THE USE OF PLYWOOD COVERBOARDS TO SAMPLE HERPETOFAUNA IN A CALIFORNIA OAK WOODLAND

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ABSTRACT: Methods for assessing terrestrial herpetofauna have included pitfall traps, time- and area-constrained searches, and, recently, artificial cover objects. As part of a study of the response of terrestrial vertebrates to prescribed burning in oak (*Quercus* spp.) woodland, we placed 136 plywood coverboards each on 9, 5.8-ha study plots in oak woodland at Camp Roberts in northern San Luis Obispo County, California. Boards were monitored every 7-10 days during February through April of 1995 and 1996. During this period, we recorded 2,658 encounters of 15 to 17 species of amphibians, lizards, and snakes during 33,728 coverboard checks: 4 or 5 species of amphibians, 5 or 6 lizards, and 6 snake species. About half (15 to 17 of 31) of herpetofaunal species predicted to occur in San Luis Obispo County by the California Wildlife-Habitat Relationships (WHR) system were observed under coverboards. Coverboards sampled proportionately, but not significantly ($P > 0.05$), more species (15 to 17 of 31) in San Luis Obispo County than either timed searches (5 of 25) or pitfall arrays (8 of 25) sampled in oak woodlands in Madera County. A notably higher proportion of snakes was sampled by coverboards (6 of 14) than by timed searches (1 of 12) or pitfalls (0 of 12). Encounter rate was higher ($P < 0.001$) for coverboards (7.9%) than pitfalls (1.0%). A detected species assemblage comparable with that of other herpetofaunal sampling techniques, low cost of materials, low maintenance, short operation time, and low risk of injury to encountered amphibians and reptiles suggest that coverboards may be a technique worth consideration for sampling herpetofauna in oak woodlands.

Key Words: amphibians, artificial cover objects, coverboards, herpetofauna, reptiles, sampling, techniques

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Widespread concern exists that amphibians are declining in many areas, probably due to habitat destruction, environmental pollution, and general environmental degradation (Barinaga 1990, Wyman 1990, Wake 1991). The overall status of herpetofauna in California's 3 million hectares of oak (*Quercus* spp.) woodlands has not been examined. However, increasing habitat alterations, land conversion, and residential development in oak woodland habitats raises concern for the well being of herpetofauna. It also points out the need for the development of more effective and inexpensive techniques than currently exist to monitor amphibians and reptiles. Reptiles and amphibians are a difficult group of animals to sample in natural systems because of their generally small size and secretive habits (Gibbons 1988). Traditional methods of pitfall traps and time- or area-constrained searches (Welsh 1987) are labor intensive and may kill or injure animals, or significantly alter habitat. Therefore, information on alternative techniques will be helpful in designing environmental monitoring programs.

Our objectives were to (1) present an example of the use of plywood coverboards in California oak woodland, and (2) compare the effectiveness of plywood coverboards with 2 other commonly used herpetofaunal sampling methods: pitfall arrays and time-constrained searches.

STUDY AREA

Camp Roberts, a military facility of the California Army National Guard, is located in northern San Luis Obispo County (the northern portion of Camp Roberts is in Monterey County), 18 km north of Paso Robles, California (Fig. 1). The facility comprises 17,800 ha, of which approximately 7,200 ha is classified as oak woodland (Camp Roberts EMAP 1989). The dominant overstory tree is blue oak (*Quercus douglasii*) with variable contributions of coast live oak (*Q. agrifolia*). Where it occurs, understory is comprised of toyon (*Heteromeles arbutifolia*), redberry (*Rhamnus crocea*), bigberry manzanita (*Arctostaphylos glauca*), ceanothus (*Ceanothus* spp.), poison oak (*Toxicodendron diversilobum*), and, infrequently, chamise (*Adenostoma fasciculatum*). On the woodland floor, wild oats (*Avena* spp.), bromes (*Bromus* spp.), and fescues (*Festuca* spp.) predominate. Common forbs include deerweed (*Lotus scoparius*), filaree (*Erodium* spp), hummingbird sage (*Salvia spathacea*), and miner's lettuce (*Claytonia perfoliata*).

