Effect of Prescribed Fire for Tick Control in California Chaparral

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ABSTRACT Prescribed fire was investigated as a method for controlling ixodid and argasid ticks in chaparral habitats in northern California. Two experimental and two adjacent control plots within a wildlife preserve were monitored for 1 yr postburn. Ticks were collected by flagging vegetation, by CO_2-baited pitfall trap, and by live-trapping rodents. Twice as many rodents were caught at control sites compared with burn sites and no dusky-footed woodrats, *Neotoma fuscipes* Baird, were found in the treatment sites postburn. This species is known to be a reservoir of the agents of Lyme disease, *Borrelia burgdorferi* sensu stricto Johnson, Schmid, Hyde, Steigerwalt & Brenner, and human granulocytic anaplasmosis, *Anaplasma phagocytophilum* Dumler, Barbet, Bekker, Dasch, Palmer, Ray, Rikihisa, Rurangirwa. Six ixodid tick species were removed from rodents (*Ixodes pacificus* Cooley & Kohls, *Ixodes jellisoni* Cooley & Kohls, *Ixodes spinipalpis* Hadwen & Nuttall, *Ixodes woodi* Bishopp, *Dermacentor occidentalis* Marx, and *Dermacentor parumapertus* Neumann), two of which transmit bacterial zoonotic agents to people in the far-western United States. There was no decrease in number of ticks per animal trapped at either burn site compared with controls; in fact, the mean number of immature *I. pacificus* per rodent was significantly higher at one burn site than its control site. Soil refugia may protect ticks from fire-induced mortality; the argasid tick *Ornithodoros coriaceus* Koch, which lives in soil, was unaffected by the prescribed fire as were *I. pacificus* and *D. occidentalis* buried in packets 2.5 cm below ground. We conclude that although prescribed fires in chaparral habitats may diminish local rodent abundance, it does not decrease tick loads on rodents. Furthermore, burning chaparral does not result in a decreased abundance of adult ixodid ticks on vegetation and apparently does not affect argasid or ixodid ticks that are sheltered within soil refugia.

KEY WORDS tick control, fire ecology, chaparral, *Ixodes pacificus*, *Dermacentor occidentalis*

Tick-control methods tailored to the diverse ecology and land use of western North America are limited. Although application of acaricides to vegetation (Monsen et al. 1999) or host-targeted methods (Lane et al. 1998) has proven effective in reducing ticks locally, these methods generally are not used in California. Prescribed burns have been shown to reduce the abundance of blacklegged ticks, *Ixodes scapularis* Say, locally, but the tick populations seem to rebound after ≈1 yr (Wilson 1986, Mather et al. 1993, Stafford et al. 1998). In western North America, summer wildfires are a part of the underlying ecology and prescribed burns are commonly employed for land-management purposes (Biswell 1989, Husari et al. 2006). Chaparral is a common plant community throughout much of California and Baja Mexico and is one of the most flammable plant communities in North America (Bolsinger 1989).

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To date, no study has investigated the effect of wild or prescribed burning on tick abundance in any habitat type in western North America. The two most commonly encountered ticks in this region are the western blacklegged tick, *Ixodes pacificus* Cooley & Kohls, and the Pacific Coast tick, *Dermacentor occidentalis* Marx. *I. pacificus* is an important vector of *Borrelia burgdorferi* sensu stricto Johnson, Schmid, Hyde, Steigerwalt & Brenner, the agent of lyme disease in North America (Burgdorfer et al. 1985) as well as *Anaplasma phagocytophilum* Dumler, Barbet, Bekker, Dasch, Palmer, Ray, Rikihisa, Rurangirwa, the agent of human granulocytic anaplasmosis (Richter et al. 1996). Other nonhuman biting *Ixodes* species found in chaparral, such as *Ixodes spinipalpis* Hadwen & Nuttall and *Ixodes jellisoni* Cooley & Kohls, have been shown to be competent enzootic vectors of *B. burgdorferi* sensu lato group spirochetes (Brown and Lane 1992, Lane et al. 1999, Brown et al. 2006). *D. occidentalis* transmits *Francisella tularensis* McCoy and Chapin and has been shown to harbor pathogenic spotted fever group *Rickettsia* such as *Rickettsia rickettsii* and *Rickettsia* 364D (Philip et al. 1981, Wikswo et al. 2008). The Pajahuello tick, *Ornithodoros coriaceus* Koch, a common argasid tick throughout California oak (*Quercus* spp.) woodlands and chaparral habitats

