REPTILE USE OF SHRUBSTEPPE AND CONSERVATION RESERVE PROGRAM HABITATS IN EASTERN WASHINGTON, USA.

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Abstract-

Introduction

While shrubsteppe vegetation once comprised the dominant vegetative cover in eastern Washington (Daubenmire 1970), it now occurs in less than 40% of it's historic Washington range, and much of it is degraded, fragmented, and/or isolated from other remnants (Dobler et al. 1996, Jacobson and Snyder 2000). Primary factors in shrubsteppe loss include type conversions for crop or livestock production (Buss and Dziedzic 1955, Vale 1974, Swenson *et al*. 1987, Vander Haegen *et al*. 2001), inundation by hydroelectric water impoundments (Howerton 1986), fragmentation by roads, transmission lines, energy development, canals (Noss et al., 1995, Hann et al., 1997, Vander Haegen *et al*. 2001), and altered vegetative structure and species composition resulting from over-grazing, exotic plant invasion, and altered fire frequency (Yensen *et al*. 1992, Vander Haegen *et al*. 2001).

Shrubsteppe loss and degradation has had profound negative effects on shrubsteppe-associated wildlife. Population declines have been documented for numerous bird and mammal species, e.g., sage-grouse (*Centrocercus* spp.), Brewer's sparrow (*Spizella breweri*), sage sparrow (*Amphispiza belli*), sage thrasher (*Oreoscoptes montanus*; Connelly et al., 2000, Knick and Rotenberry 2002, Vander Haegen et al., 2000), pygmy rabbit (*Brachylagus idahoensis,* WDFW 1993, USDI 2003), and Washington ground squirrel (*Spermophilus washingtoni*, Betts 1999, Finger et al., In Press).

Many amphibian and reptile species are associated with shrubsteppe and have declined as well (Vander Haegen et al. 2001). The sharptail snake (*Contia tenuis*) and striped whipsnake (*Masticophis taeniatus*) are Washington state candidates for threatened status, the night snake is a state monitor species; the sagebrush lizard (*Sceloporus graciosus*) is a federal species of concern, and the northern leopard frog (*Rana pipiens*) is endangered in Washington State and has been petitioned for listing at the federal level (Anonymous 2006). For many of these species, population declines associated with habitat loss are suspected.

Established in 1985 and originally focused on economic assistance, the Conservation Reserve Program (CRP) paid farmers to remove farm and range land from production and plant permanent vegetative cover to conserve soil (Bidwell and Engle 2005). Early enrollments didn't consider wildlife needs, but as recognition of the potential benefits to wildlife increased, later enrollments began considering wildlife habitat needs and other environmental factors (Hyberg 2005). In effect, the CRP constitutes a national effort to increase habitat for grassland and shrubsteppe wildlife (Hyberg 2005); and is the largest habitat improvement project in eastern Washington. In Washington, over 405,000 ha (1 million ac) of agricultural land has been planted to non-native grasses, native grasses, forbs and shrubs under the CRP. Despite the potential of CRP land as amphibian and reptile habitat, we are aware of no studies that have examined use of CRP lands by these taxa.

Our objectives were therefore to evaluate the potential role of CRP in conservation of amphibians and reptiles in Washington. Specifically, we wished to compare amphibian and reptile distributions in CRP lands with those in nearby native shrubsteppe, and compare amphibian and reptile patterns of occurrence in CRP lands of different ages and set in different landscape contexts to provide information that will benefit management of CRP in Washington to benefit shrubsteppe associated amphibians and reptiles.

Study Area and Design

Study Area- The four county area encompasses 22,699 km^2 (8,767 mi^2) and ranges in elevation from 116 m (380 ft) along the Columbia River to 1,292 m (4,240 ft) at Badger Mountain (Fig. 1). Topography consists of nearly level to moderately sloping bottomlands and terraces, basins, potholes, and hilly-to-mountainous uplands. Soil types throughout the area are a variety of loams and sands, with gravel, cobble, and rock occurring on exposed slopes (Lenfesty 1967, Beieler 1981, Gentry 1984).

