped each grid twice monthly (on consecutive nights) from May–October of 2004 and 2005, for a total of 8640 trap-nights. Moon phase, tag loss, and low recapture rates complicated the intensive trapping protocol. Specifically, most of the rodents in the riparian grid lost their ear tags during the first three months of trapping (after which we switched to toe-clipping). The lack of accurate data for May–July of 2004 prevented us from using the 2004 riparian trapping results for survival analyses. Likewise, near-full moons in 2005 resulted in low capture and recapture rates in the NS and FS grids. Therefore, for our MNKA and survival analyses we only included trapping data from 2005 for the riparian grid and from 2004 for the near- and far-scrub grids.

Table S1. Carnivora and Rodentia of the San Pedro (see Soykan et al. 2009 for references). While not all of the species listed below interact strongly, if at all, they are listed to give the reader an idea of the diverse mammal fauna of the region.

Order	Family	Scientific name	Common name
Carnivora	Canidae	*Canis familiaris*	Domesticated dog
		Canis latrans	Coyote
		Urocyon cinereoargenteus	Gray fox
		Vulpes macrotis	Kit fox
	Felidae	*Felis silvestris*	Domesticated cat
		Lynx rufus	Bobcat
		Puma concolor	Puma
	Mephitidae	*Conepatus mesoleucus*	Common hog-nosed skunk
		Mephitis macroura	Hooded skunk
		Mephitis mephitis	Striped skunk
		Spilogale gracilis	Western spotted skunk
	Mustelidae	*Taxidea taxus*	American badger
	Procyonidae	*Bassariscus astutus*	Ringtail
		Nasua narica	White-nosed coati
		Procyon lotor	Northern raccoon
	Ursidae	*Ursus americanus*	Black bear
Rodentia	Castoridae	*Castor canadensis*	Beaver
	Cricetidae	*Neotoma albigula*	White-throated wood rat
		Onychomys leucogaster	Northern grasshopper mouse
		Onychomys torridus	Southern grasshopper mouse
		Peromyscus boylii	Brush mouse
		Peromyscus eremicus	Cactus mouse
		Peromyscus leucopus	White-footed mouse
		Peromyscus maniculatus	Deer mouse
		Reithrodontomys fulvescens	Fulvous harvest mouse
		Reithrodontomys megalotis	Western harvest mouse
		Reithrodontomys montanus	Plains harvest mouse
		Sigmodon arizonae	Arizona cotton rat
		Sigmodon fulviventer	Fulvous cotton rat
		Sigmodon ochrognathus	Yellow-nosed cotton rat
	Erithizontidae	*Erithizon dorsatum*	Porcupine
	Geomyidae	*Thomomys bottae*	Botta's pocket gopher
	Heteromyidae	*Chaetodipus baileyi*	Bailey's pocket mouse
		Chaetodipus hispidus	Hispid pocket mouse
		Chaetodipus intermedius	Rock pocket mouse
		Chaetodipus penicillatus	Desert pocket mouse
		Dipodomys merriami	Merriam's kangaroo rat
		Dipodomys ordii	Ord's kangaroo rat
		Dipodomys spectabilis	Banner-tailed kangaroo rat
	Muridae	*Mus musculus*	House mouse
	Sciuridae	*Ammospermophilus harrisii*	Harris's antelope squirrel
		Cynomys ludovicianus	Black-tailed prairie dog
		Spermophilus spilosoma	Spotted ground squirrel
		Spermophilus tereticaudus	Round-tailed ground squirrel
		Spermophilus variegatus	Rock squirrel

Table S2. Mean and median distance-from-river estimates for five individual striped skunks during the dry and wet seasons.

Distance-from-river	Skunk				
Metric	m1	m2	m3	m4	m5
Mean (dry season)	210.76	73.12	49.75	159.25	103.64
Mean (wet season)	407.19	266.67	73.44	231.66	165.46
Median (dry season)	86.79	54.00	34.53	44.46	69.71
Median (wet season)	106.11	166.57	70.27	141.36	78.21

Table S3. Minimum number known alive and biomass estimates for individual rodent genera in each of the three intensive trapping grids.