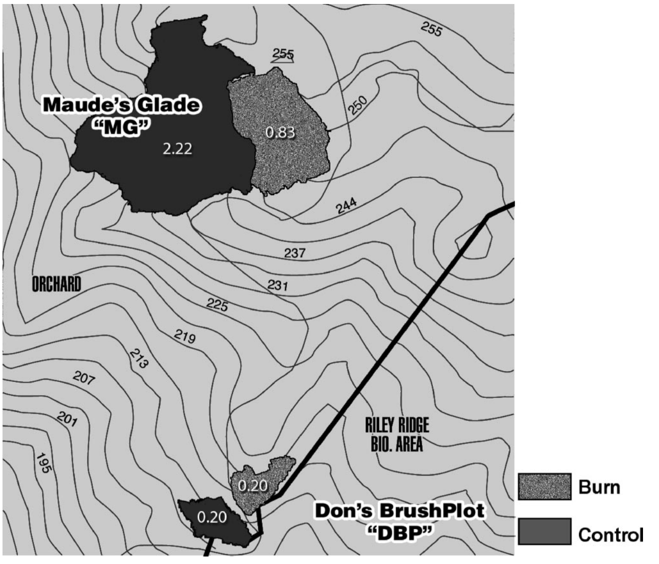

Fig. 1. Burn and Control Plots, Hopland Research and Extension Center, Mendocino, County, CA.

is notorious for causing allergic hypersensitivity reaction in some people (Furman and Loomis 1984). This argasid tick is not associated with human disease but is the recognized vector of the agent of epizootic bovine abortion (Schmidtmann et al. 1976). No study to date has looked at the effect of fire as a control method for any argasid tick species worldwide.

The objective of this study was to evaluate the effect of prescribed burning on the abundance and longevity of several human-biting ticks. The specific goals were to 1) determine whether a single late spring fire would reduce adult *I. pacificus* and *D. occidentalis* questing on vegetation during the following fall and winter; 2) ascertain whether there was a decline in rodents and ectoparasites on rodents, in burned versus control sites for 1 yr postburn; 3) discover whether fire would affect the abundance of the argasid tick *O. coriaceus;* and 4) determine whether adult ixodid ticks buried in soil and leaf litter could survive a burn.

Materials and Methods

Study Sites. This study was conducted in chaparral habitat at the University of California, Hopland Research and Extension Center, in Mendocino County, CA, and took advantage of two prescribed fires on 1 June 1995 intended to reduce fire load in two chaparral plots: Maude's Glade (MG) and Don's Brush Plot (DBP). Area of each study site measured as follows: MG-burn, 0.83 ha; MG-control, 2.22 ha; DBP-burn, 0.20 ha; and DBP-control, 0.20 ha. Control sites were located adjacent to each burn site (Fig. 1).

In May 1995, 1 mo before burn, vegetation was evaluated along seven 10-m line intercept transects marked by 1.8-m-high metal stakes set in randomly determined locations throughout the burn and control plots. The percentage of vegetative cover was recorded for each species and bare ground also was recorded. Chaparral height was measured at 0, 2.5, 5, 7.5, and 10 m on each transect. Fuel samples were taken ≈30 min before ignition to determine fuel moisture content by species. Samples were immediately stored in 1-cm soil sampling cans and dried in the laboratory for 24 h at 90°C. Percentage of moisture content was calculated on a dry weight basis and equaled weight of water/oven dry weight of fuel × 100 and visually characterized as either live or dead fuel. Chaparral in both plots was ≈40 yr old.