Two dominant native vegetative types existed before the arrival of Euro-Americans and still persist in areas not converted to agriculture (Daubenmire 1970). The *Artemisia tridentata – Agropyron* type has *Artemisia tridentata* as its principal shrub and

Pseudreogneria spicatum as its principal grass, while the *Artemisia tripartita – Festuca* type has an irregular layer of *A. tripartita* over a continuous herb layer that includes *Festuca idahoensis*. *Artemisia tridentata*, where present, generally occurs on disturbed sites. Agricultural croplands now dominate the majority of the area, and the majority of the non-cropland area is grazed by domestic livestock.

Local maximum average daily temperature is 30.7 C (87 º F) and occurs in July, while a minimum average daily temperature of -7.8 C (18º F) occurs in January (30-year average for 1971 – 2000; WRCC 2005). Average annual precipitation is 20.3 cm (8.0 in), with 40% of annual totals normally falling during November – January (WRCC 2005). Precipitation is heaviest during winter and light during summer, and ranges from 17.8 cm annually at lower elevations to 35.6 cm at higher elevations (Lenfesty 1967, Beieler 1981, Gentry 1984).

We surveyed amphibian and reptile communities in three site types; new CRP fields, old CRP fields, and native shrubsteppe, with each type replicated in landscapes dominated by agriculture and in landscapes dominated by shrubsteppe vegetative cover. Shrubsteppe vegetative communities were dominated by native vegetation, with an overstory of big sagebrush and an understory of bunchgrasses and forbs. “Young” CRP vegetative communities were former agricultural lands planted in the 1998-2000 sign-up to a mix of non-native and native species including big sagebrush. Old CRP vegetative communities were former agricultural fields planted to non-native bunchgrasses in previous sign-ups (1986-1988). Each site type was represented in each of eight clusters of replicates. Sites within clusters were located relatively close to one another, and clusters were distributed widely to help control for environmental variation across the four-county study area (Chapter X).

Methods

Field data collection- We used time-and-area-constrained searches and drift fence arrays to document relative abundance of reptiles and amphibians among sites. In 2003, we conducted time-and-area-constrained searches at five (n=30 sites) of the eight clusters of treatment replicates (Black Rock, Chester Butte, Coyote Canyon, Jameson Lake, Pacific Lake). During 2004, we surveyed all eight clusters of treatment replicates (n=48 sites).

Searches at each site were conducted within flagged, square 400 m x 400 m (16 ha) areas that were ≥ 200 m from the nearest dissimilar vegetative edge. Each survey lasted 1.5 – 2 person-hours, with duration reflecting structural complexity of individual plots. We searched first in areas containing attributes appropriate for basking, dening, or foraging by potentially present species, then searched through progressively less optimal-looking areas. In plots containing little vegetative or structural diversity, two observers searched the plot by walking a systematic zig-zag pattern while spaced 5 – 10 m apart.

We surveyed each site twice in 2003, (excepting Jameson Lake sites which were surveyed once), while in 2004 all sites were surveyed ≥3 times, with recurring surveys at each site rotated among morning, afternoon, and evening periods in order to sample sites evenly across a range of ambient temperature conditions.

We installed one drift fence array at the center of each plot. Arrays were peace sign-shaped, with arms radiating outward from array center and oriented 120^{o} apart. Fences were 1.5 mm mesh nylon window screen, were 10 m length and 45 cm in height, buried to ≥10 cm depth along the bottom edge, and held erect with wooden stakes. Funnel traps were constructed of the same material and were 46 – 61 cm in length, 17 – 20 cm diameter, and had 5.1 cm funnel openings. Traps were located along each arm at 0.5 m from array center and at the distal end (Fig. 1). Central traps were double-ended, while distal traps had funnels facing inward. Traps contained soil and polyester batting during cold weather, and were shaded with perforated landscaping cloth during warm weather. Funnel entrances were plugged when not in use.