METHODS

During the summer of 1993, we used topographic maps and ground reconnaissance to select oak stands in the southern half of Camp Roberts where there was least potential for interference with military activities. We

selected oak stands that were >16 ha in size, had an estimated canopy cover of >50%, had areas of dense understory, and where accumulations of downed woody material occurred. Within these stands, we established 9, square, 5.8-ha plots in summer 1993 (Fig. 1). We used a compass and meter tape to lay out a 17 × 17 sampling grid (289 intersections) every 15 m in perpendicular directions.

In January and February 1994, we placed a single 1.3 × 61.0 × 61.0-cm plywood coverboard (Grant et al. 1992) flush with the ground within 2 m of each intersection on alternate lines on each plot (136 coverboards per plot) (Fig. 2). Every 7-10 days during late January through April 1995-96, we recorded the species and number of amphibians and reptiles observed under the coverboards.

We compared the number of species we observed under coverboards on the 9 study plots at Camp Roberts with the number of species predicted by the California Wildlife Habitat Relationships (WHR) System (Airola 1988) to occur in dense to moderately dense blue oak and coastal oak woodland (stages 5M and 5D in both "Blue Oak Woodland" and "Coastal Oak Woodland") in San Luis Obispo County. Further, using 2 × 2 c2 contingency tables (with Yates correction factor [Zar 1984:64]), we compared the proportion of observed (coverboards) to expected (WHR) numbers of species in San Luis Obispo County to the observed and predicted numbers of species for time-constrained searches and pitfall traps from a study conducted during 1987-90 by Block and Morrison (1991). Block and Morrison (1991) worked in moderate to dense blue oak and blue oak-grey