Prescribed Fires. Prescribed fires were ignited on 1 June 1995 by hand crews using drip torches in a strip headfire configuration (Martin and Dell 1978) to produce relatively uniform fire behavior. Flame lengths were estimated from a video taken of the fire. A set of 10 steel stakes spaced 2 m apart were installed along the edge of the chaparral to measure rate of fire speed, calculated by averaging time required to move between stakes.

For 13 mo, beginning 1 mo before burn, control and treatment areas in Maude's Glade and Don's Brush Plot were monitored by flagging vegetation and with CO_2-baited pitfall traps for presence of ticks and by live trapping rodents to assess their abundance and that of their associated ticks.

Rodent Trapping. Nonfolding Sherman traps (Tallahassee, FL) (7.5 by 7.5 by 25.5 cm) were set out next to wooden stakes at 7.5-m intervals along the ecotones of all four areas. Forty-five traps were set per line at MG-burn and control and 32–38 at DBP-burn and control. Traps were baited with a mixture of rolled corn, oats, barley, and cane molasses. Animals were trapped 1 wk before the burn (24–31 May 1995) and monthly thereafter for 2 nights per site, except during January when rainy weather permitted only one night of trapping. Treatment and control plots were trapped simultaneously for two consecutive nights for a total of 25 nights of trapping, and an overall total of 4,134 trap-nights (2,249, MG; 1,885, DBP). Rodents were anesthetized with methoxyflurane, identified to species, marked with numbered ear tags (size 1 monel, National Band and Tag Co., Newport, KY), and fleas and ticks were removed with jeweler's forceps and placed in 70% ethanol for later identification. Rodents were released at capture sites after recovery from anesthesia. Use of animals in this research was reviewed and approved by the animal care and use committee at the University of California at Berkeley and by the California Department of Fish and Game.

Flagging. Ticks were flagged from vegetation or from ground between 0800 and 1000 hours by using a standard 1-m square white flannel tick flag for either one or two consecutive days dependent upon weather with total of 24 and 23 flag days at each MG and DBP site, respectively. The ecotone of each plot was flagged along 45 10-m-long transects. A flag-sample consisted of one sweep taken in a 180 arc from a particular bush; the number of flag samples varied between 24 and 184 per day per plot. In areas where burn had destroyed plants, vegetation remnants or the ground was dragged. All ticks collected were recorded per flag sample to species and sex and released at site of capture. Abundance of ticks was evaluated as ticks collected per 100 flag samples; this was determined by dividing the number of ticks collected flagging each plot per month by the number of flag samples and multiplying by 100.

CO_2-Baited Pitfall Traps. To collect ticks that may be active in the soil or leaf-litter, CO_2 trapping was conducted monthly beginning 1 mo before the fire and ending June 1996. Ten white enamelware pans (18 by 29 by 5 cm) were buried at 15-m intervals along the ecotonal chaparral so that they functioned as pitfall traps (Lane et al. 1985). Five to 10 g of dry ice was added to the center of each pan, elevated by two small wooden strips, during the warm part of day (1000–1200 hours control sites; 12–1400 hours treatment sites). After 2 h, the number, species, sex, and life stage of ticks per pan were recorded, and ticks were released at their sites of capture.

Survivability of Ticks. Adult *I. pacificus* (n = 60 females; n = 36 males) and *D. occidentalis* (n = 100 females; n = 100 males) were equally divided among 40 silkscreen packets (5 by 7 cm). The packets were placed next to numbered metal stakes used for vegetative analyses in both control and treatment plots 1 wk before the burn and were buried under 2.5-cm soil and leaf litter. In total, 10 packets were placed at each control and burn site, with each of five packets containing either *I. pacificus* (n = 3 females and 1 or 2 males) or *D. occidentalis* (n = 5 females and 5 males). The packets were checked the morning of the burn, 1 wk after and monthly for three more months.

