Wildlife Survival in Brush Burns

W. E. HOWARD, R. L. FENNER, AND
H. E. CHILDS, JR.

Specialist, Field Station Administration, University of California, Davis; Forest Comburologist, Fenner and Day Company, Richmond, California; and Instructor, Life Sciences Department, Cerritos Junior College, Norwalk, California

Control burning of brush is now a common practice in range-improvement in California. Frequently, before burning, some or all of the brush is mashed down with mechanical equipment or killed by chemical sprays. To learn how destructive such fires are to wildlife, a study was made to measure the survival of animals, either surrounded by fire or in various environments within such a fire. The study took place at the San Joaquin Experimental Range, O'Neals, California.

Information on wildlife survival was obtained in three ways: (1) caged animals were placed in different habitats within the fire area, with temperature-recording devices on the cages; (2) birds and animals drinking at a spring were counted on three mornings both before and after the area was burned; and (3) the behavior of individual animals during the fire was observed from within the burn and from points behind the advancing fire.

This material has been gathered from two burns. The data on birds drinking at a spring came from a 200-acre reburn on July 26, 1952; it was first burned in 1950. The spring was on the John O'Neal property, adjacent to the Experimental Range. The rest of the information was acquired from a 200-acre burn on the Experimental Range on September 6, 1952. In both instances some brush had been knocked down by a bulldozer the previous year. The second-mentioned burn was accomplished by area ignition—the simultaneous ignition of all sides and the middle. To that end, some of the periphery and the center of the area were wired with incendiary bombs so hazardous areas could be ignited electrically while men with torches ignited the remainder of the boundary.

In both fires the principal vegetation was annual grasses and forbs, wedge-leaf ceanothus *(Ceanothus cuneatus)*, Mariposa manzanita *(Arctostaphysos mariposa)*, interior live oak *(Quercus wislizenii)*, blue oak *(Quercus douglasii)*, and Digger pine *(Pinus sabiniana)*. Both brush and trees were sufficiently sparse to require grass for fuel between patches of woody vegetation. Nevertheless, the heat was intense — at least 1200° F. near some woody vegetation.

Caged Animals

To test the protection from fire that various environmental situations may offer, an experiment was conducted with 37 caged animals: four rattlesnakes *(Crotalus viridis)* and two ground squirrels *(Citellus beecheyi)* in Horn-Fitch hardware-cloth squirrel traps (6 by 6 by 18 inches); 8 white-footed mice *(Peromyscus maniculatus, P. boylei,* and *P. truei)* and 23 laboratory rats in Sherman sheet-metal live traps (3 x 3 x 10 inches). Thirteen of the Sherman traps were buried with their tops 2 to 7 inches below the ground surface (Figure 1). All other cages were placed in crevices of rock outcroppings or in depressions under rocks. Four additional traps, containing rats as controls, were buried in a sunny area of sparse grass outside the burn, with the trap tops at depths of 1½, 2½, 5, and 7 inches. Cages and traps in the burn area were not exposed to the heat of the sun.

Two temperature recorders were placed on each Sherman trap, one on the top and the other on the floor, under the trigger treadle, so the caged animals could reach neither recorder. The two cages containing squirrels each had a single recorder attached at one end. No temperatures were obtained on the rattlesnake cages.

For determining maximum temperatures, narrow bands of various colors of Tempilaq Thinner (Tempil Corporation, New York City) were painted on a

FIGURE 1. Thirteen caged rodents were buried 2 to 7 inches deep before the controlled burn. Only those that were under fallen logs succumbed during the fire.

thin sheet of mica, each color with a different melting point. Narrow (⅛-inch) strips were cut from the sheet at right angles to the bands of paint so that each contained a small amount of each color. Temperature increments were 12½° F., but after the fire, it was possible to estimate maximum temperature to about 5° F. by the extent of melting.

Animal survival, temperature recordings, and fuel conditions are all closely correlated (Table 1). Traps placed beneath logs or dead brush reached lethal temperatures even when buried 6 inches deep. Two traps buried 4 inches and 2 or 3 feet from a large six-foot blue oak stump consumed by fire also became a little too hot for the animals. Animals in rock outcrops survived as long as shielded from radiant heat and as long as the crevice did not serve as a chimney to adjacent burning vegetation.

The lethal temperature for the caged rodents in the burn seems to have been between 138° and 145° F. (Figure 2). Except for three rats (presumably suffocated), all animals, including controls exposed to the heat of the sun, survived when one of the two temperature recordings was 138° or less; whereas all animals succumbed when the minimum temperature was 145° or above. Two of the three that suffocated had been placed in a small depression in the ground that was open on the sides but covered with a flat rock to shield them from the sun (Cages 22 and 23, Table 1). The fire that passed over them was only a grass fire but they were near extremely hot spots, and, presumably, the oxygen supply near the ground was temporarily exhausted. The third rat (cage 27) that presumably suffocated was in a trap that had all but the door buried.

The lower cage temperature is believed to be the significant one. This is borne out by a survival in cage 24, where the top surface reached 300° and the trigger only 140°. When the average of all the double cage-temperature recordings are used, mortality and survival seem to overlap at 142° to 145° F.