	Number of individuals known alive					
Genus / Grid	May	Jun	Jul	Aug	Sep	Oct
Chaetodipus Riparian grid	38	40	54	45	10	12
Chaetodipus Near-scrub grid	3	7	15	7	13	13
Chaetodipus Far-scrub grid	6	11	18	11	3	1
Dipodomys Riparian grid	1	2	0	0	0	0
Dipodomys Near-scrub grid	4	3	3	3	3	6
Dipodomys Far-scrub grid	23	26	26	21	15	15
Neotoma Riparian grid	4	2	2	2	4	2
Neotoma Far-scrub grid	2	2	2	3	1	1
Onychomys Riparian grid	0	1	0	0	0	0
Onychomys Far-scrub grid	5	3	6	9	9	8
Peromyscus Riparian grid	6	5	5	5	8	20
Peromyscus Near-scrub grid	2	2	0	0	0	1
Peromyscus Far-scrub grid	0	0	0	0	2	1
	Biomass of rodents known alive (kg)					
Chaetodipus Riparian grid	0.646	0.68	0.918	0.765	0.17	0.204
Chaetodipus Near-scrub grid	0.051	0.119	0.255	0.119	0.221	0.221
Chaetodipus Far-scrub grid	0.102	0.187	0.306	0.187	0.051	0.017
Dipodomys Riparian grid	0.045	0.09	0	0	0	0
Dipodomys Near-scrub grid	0.18	0.135	0.135	0.135	0.135	0.27
Dipodomys Far-scrub grid	1.035	1.17	1.17	0.945	0.675	0.675
Neotoma Riparian grid	0.632	0.316	0.316	0.316	0.632	0.316
Neotoma Far-scrub grid	0.316	0.316	0.316	0.474	0.158	0.158
Onychomys Riparian grid	0	0.025	0	0	0	0
Onychomys Far-scrub grid	0.125	0.075	0.15	0.225	0.225	0.2
Peromyscus Riparian grid	0.126	0.105	0.105	0.105	0.168	0.42
Peromyscus Near-scrub grid	0.042	0.042	0	0	0	0.021
Peromyscus Far-scrub grid	0	0	0	0	0.042	0.021

Note: near- and far-scrub data are from 2004, while riparian data are from 2005.

Table S4. Ratio of interior capture rate to overall capture rate. Interior traps were ≥30 m from the edge of the trapping grid.

Year	Habitat	Ratio
2004	NS	0.559
2004	FS	0.705
2005	NS	0.477
2005	FS	0.693

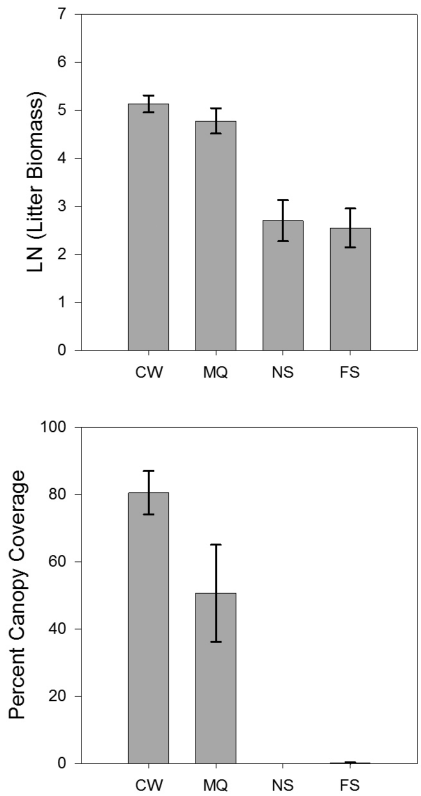

Figure S1. Mean litter biomass and canopy coverage by habitat type (±2 SE). The litter biomass data indicate a large difference (about two orders of magnitude) between primary production in desert-scrub and riparian habitats. Production within riparian and desert-scrub habitats, however, does not seem to vary by habitat type (i.e. CW ≈ MQ and NS ≈ FS). Canopy coverage is significantly greater in cottonwood-willow habitats than any others, and significantly greater in mesquite habitats than desert-scrub habitats.