Statistical Analysis. All data sets were characterized as nonparametric with Shapiro–Wilk W tests. Abundance of ticks flagged (adult *I. pacificus* and *D. occidentalis*), collected from animals (immature *I. pacificus* and all tick species combined), and collected in pitfall traps (*O. coriaceus* and *D. occidentalis*) were compared between burn and control sites at Maude's Glade or Don's Brush Plot by using Wilcoxon rank sum tests for comparison of nonparametric data. Similarly survival of adult *I. pacificus* and *D. occidentalis* (both sexes combined) were compared between burn and control sites by using paired Wilcoxon rank sum test. All tests were performed with the JMP IN statistical program (SAS Institute 2000).

Results

Burn Characteristics and Vegetation. Before the burn, DBP and MG had between 87 and 91% vegetative cover. At DBP, chamise (*Adenostoma fasciculatum* Hook. & Arn.) was the dominant plant (84.4% burn; 70.3% control). Both had ≈1% leather oak (*Quercus durata* Jeps.) cover, and 14% of the surface was bare soil. One difference between the two sites was that the DBP-control had 16.6% buck brush (*Ceanothus cuneatus* Nutt. variety *cuneatus*) cover, whereas the burn plot had no buck brush present. Vegetative cover at MG was composed of chamise (68.0% burn; 68.3% control), buck brush (12.0% burn; 19.2% control), and leather oak (11.0% burn, 3.7% control); ≈8–9% of both plots were bare soil. Live fuel moisture content was high and averaged >130%; dead fuel moisture (<6.4 mm in diameter) was 8%. The chaparral in all four plots was mature with an average shrub height of >1.2 m (DBP-burn, 1.1 m; DBP-control, 1.3 m; MG-burn, 1.2 m; and MG-control, 1.3 m).

The weather conditions on the burn day were warm and calm. At DBP, the temperature was 21°C, with a wind speed of 1 mph, 61% RH, and 100% cloud cover. At MG, the temperature was 26°C, with a wind speed of 3 mph, 49% RH, and 60% cloud cover. Although the fire behavior and coverage at both plots was relatively uniform, flame lengths were higher at MG (12 m) than DBP (9 m), which were associated with higher air temperature and lower relative humidity during combustion. The fire rate of spread was similar in both areas (DBP, 0.32 m/s; MG, 0.38 m/s).

The aboveground chaparral structure was drastically changed by the fires. No live branches were found in the shrub-line intercept transects indicating uniform fire coverage. Shrub skeletons did exist in the plots but were composed of materials with large diameter that provided little shade.

Rodent Trapping. Six rodent species were caught at the study sites: California kangaroo rat (*Dipodomys californicus californicus* Merriam), brush mouse (*Peromyscus boylii* Baird), piñon mouse (*P. truei sequoiensis* Hoffmeister), deer mouse (*P. maniculatus gambelii* Baird), dusky-footed woodrat (*Neotoma fuscipes* Merriam), and western harvest mouse (*Reithrodontomys megalotis longicaudus* Baird).

Postfire, there were half as many individuals trapped at the burn compared with control sites: MG-burn, n = 25; control, n = 54; DBP-burn, n = 27; and control, n = 56 (Table 1). Similarly, the catch rate (number of animals caught per trap per month) at the burn site was half that at control sites (Figs. 2 and 3). A week before fire, one woodrat and one piñon mouse were caught at MG-burn and two woodrats were

Table 1. Tick burdens of rodents caught post-burn at burn and control sites, HREC, 1995–1996