In 2003, we surveyed using drift fence arrays at 24 of the 48 sites (Black Rock, Chester Butte, Coyote Canyon, Pacific Lake). In 2004, we used drift fence arrays at all 48 sites. Herptiles observed incidentally by herp surveyors while installing or checking arrays were tallied as incidental observations, with level of "incidental survey effort" considered equivalent to array-nights of effort at each site. All captured herptiles except venomous snakes received a unique toe or caudal scale clip, were sexed, weighed, measured (snout-vent length; svl), and released under cover nearest the point of capture. Shed snake skins were keyed to species when possible, and accepted in generation of species lists.

We measured vegetation in up to eight randomly located 100 m^2 plots in each distinct cover type (e.g., grassland, shrubland, crp) per site. In each sampling plot we recorded slope, aspect, general habitat type, and listed all plant species present. We estimated cover to the nearest one percent for shrubs, sub-shrubs, perennial grasses, annual grasses, forbs, rocks/gravel, standing dead vegetation, bare ground, soil crust, and litter (dead and detached vegetative material). Maximum height was recorded for each relevant category, and shrub density was estimated within a randomly chosen quarter (3.75 x 6.67 m) of each plot. We took Robel pole readings at five points spaced evenly along each of the two long axes of the plot border (n = 10 points per plot). Robel poles were read from 4 m distant and scored as visible/not visible in 10 cm increments from ground to 1 m above ground.

Analyses- We documented frequency of occurrence of each species at each site and for each survey method. Generalized linear mixed models with the logarithm as the link function, the Poisson distribution function, and random effects associated with each year and site combination were used to analyze the data. Because level of search effort differed among sites, the logarithms of search units were used as an offset in the model so that ratio of the raw occurrence per unit of survey effort (search-hours or array-nights) was modeled. To set incidental observation data on a scale similar to the other survey methods, the number of array nights were considered as the total survey effort for this survey type. We used site type (new CRP, old CRP, shrubsteppe), setting (agricultural or shrubsteppe landscape matrix), survey method, and percent cover of shrubs, perennial grass, rock-gravel, and bare ground as the predictor variables. Individual species were modeled when abundant enough to satisfy analytical power requirements. Remaining species data were pooled and modeled as a group.

Results

We conducted time-and-area-constrained searches during 25 June – 27 August in 2003, and 14 May – 30 September in 2004. Level of search effort ranged from 15.2

hours at new CRP sites in cropland landscapes − 19.4 hours at shrubsteppe sites in cropland landscapes in 2003, and from 18.0 hours at new CRP sites in cropland landscapes − 44.3 hours at shrubsteppe sites in shrubsteppe landscapes in 2004. We conducted drift fence array sampling during 29 July − 27 August in 2003, for a total of 143 array nights, and during 23 April – 10 September in 2004, for a total of 724 array nights of sampling. Sampling effort was 23 – 24 array nights in all site types in 2003, and ranged from 108 array nights in new CRP sites in shrubsteppe landscapes – 129 array nights at old CRP sites in shrubsteppe landscapes in 2004.

We observed 168 individuals representing 10 species (Table 1). Short-horned lizards (*Phrynosoma douglassii*) were most frequently encountered and widely distributed, and were the only species observed in all 6 site types. Western rattlesnakes (*Crotalus viridis*), racers (*Coluber constrictor*), and Great-basin spadefoot toads (*Scaphiopus intermontanus*) were encountered more frequently in shrubsteppe plots set within shrubsteppe landscpapes than in other site types, while western skinks (*Eumeces skiltonianus*) were most frequently observed in shrubsteppe sites in agricultural landscapes (Table 1). The three most common snakes –gopher snakes (*Pituophis catenifer*), rattlesnakes, and racers– were never observed in CRP sites set within agricultural landscapes. The remaining four species were only rarely encountered, with 3 species represented by only one or two individuals.