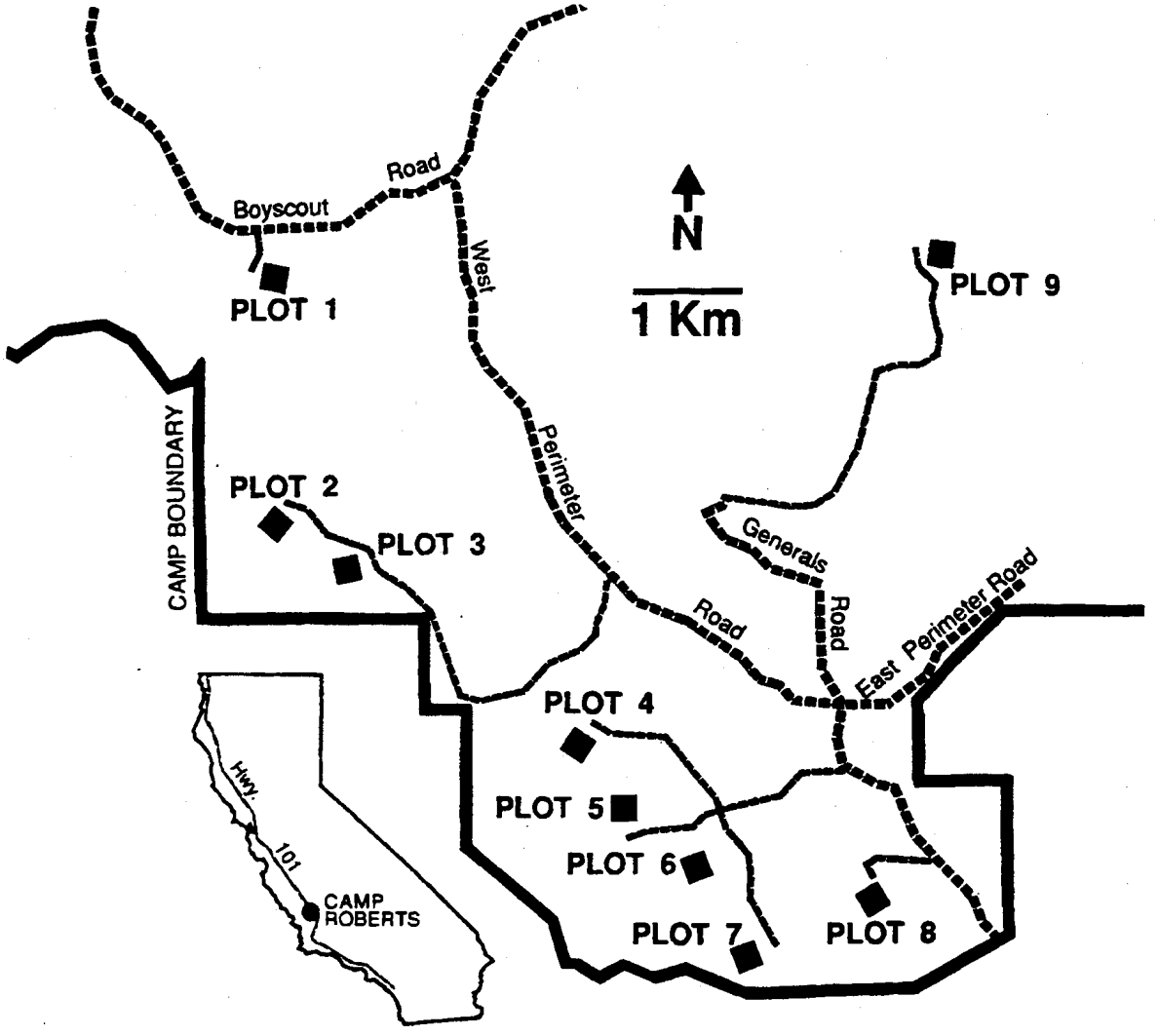

Fig. 1. Location map and plot organization of sites used to monitor relative abundance and habitat associations of herpetofauna (used here as an example of the use of coverboards to sample herpetofauna in oak woodlands) with plywood coverboards in oak woodlands of central-coastal California, February-April 1995 and 1996.

pine (*Pinus sabiniana*) stands with variable contributions of interior live oak (*Quercus wislizenii*) at the San Joaquin Experimental Range, Madera County, about 40 km north of Fresno, California. For WHR codes in Madera County, we used stages 5M and 5D in both "Blue Oak Woodland" and "Blue Oak-Digger Pine Woodland". Block and Morrison (1991) conducted 28 hours of time-constrained searching (7, 4-hour searches). Searches consisted of moving slowly through an area while searching bare ground and on, under, and in logs, rocks, and debris. They established 4 pitfall trap grids. Each grid was 6 × 6 (36 pitfalls) with 20-m intersections. The 4 grids were open for 60 days from mid-January through mid-March 1988 and 60 days from 10 November 1988 to mid-January 1989.

Our use of WHR here was not to validate the WHR model with our data nor with the data from Madera County; we used WHR only to compare the effectiveness of 3 different sampling methods (i.e., coverboards, pitfall traps, and time-constrained searches). To compare these 3 methods, we used WHR as a benchmark of what could be expected to occur on the study sites in San Luis Obispo and Madera counties.

RESULTS

Coverboards

We recorded 2,658 observations of 15 to 17 species of amphibians and reptiles during 33,728 coverboard checks in 1995 and 1996: 4 or 5 species of amphibians, 5 or 6 lizards, and 6 snake species. (Table 1). Skinks (*Eumeces skiltonianus* and potentially *E. gilberti*), slender salamanders (*Batrachoseps nigriventris* and pote ntially *B. pacificus*), and gopher snakes (*Pituophis melanoleucus*) were the most frequently encountered with 40, 19, and 4% of total observations, and 3.1, 1.5, and 0.3% of total possible observations, respectively. Twelve species had ≤ 90 total observations.