Site	Species	Individuals (total)[a]	*I. pacificus*		*D. occidentalis*		*D. paramapertus*		*I. spinipalpis*		*I. jellisoni*		*I. woodi*	
			Larvae	Nymph	Larvae	Nymph	Larvae	Nymph	Larvae	Nymph	Larvae	Nymph	Larvae	Nymph
MG-B	*D. californicus*	12 (28)	3	2	141	49	0	0	5	0	8	16 (4A)[b]	0	0
	P. boylii	2 (2)	6	0	26	7	0	0	0	0	0	0	0	0
	P. truei	1 (1)	1	0	0	0	0	0	0	1	0	0	0	0
	P. maniculatus	10 (17)	7	0	9	0	0	0	2	0	0	0	0	0
	N. fuscipes	0	0	0	0	0	0	0	0	0	0	0	0	0
	R. megalotis	0	0	0	0	0	0	0	0	0	0	0	0	0
		Total	17	2	176	56	0	0	7	1	8	16 (4A)[b]	0	0
MG-C	*D. californicus*	9 (20)	24	0	46	2	0	0	2	0	98	3	0	0
	P. boylii	7 (7)	1	0	7	0	0	0	0	0	0	0	0	0
	P. truei	9 (13)	1	0	28	1	0	0	1	0	0	0	0	0
	P. maniculatus	19 (37)	47	0	11	3	0	0	6	0	0	0	1	0
	N. fuscipes	7 (12)	3	0	48	8	0	0	0	0 (2A)[b]	0	0	1	0
	R. megalotis	3 (3)	4	0	0	0	0	0	1	0	0	0	0	0
		Total	80	0	140	14	0	0	10	2A[b]	98	3	1	0
DBP-B	*D. californicus*	6 (16)	53	1	96	48	5	0	2	0	0	11	0	0
	P. boylii	7 (9)	20	0	32	9	0	0	0	0	0	0	3	0
	P. truei	7 (18)	19	0	5	4	0	0	1	0	0	0	0	0
	P. maniculatus	7 (9)	9	0	21	2	0	0	0	0	0	0	0	0
	N. fuscipes	0	0	0	0	0	0	0	0	0	0	0	0	0
	R. megalotis	0	0	0	0	0	0	0	0	0	0	0	0	0
		Total	101	1	154	63	5	0	3	0	0	11	3	0
DBP-C	*D. californicus*	8 (35)	14	2	97	16	3	0	1	0	12	5	0	0
	P. boylii	8 (12)	3	0	118	1	0	0	0	0	0	0	0	0
	P. truei	7 (24)	12	1	70	0	0	0	0	0	0	0	0	0
	P. maniculatus	18 (44)	46	0	75	0	0	0	3	0	0	0	0	0
	N. fuscipes	14 (47)	4	0	175	32	2	0	0	0 (1A)[b]	0	0	0	15 (1A)[b]
	R. megalotis	1 (1)	0	0	0	0	0	0	0	0	0	0	0	0
		Total	79	3	535	49	7	0	4	1A[b]	12	5	0	15 (1A)[b]

[a] A number in parentheses refers to total number caught, including recaptures.
[b] Adult ticks.

caught MG-control sites, six woodrats and three piñon mice were caught preburn at DBP-control, and a piñon mouse and a brush mouse were found in DBP-burn. No woodrats were found in either of the treatment sites postburn; woodrat nests were observed before burn in these sites and were destroyed in the fire.

Trapped rodents were infested with six tick species: *D. occidentalis*, *Dermacentor parumpertus* Neumann, *I. pacificus*, *I. spinipalpis*, *I. jellisoni*, and *Ixodes woodi* Bishopp (Table 1). Surprisingly, there was no significant difference in the number of immature *I. pacificus* per animal trapped at MG burn site (mean = 0.46) compared with control (mean = 0.86) (S = 3,233; df = 137; $P = 0.94$). Even more surprising was the significantly higher mean number of immature *I. pacificus* per rodent at the burned site at DBP (mean = 1.87) compared with the control (mean = 0.53) (S = 6,769; df = 213; $P = 0.0002$). Overall, including all tick species (sexes and stages combined), there were almost twice