Species detectability varied by survey type (Table 2). While short-horned lizards were frequently observed via all survey types, other species' detectability varied among survey types. Gopher snakes were most frequently observed incidentally. Western rattlesnakes were observed most frequently during area searches, and were rarely caught in funnel traps, while western skinks, racers, and Great-basin spadefoot toads were most frequently caught in funnel trap arrays.

Short-horned lizards were the only species encountered frequently enough to model individually. When adjusted for survey method, site age was a significant predictor of probability of occurrence of short-horned lizards among site types (Table 3), while landscape setting and the vegetative variables were not. Probability of encountering short-horned lizards was lower in new CRP sites than in either old CRP or native shrubsteppe sites, with no difference between old CRP and native shrubsteppe sites.

The three amphibian species were rare among all study sites, and were likely influenced by water features, which we did not address. Therefore, we excluded amphibians from the analysis and modeled western rattlesnakes, gopher snakes, racers, western terrestrial garter snakes (*Thamnophis elegans*), night snakes (*Hypsiglena torquata*), and western skinks as a reptilian group. Site age and landscape setting were both significant predictors of reptile occurrence among sites. Probability of occurrence was lower in both new and old CRP sites than in native shrubsteppe habitat. Probability of occurrence was also lower in sites set within agricultural landscapes than in sites set within shrubsteppe landscapes. Once again, vegetative variables did not influence probability of occurrence among site types.

Discussion

Both site type and landscape setting influenced reptile distributions in eastern Washington. The agricultural landscapes we evaluated were highly fragmented and dominated by tilled cropland, while our shrubsteppe landscapes had relatively little agricultural disturbance. Land conversion resulting in habitat loss and fragmentation is a well-documented cause of biodiversity declines (Ehrlich and Ehrlich 1970, Soulė 1983), and amphibians and reptiles are no exception (Smith et al. 1996, Sarre 1998, Hecnar and M'Closkey 1996). In small or isolated habitat remnants, stochastic events elevate extinction vulnerability (Hokit et al., 1999, McCoy and Mushinsky 1999). Deterministic factors such as abundance, survival, morphology, and recruitment are also influenced by remnant size (Sumner et al., 1999, Hokit and Branch 2003).

Short-horned lizards were the most frequently encountered and widely distributed species we observed. Probability of short-horned lizard occurrence was not influenced by landscape setting, but was lower in young CRP sites than in either old CRP or native shrubsteppe. Lillywhite (1977), working with *Phrynosoma coronatum* and Reynolds (1979) working with *P. hernandesi* documented loss or reductions (respectively) of short-horned lizards from rangeland areas after conversion from native shrub vegetation to grasslands. Lillywhite (1977) also found coast horned lizards (*P. coronatum*) absent from grassland sites containing less than 5 percent shrub cover. Our new CRP sites were generally homogeneous grasslands that averaged 2 percent shrub cover (WDFW, Unpublished Data). While short-horned lizards occur in a variety of vegetative types including sagebrush and bunchgrass-dominated areas, requisite site conditions appear to include burrows or loose soils for burrowing (Brown et al. 1995, Hammerson 1999, Stebbins 2003), ant prey (Knowlton 1934, Powell and Russell 1984), and shrub densities above that present on our new CRP sites.

The pooled reptile group was less likely to occur in either CRP site type than in native shrubsteppe, and also less likely to be present in cropland-dominated landscapes than in native shrubsteppe landscapes. Many reptile species in agriculture-dominated landscapes persist primarily within remnant native vegetation fragments and rarely occur in the cleared matrix (Driscoll 2004). Snakes also suffer intentional persecution from humans, are killed in large numbers along roads (Klauber 1972, Brown et al., 1995, Hammerson 1999), and suffer heavy mortality from farm mowing machinery (Capron, cited by Collins 1993). Although CRP can provide vegetation structure similar to native shrubsteppe, it often may lack physical characteristics that may be necessary for some reptiles.