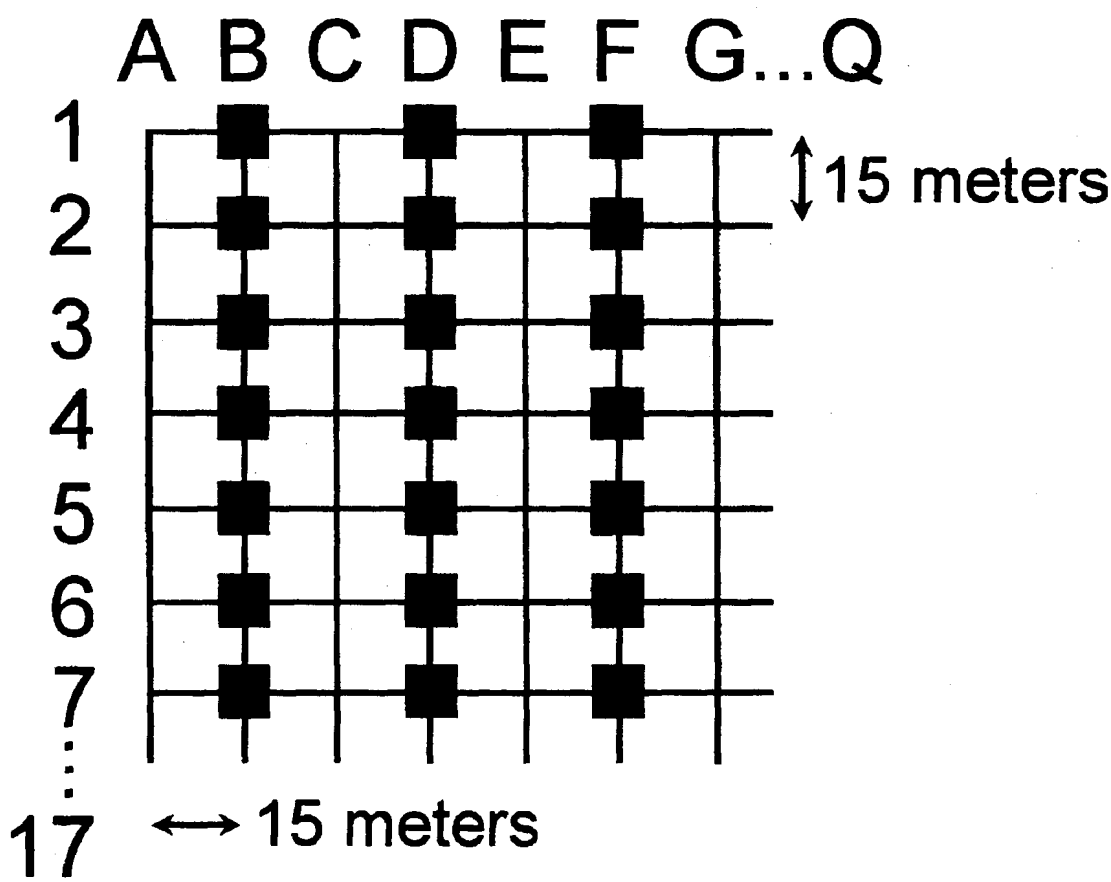

Fig. 2. Diagram of coverboard grid layout on 1 of 9, 5.8-ha study plots monitored during February-April 1995 and 1996 at Camp Roberts, California. Figure not drawn to scale (coverboards are 61 cm on a side).

WHR Predictions

Coverboards.--Of the 8 lizard species predicted to occur in San Luis Obispo County by WHR, 5 or 6 were observed under coverboards (Table 2). Of those predicted to occur that were not found, the coast horned lizard (*Phrynosoma coronatum*) and the desert-night lizard (*Xantusia vigilis*) likely do not occur on our study plots. Field identification of a third, the Gilbert's skink (*Eumeces gilberti*), has been problematic. We suspect that we have observed the Gilbert's skink, but have not yet distinguished it from the western skink.

We observed 4 or 5 of the 9 amphibian species predicted by WHR to occur, and 6 of the 14 predicted snake species, respectively, under coverboards (Table 2). As with the lizards, most of the amphibian and snake species not observed under coverboards may not occur on the study plots, or, as in the case of the Pacific slender salamander, may not have been distinguished from the black-bellied salamander. Among amphibians, habitat requirements of the California newt (*Taricha torosa*), western spadefoot (*Scaphiopus hammondi*), foothill yellow-legged frog (*Rana boylei*), and the bullfrog (*R. catesbeiana*) are not met on the study plots. Similarly, among snakes, habitat requirements are not met for the California mountain kingsnake (*Lampropeltis zonata*), western aquatic garter snake (*Thamnophis couchi*), or the western rattlesnake (*Crotalus viridis*).