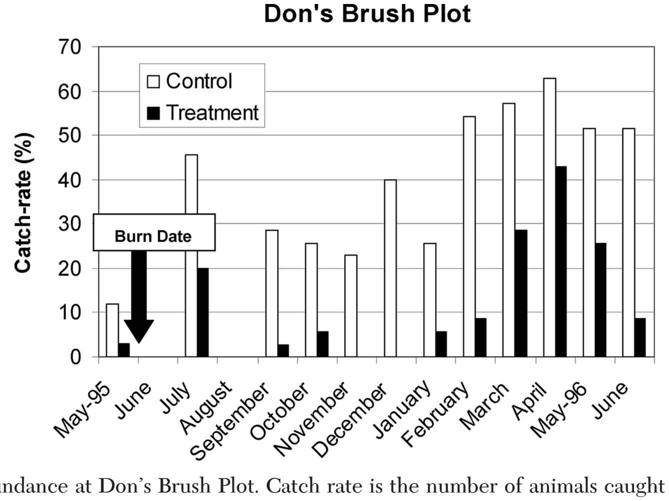

Fig. 2. Rodent abundance at Don's Brush Plot. Catch rate is the number of animals caught per trap per month.

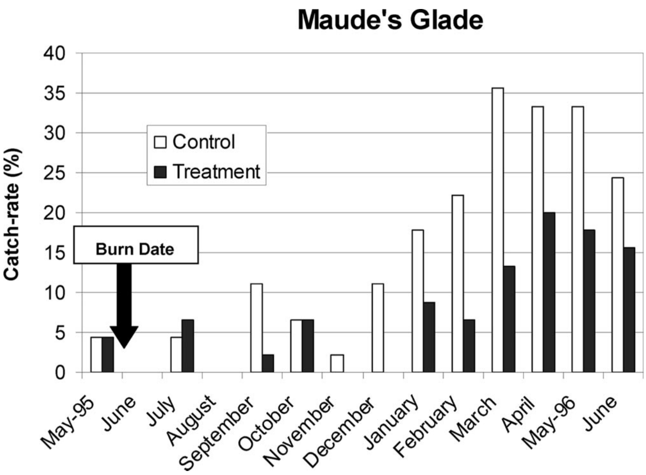

Fig. 3. Rodent abundance at Maude's Glade. Catch rate is the number of animals caught per trap per month.

as many ticks on the animals caught in the burn plots than the control plots (MG-B, 8.06 ticks per animal; MG-C, 3.78 ticks per animal; DBP-B, 6.48 ticks per animal; DBP-C, 4.44 ticks per animal), but the results were only significantly different at DBP (MG, S = 3,529; df = 137; $P = 0.15$; DBP, S = 6,458; df = 213; $P = 0.02$). Thus, it was evident that there was no decline and perhaps even an increase in the abundance of immature *I. pacificus* on trapped rodents postburn.

Postburn Tick Abundance. There was no significant difference in number of adult ticks (sexes combined) collected per 100 flagged samples per site per month for either *I. pacificus* or *D. occidentalis* postburn compared with control sites: MG: *I. pacificus* S = 126, df = 20, $P = 0.97$ and *D. occidentalis* S = 132, df = 20, $P = 0.71$; DBP: *I. pacificus* S = 144, df = 20, $P = 0.19$ and *D. occidentalis* S = 125, df = 20, $P = 0.97$ (Fig. 4).

Postburn, there was no significant difference in the number of *D. occidentalis* (sexes and life stages combined) caught in CO_2 pitfall traps per day at MG (S = 178, df = 22, $P = 0.11$) or at DBP (S = 170; df = 22; $P = 0.25$) (Table 2). Moreover, the prescribed burn did not decrease the abundance of *O. coriaceus* locally. Although there was no difference in the abundance of *O. coriaceus* (sexes and life stages combined) between treatment and control sites at MG (S = 156; df = 22; $P = 0.74$), there were significantly more ticks trapped per day at the burn site of DBP than the control site (S = 100, df = 22, $P = 0.004$); the DPB burn site had high numbers before burn.