None of the species in our reptile group were highly abundant. The two numerically dominant members of this group (western skink and western rattlesnake) associate with structure in the form of talus, ledge, rock fissures, or sticks and logs (Diller and Wallace 1996, Rutherford and Gregory 2003). Historically, soil depth and rock were important determinants of where agricultural conversion occurred, and most shrubsteppe remnants in Washington have shallow soils containing rock, talus, or ledge cover, while the majority of agricultural and CRP lands do not (Vander Haegen et al. 2001). It may be that the areas least suitable for agricultural development were well suited for these two species.

We observed gopher snakes in all three site-types, but only at sites set in native shrubsteppe landscapes. More than 90 percent of racer observations were in shrubsteppe sites, with 90 percent of these at sites set in shrubsteppe landscapes. Gopher snakes and racers occur across a relatively wide range of vegetative cover types in Washington (Brown et al. 1995, Diller and Wallace 1996, Vander Haegen et al., 2001) but both species also require cover in the form of rocks, shrubs, or burrows (Brown and Parker

1982, Brown et al. 1995, Stebbins 2003), and demonstrated a clear association with native shrubsteppe vegetation.

Prey availability also is an important factor in determining site occupancy by snakes (Toft 1985, Vitt 1987). In southwestern Idaho, ground squirrels (*Spermophilus townsendii*) and cottontail rabbits (*Sylvilagus nuttallii*) comprised the majority of prey biomass consumed by western rattlesnakes and gopher snakes (Diller and Wallace 1996). Cottontail rabbits were more abundant in native shrubsteppe than in CRP in our study (Chapter X) and we did not document a single ground squirrel colony on our CRP sites. However, several small rodents (*Peromyscus maniculatus, Perognathus parvus, Reithrodontomys megalotis*) occurred on CRP sites in good numbers (Chapter X) and the snakes we encountered all are reported to prey readily on a variety of rodents or insects (Wallace and Diller 1990, Shewchuk and Austin 2001, Rodriguez-Robles 2002), so we discount prey availability as a main factor influencing snake distributions among our study sites.

Management Implications

Young (4 – 6 year old) CRP fields had little conservation value for reptiles, regardless of landscape setting. Fifteen year old CRP fields set in cropland landscapes supported short-horned lizards in similar numbers as in native shrubsteppe sites, but contained few other reptiles. Old CRP fields set in native shrubsteppe landscapes and native shrubsteppe remnants both contained multiple species of shrubsteppe reptiles, albeit in lower abundances than occurred in shrubsteppe sites set in intact shrubsteppe landscapes. We conclude that conservation of native shrubsteppe reptiles depends foremost on conservation of landscape-scale areas of native shrubsteppe habitat. In addition, focusing

CRP fields within shrubsteppe landscapes, keeping them enrolled (i.e. undisturbed by agriculture) for at least 15 years, and preserving shrubsteppe fragments all have greater conservation value for shrubsteppe reptiles than does actively-farmed cropland or CRP fields in a primarily cropland landscape.

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Table 1. Occurrence of amphibians and reptiles within treatment types, pooled among survey methods, Adams, Douglas, Grant, and Lincoln Counties, WA, 2003 - 2004.

	Treatment[a]						
	nc	ns	oc	os	sc	ss	Total
Short-horned lizard [b]	3	5	16	22	13	15	74
Western skink	1	2	0	4	10	5	22
Western rattlesnake	0	1	0	2	1	23	27
Racer	0	1	0	0	1	9	11
Gopher snake	0	1	0	4	0	6	11
W. terrestrial Garter snake	0	0	1	0	3	0	4
Night snake	0	0	0	0	0	1	1
Grest Basin spadefoot	0	0	3	0	1	7	11
Long-toed salamander	0	0	0	0	1	0	1
Tiger salamander	1	0	1	0	0	0	2
Unidentified lizard	0	0	0	1	0	0	1
Unidentified snake	0	0	0	0	0	3	3

[a] nc = new crp in cropland landscape; ns = new crp in shrubsteppe landscape; oc = old crp in cropland landscape; os = old crp in shrubsteppe landscape; sc = shrubsteppe plot in cropland landscape; ss = shrubsteppe plot in shrubsteppe landscape.
[b] See Appendix A for scientific names.