Coverboards vs. Timed Searches and Pitfall Arrays.--Of the 31 species of amphibians, lizards, and snake species predicted by WHR to occur in San Luis Obispo County, 15 to 17 were observed under coverboards (Table 2). Similarly, of 25 WHR-predicted species for Madera County, 5 were collected during timed searches and 8 were collected by pitfall arrays. The number of species found (observed) vs. WHR-predicted (expected) was not statistically different in San Luis Obispo County for coverboards than in Madera County for timed searches ($\chi^2_{\text{corrected}} = 1.63$, df = 1, $P = 0.20$) or for pitfall arrays ($\chi^2_{\text{corrected}} = 0.31$, df = 1, $P = 0.58$) (Table 2). In contrast, the overall encounter rate was significantly greater for coverboards in San Luis Obispo County (2,658 encounters per 33,728 coverboard checks [7.9%]) than for pitfall traps in Madera County (167 encounters per 17,280 trap-nights [0.97%]; $\chi^2_{\text{corrected}} = 954.37$, df = 1, $P < 0.001$).

By taxa, similar proportions of WHR-predicted species of amphibians were sampled by coverboards (4 or 5 species observed of 9 species predicted) and pitfall traps (4 of 7), compared to the relatively small proportion sampled by timed searches (1 of 7). Similar proportions of species of lizards were sampled by coverboards (5 or 6 of 8), timed searches (3 of 6), and pitfall traps (4 of 6). A higher proportion of snakes was sampled by coverboards (6 of 14) than either the timed searches (1 of 12) or the pitfall traps (0 of 12).

Costs and Labor

Each coverboard cost approximately $1.35 US in 1993. Installation of coverboards required locating the site on the pre-established sampling grid, working the coverboard into the duff, and affixing an identification number with marking pen or paint. Maintenance has consisted of remarking the coverboards with paint and repositioning coverboards dislodged by falling branches, wind, gophers (*Thomomys bottae*), ground squirrels (*Spermophilus beecheyi*), or feral pigs (*Sus scrofa*). Training and expertise required to observe herpetofauna under coverboards is probably less than that required for timed searches and approximately the same as for pitfall traps

Although we did not measure the time required to install our coverboards, and Block and Morrison (1991) did not report the time required to install their pitfall arrays, we think installing coverboards was less time-consuming because coverboards did not require holes to be dug to accommodate the sampling device. However, coverboards may require time to acclimate (e.g., leach

Table 1. Results of plywood coverboard surveys conducted in oak woodland on 9, 5.8-ha study grids during February-April 1995 and 1996 at Camp Roberts, California. A total of 33,728 coverboard checks was made.

Taxa	No. species	Total observations	Percent success
Amphibians	4 or 5	540	1.6
Lizards	5 or 6	1,851	5.5
Snakes	6	267	0.8
Total	15 to 17	2,658	7.9

chemicals used during manufacture of plywood) to be used by herpetiles (Grant et al. 1992). We permitted coverboards 6-12 months to acclimate.

The time required to inspect coverboards probably is similar to that for pitfall arrays. However, when attempting to obtain an estimate of relative abundance or species diversity of herpetiles for a sample area, inspecting coverboards (or pitfalls) requires less time than conducting timed searches (Norman Scott, Biologist, USGS BRD, Piedras Blancas Research Station, San Simeon, Calif., pers. comm. [telephone conversation, 15 October 1997]).

CONCLUSIONS AND RECOMMENDATIONS

Coverboards sampled most of the herpetofaunal species that occurred in mixed blue oak-coast live oak stands. Coverboards, pitfall arrays, and time-constrained searches sampled comparable numbers of species of herpetofauna in blue oak and mixed oak woodlands; however, encounter rates were higher with coverboards than pitfall arrays. Coverboards sampled snakes better than pitfall traps. Coverboards also offered more flexibility in their surveillance than pitfall traps: whereas pitfalls should be checked daily to minimize injury to animals, coverboards can be left unchecked indefinitely. Overall, coverboards had considerable advantages over pitfall traps in initial cost, labor for installation, maintenance, operation time, and potential danger to the animals from physical stress due to exposure, drowning, or predation. Compared to timed searches, coverboards offered greater potential for installing a standardized sampling scheme among study sites and observers because they were less subject than timed searches to bias associated with an individual observer's movement rate

Table 2. Number of species of herpetofauna predicted by the California Wildlife-Habitat Relationships system (WHR) compared to the number of species encountered by coverboards (CB) during 1995 and 1996 at Camp Roberts, San Luis Obispo County; and species encountered by timed searches (TS) and pitfall traps (PF) during 1987-1990 at the San Joaquin Experimental Range, Madera County.