Survivability of Ticks. Remarkably, the fire did not cause immediate mortality of *I. pacificus* or *D. occidentalis* adult ticks buried under 2.5-cm soil. Of note, 1 wk postfire, some of the packets in the burn site had condensation on the outside, perhaps due to fire driving moisture down into the soil. The majority of ticks were dead by the late July and all ticks were dead by late August. There was no significant difference in tick mortality between burn and control sites for either *I. pacificus* or *D. occidentalis* males and females (MG, *I. pacificus* S = 648, df = 48, $P = 0.83$ and *D. occidentalis* S = 667, df = 48, $P = 0.54$; DBP, *I pacificus* S = 677, df = 48, $P = 0.40$ and *D. occidentalis* S = 677, df = 48, $P = 0.72$).

Discussion

Although studies conducted in mixed hardwood and coniferous forests have shown that controlled burning of vegetation can reduce the abundance of human-biting ticks for up to a year (Wilson 1986, Mather et al. 1993, Davidson et al. 1994, Stafford et al. 1998), burning chaparral seems to be ineffective for reducing tick abundance locally. After a large wildfire in southern California chaparral in 2007, ticks were found questing on islands of refugia within months of the fire (R. Spano and L. Krueger, personal communication); thus, visitors to recently burned chaparral should not assume that risk of encountering ticks is diminished. Wildfire burns an average of 51,000 ha/yr of California shrubland (data from 1950 to 1999), most of which is chaparral, however current burning rates are ≈6% of what burned prehistorically (pre-1800) in California (Stephens et al. 2007).

This is the first study ever to look at the abundance of rodent hosts and host tick abundance after a fire. As expected, due to loss of harborage, the rodent population dramatically decreased postburn. Paradoxically, there was no decline in the number of ticks on rodents in burned areas and in one of the plots, there actually were many more immature *I. pacificus* per rodent postburn, essentially canceling out any benefit from the reduction in vertebrate hosts. One potential explanation for this finding is that rodents in the burn areas may have been forced to travel farther to obtain food, thereby exposing themselves to more host-seeking ticks. One rodent in particular was markedly absent from the burn sites, the dusky-footed woodrat, a known lyme disease and *A. phagocytophilum* reservoir (Lane and Brown 1991, Brown and Lane 1992, Nicholson et al. 1999). This species is closely associated with highly flammable large wooden houses (Linsdale

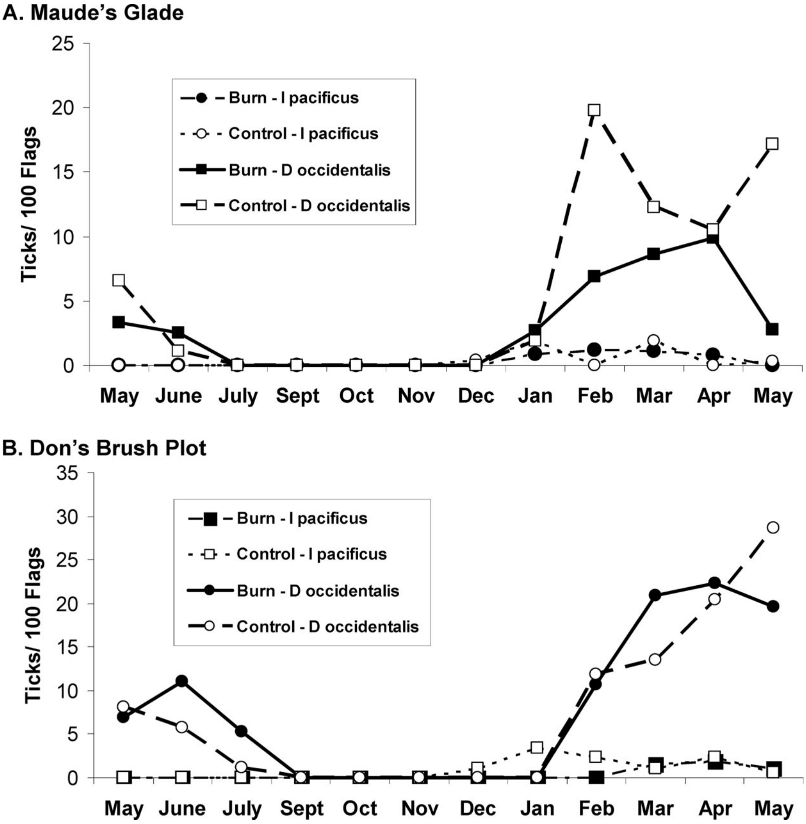

Fig. 4. Adult ticks collected during 1–2 days of flagging per month at control and burn sites, Hopland Research and Extension Center.

and Tevis 1951), and the absence of this animal postburn may have some positive effects locally in terms of reduced tick-borne disease transmission.