Table 2. Occurrence of amphibians and reptiles by survey method, with treatments pooled, Adams, Douglas, Grant, and Lincoln Counties, WA, 2003 - 2004.

	Survey Type			
	Area search	Funnel trap	Incidental obs[a]	Total
Short-horned lizard [b]	25	20	29	74
Western rattlesnake	19	1	7	27
Western skink	9	11	2	22
Gopher snake	3	2	6	11
Racer	3	6	2	11
W. terrestrial garter snake	1	1	2	4
Night snake	0	1	0	1
Great-basin spadefoot toad	0	8	3	11
Long-toad salamander	0	0	1	1
Tiger salamander	0	2	0	2
Unidentified snake	3	0	0	3
Unidentified lizard	0	0	1	1
Total Abundance	63	52	53	168
No. Species	6	9	8	10

[a] Herptile crew incidental observations.
[b] See Appendix A for scientific names.

Table 3. Mixed Poisson regression model parameters for short-horned lizards and a reptile group characterizing environmental factors associated with abundance in Conservation Reserve Program and shrubsteppe habitats in eastern WA, 2003 – 2004.

	Variable	NumDF	DenDF	F score	Prob
Short-horned lizard	Shrub	1	142	0.697	0.405
	Perennial grass	1	142	0.068	0.795
	Rock/gravel	1	142	0.124	0.725
	Bare ground	1	142	0.008	0.928
	Survey type	2	142	5.894	0.003
	Site age	2	142	3.476	0.034
	Landscape setting	2	142	0.811	0.369
Reptile group	Shrub	1	142	0.736	0.392
	Perennial grass	1	142	0.397	0.530
	Rock/gravel	1	142	1.462	0.229
	Bare ground	1	142	1.034	0.311
	Survey type	2	142	22.183	<0.001
	Site age	2	142	3.784	0.025
	Landscape setting	1	142	11.150	0.001

Appendix A. Common and scientific names of amphibians and reptiles encountered during amphibian and reptile sampling in 2003 and 2004.

Binomial	Common name
Phrynosoma douglasii	short-horned lizard
Eumeces skiltonianus	western skink
Crotalus viridis	western rattlesnake
Coluber constrictor	racer
Pituophis catenipher	gopher snake
Thamnophis elegans	western terrestrial garter snake
Hypsiglena torquata	night snake
Scaphiopus intermontanus	Great-basin spadefoot toad
Ambystoma macrodactylum	long-toed salamander
Ambystoma tigrinum	tiger salamander

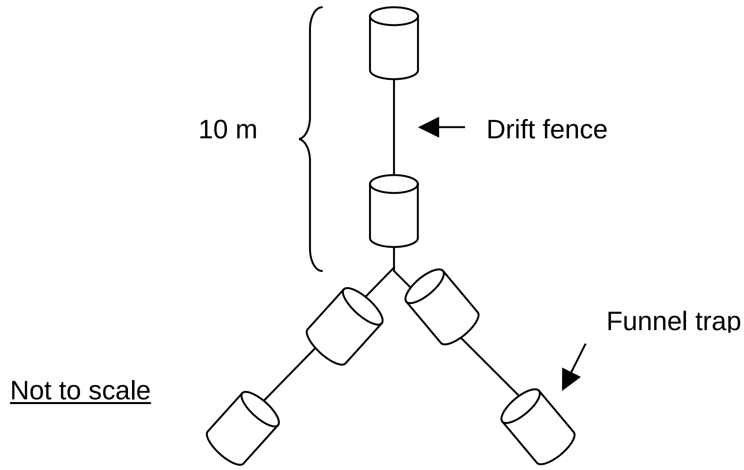

Figure 1. Drift-fence array design used to sample reptiles and amphibians in each of six site-types in Adams, Douglas, Grant, and Lincoln Counties, WA, 2003 – 2004.