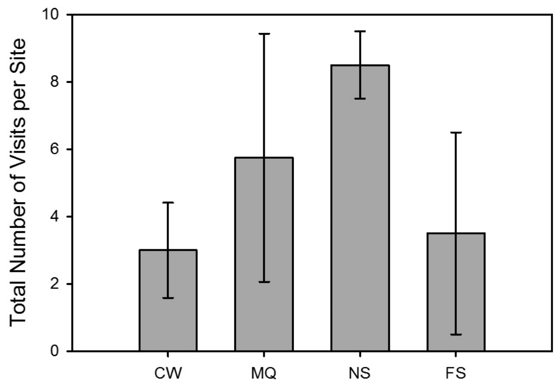

Figure S2. Predator visits to scent stations by habitat type (±2 SE). Predators visited scent stations most frequently in near-scrub (NS) and mesquite (MQ) habitats. The high variability is a result of small sample size and required the use of nonparametric statistics. Nevertheless, there was a marginally significant difference in predator visits between near-scrub and cottonwood-willow (CW) habitats and between near-scrub and far-scrub (FS) habitats.

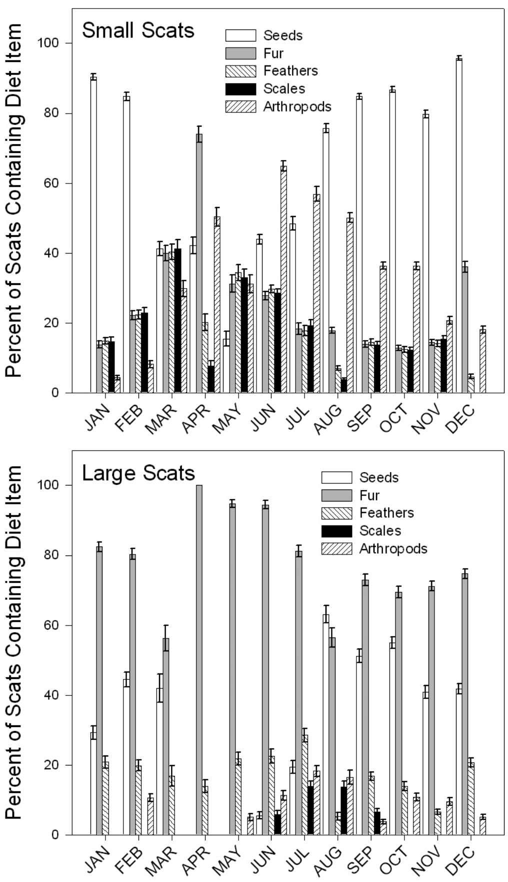

Figure S3. Percentage of small and large predator scats containing each of five diet items by month. The percentage of scats containing seeds and fur varied over time but were always significantly different. Means and 95% confidence intervals were calculated by bootstrapping the original data 100 times.

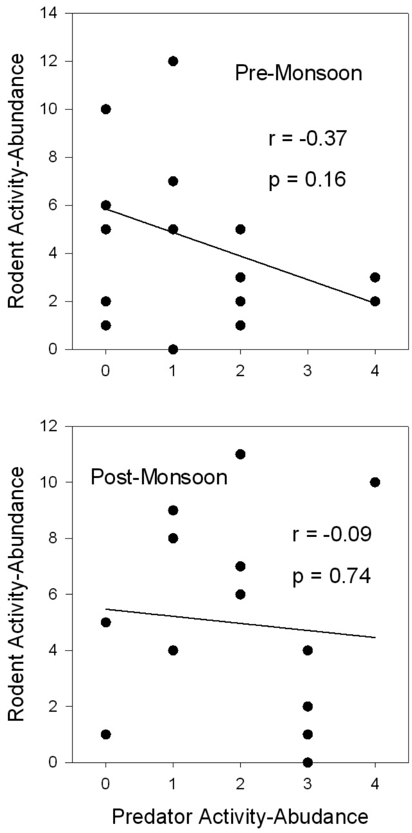

Figure S4. Pre- and post-monsoon correlations between predator and rodent activity-abundance estimates. Neither correlation is statistically significant, indicating little or no relationship between the activity-abundance of mammalian carnivores and rodents.