Ticks generally were not found on burned vegetation but were collected by flagging the remaining sparse vegetation in the burned areas. The abundance of adult hard ticks flagged from chaparral in postburned areas actually was comparable with that from the sites that were not burned. Of course, there was less intact vegetation in burned areas, so overall tick numbers on vegetation were probably decreased. Furthermore, results from CO_2 pitfall traps indicate that burning does not increase mortality of the ixodid tick *D. occidentalis* nor the argasid tick *O. coriaceus* in soil or leaf litter. Of note, the high abundance of *O. coriaceus* in one postburn site is probably due to the preburn abundance at this site. Nevertheless, these findings suggest that ticks may find refugia within in the soil.

That *I. pacificus* and *D. occidentalis* adults survived in packets placed under 2.5-cm soil for up to 2–3 mo lends further support to our finding that soil is an insulating habitat for ticks. It is not surprising that ticks within packets died by late August as previous results indicate that *I. pacificus* adults typically perish in northwestern California by July (Padgett and Lane 2001). Likewise, the high numbers of immature ixodid ticks on rodents in the spring postburn suggests that the fire had little impact on eggs and replete larvae sequestered in the burned areas before June; *I. pacificus* eggs typically hatch and replete larvae molt in August (Padgett and Lane 2001). Immature stages of *I. pacificus* are capable of surviving through the hot, dry summers characteristic of a Mediterranean climate, probably in behavioral diapause.

Fire ecology is complex and may include indirect effects that actually may improve habitat for vertebrate hosts of ticks (Amacher et al. 2008). Although fire impacted habitats temporarily may be less hospitable to small rodents and birds due to less harborage, over time herbivores such as deer and lagomorphs that

Table 2. Mean ticks per trap day, carbon dioxide trapping at Maude's Glade and Don's Brush Plot, 1995–1996

	Preburn (single collection)		Postburn (12 monthly collections)	
	Ornithdoros coriaceus	*Dermacentor occidentalis*	*Ornithdoros coriaceus*	*Dermacentor occidentalis*
MB-treatment	0.1	0.2	0.15 (0–8)	0.27 (0–12)
MB-control	0	0.7	0.18 (0–8)	2.40 (0–179)
DBP-treatment	3.6	1.8	2.13 (0–66)	0.84 (0–50)
DBP-control	1	0.5	0.32 (0–14)	1.88 (0–120)

Trap day is number of collection days × 10 pans each.

are attracted to newly emergent nutritious forage may distribute ticks to burned areas within a short time. In the Hopland area, deer are the primary hosts of *D. occidentalis, I. pacificus,* and *O. coriaceus* and jackrabbits and brush rabbits are hosts to *D. occidentalis, D. parumpertus,* and *I. pacificus* (Furman and Loomis 1984, Westrom et al. 1985, Castro and Wright 2007). One might assume that tick abundance would decline precipitously after a burn because of the direct effects of the fire itself as well as the subsequent lack of shade, increased temperature, and solar radiation, and decreased humidity. In contrast, our findings suggest this is not the case in chaparral. Tick survival was not only higher than anticipated, but the density of the desiccation-susceptible immature ixodid ticks on rodents inexplicably was significantly higher in the burned versus control plots in one of the two pairwise comparisons.

These results do not support the recommendation of single prescribed burns in chaparral for tick control. Although large or more frequent burns may yield different results, ticks seem to survive on unburned vegetation or in soil refugia; therefore, people who work, recreate, or live adjacent to recently burned chaparral habitat should not assume the risk of tick exposure has decreased.

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