	San Luis Obispo Co.		Madera Co.[a]		
Taxa	WHR	CB	WHR	TS	PF
AMPHIBIANS					
California newt (*Taricha torosa*)	X		X		X
Ensatina (*Ensatina eschscholtzii*)	X	X	X		
Black-bellied salamander (*Batrachoseps nigriventris*)	X	X			
California slender salamander (*Batrachoseps attenuatus*)				X	X
Pacific slender salamander (*Batrachoseps pacificus*)	X	?	X		
Arboreal salamander (*Aneides lugubris*)	X		X		
Western spadefoot (*Scaphiopus hammondi*)					X
Western toad (*Bufo boreas*)	X	X	X		X
Pacific tree frog (*Hyla regilla*)	X	X			
Foothill yellow-legged frog (*Rana boylei*)	X		X		
Bullfrog (*Rana catesbiana*)	X		X		
Amphibian Totals	9	4 to 5	7	1	4

Table 2. Continued

	San Luis Obispo Co.		Madera Co.[a]		
Taxa	WHR	CB	WHR	TS	PF
LIZARDS					
Western fence lizard (*Sceloporus occidentalis*)	X	X	X	X	X
Western skink (*Eumeces skiltonianus*)	X	X			
Gilbert's skink (*Eumeces gilberti*)	X	?	X	X	X
Coast horned lizard (*Phrynosoma coronatum*)	X		X		
Desert night lizard (*Xantusia vigilis*)	X				
Western whiptail (*Cnemidophorus tigris*)	X		X		
Southern alligator lizard (*Gerrhonotus multicarinatus*)	X	X	X		
Northern alligator lizard (*Gerrhonotus coeruleus*)			X		
California legless lizard (*Anniella pulchra*)	X	X			
Side-blotched lizard (*Uta stansburiana*)		X		X	X
Lizard Totals	8	5 to 6	6	3	4
SNAKES					
Ring-necked snake (*Diadophis punctatus*)	X	X	X		
Sharp-tailed snake (*Contia tenuis*)	X		X		
California whipsnake (*Masticophis lateralis*)	X	X	X		
Racer (*Coluber constrictor*)	X		X		
Western patch-nosed snake (*Salvadora hexalepis*)	X				
Common king snake (*Lampropeltis getulus*)	X	X	X		
Gopher snake (*Pituophis melanoleucus*)	X	X	X	X	
California mountain kingsnake (*Lampropeltis zonata*)	X		X		
Common garter snake (*Thamnophis sirtalis*)	X	X	X		
Western terrestrial garter snake (*Thamnophis elegans*)	X		X		
Western black-headed snake (*Tantilla planiceps*)	X				

Table 2. Continued

Taxa	San Luis Obispo Co.		Madera Co.[a]		
	WHR	CB	WHR	TS	PF
Nightsnake (*Hypsiglena torquata*)	X	X	X		
Western rattlesnake (*Crotalus viridis*)	X		X		
Western aquatic garter snake (*Thamnophis couchi*)	X		X		
Snake Totals	14	6	12	1	0
Grand Total	31	15 to 17	25	5	8

[a] Data from Block and Morrison (1991).

and ability to find amphibians and reptiles when searching habitat.

Future studies of the use of coverboards to sample herpetofauna should include: (1) the direct spatial and temporal comparison of coverboards with other techniques; (2) comparison of coverboards and other artificial cover objects of various materials and sizes in oak woodlands; (3) Comparisons of use of coverboards in structurally different habitats and of different management kind and intensity; and (4) an examination of the potential of artificial cover objects to augment natural habitat and therefore artificially inflate estimates of population abundance.

Although much work remains in comparing the relative advantages and disadvantages of coverboards to other techniques, sampling success comparable to traditional techniques, low risk of injury to captured animals, and relatively low cost and maintenance all argue for consideration of coverboards when designing a herpetofaunal sampling program for California oak woodland.

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