Count at Spring

A second approach to the problem was to count birds and mammals that drink at a spring before and after burning. The area involved had been control burned for the first time in 1950. During a 3-hour count the morning after that burn the senior author recorded the following animals drinking at the spring: 321 valley quail; 31 cottontails (one singed by fire); 12 gray squirrels; 4 ground squirrels; 80-plus brown towhees; 27 scrub jays; and 18 acorn-storing woodpeckers (Howard, 1951). Other species were not recorded. This indicates that many animals survived the fire. Counts both before and after a fire were made in 1952. In both instances, an automobile was used as a blind.

A total of 551 individual sight records of 22 species common to the area (Childs and Howard, 1955) were made at the spring shortly after sun-up in two-hour watches on six different days (Table 2). All species were birds except for cottontails and gray squirrels. The number of animals seen each day prior to the burn was 50 (July 16), 67 (July

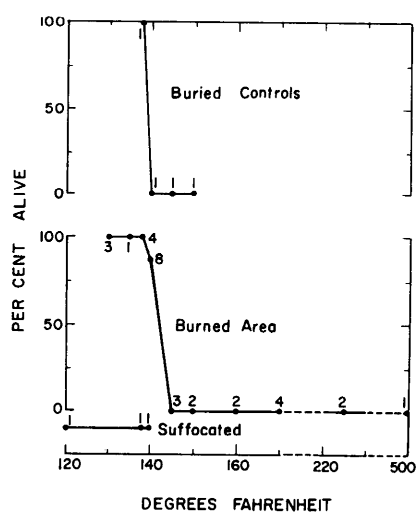

FIGURE 2. The percent of animals alive at different minimum cage temperatures. Numbers indicate how many individuals were involved at each temperature. The four controls were buried different depths, but away from the fire in an area exposed to the warm afternoon sun. The three animals presumed to have died from suffocation were not completely buried, but surrounded by fire.

Table 1. Description of the microhabitats, cage temperatures, and survival of animals subjected to a control burn.

Cage No.	Inches Buried	Degrees F. Top	Degrees F. Trigger	Dead or Alive	Species	Habitat Description
1	6	200	160	D	*Peromyscus truei*	Fallen log
2	—	300	150	D	*P. boylei*	Rock crevice
3	—	140	150	A	*P. maniculatus*	Rocks
4	2	160	145	D	*P. maniculatus*	Open grass
5	—	135	135	A	*P. boylei*	Rock crevice
6	—	140	140	A	*P truei*	Rocks
7	2	138	138	A	*P boylei*	Living ceanothus
8	5	180	160	D	*P boylei*	Mashed ceanothus
9	6	138	138	A	Juv. rat	Edge of mashed live oak
10	2	138	138	A	Juv. rat	Near mashed live oak
11	—	140	138	A	Juv. rat	Rock crevice
12	5	180	170	D	Juv. rat	Mashed brush
13	2½	225	170	D	Juv. rat	Fallen log
14	4½	170	140	D	Juv. rat	Fallen log
15	—	225	225	D	Juv. rat	Rock crevice
16	—	300	225	D	Juv. rat	Rock crevice
17	2	600	500	D	Juv. rat	Fallen log
18	—	140	130	A	Juv. rat	Rocks
19	—	140	140	A	Juv. rat	Rocks
20	—	140	140	A	Juv. rat	Rocks
21	4	170	180	D	Juv. rat	Near large oak stump
22	—	135	120	D	Juv. rat	Nos. 22 and 23, open grass, partly covered by a rock
23	—	138	138	D	Juv. rat	
24	—	300	140	A	Rat	Rock crevice
25	4	150	150	D	Rat	2½ feet from large oak stump
26	—	150	145	D	Juv. rat	Rock crevice
27	—	145	140	D	Juv. rat	Door not buried
28	7	130	140	A	Rat	Near live bush
29	—	180	170	D	Juv. rat	Rock crevice
30	—	130	140	A	Juv. rat	Rocks
31	—	140	140	A	Rat	Rocks
32	5	—	145*	D	Squirrel	Mashed ceanothus. *Recorder 7½"
33	—	—	140	A	Squirrel	Rock crevice
34	—	—	—	A	Rattlesnake	Rock crevice
35	—	—	—	A	Rattlesnake	Rock crevice
36	—	—	—	A	Rattlesnake	Rock crevice
37	—	—	—	A	Rattlesnake	Rock crevice
				Buried controls		
1	1½	150	150	D	Rat	All four buried in afternoon outside fire area in an open, sunny site.
2	2½	150	145	D	Rat	
3	5	145	192	D	Rat	
4	7	138	138	A	Rat	

24), and 75 (July 26). The area was burned later in the day on July 26. After the burn the following numbers were recorded: 208 (July 27), 106 (July 31), and 45 (August 8). The jump from 75 to 208 following the burn was probably caused by lack of opportunity to drink during the fire, with a consequent shift in the time of day of drinking. For example, we assumed that all the quail used the spring regularly before the burn, even though never more than two were recorded during the two-hour watches prior to the fire. On the morning after the burn, 107 quail were counted. On August 8 no quail were observed at the spring during the two-hour watch, though quail were known to be still living in the area. Certainly, only a few adult birds of any kind were killed by the fire—if any at all.

Direct Observation

To observe the behavior of animals surrounded by fire, two of us took positions at 4:50 p.m. (Pacific Standard time) among some large granite rock outcrops within the area to be burned. Birds in the vicinity were scrub jay, acorn-storing woodpecker, canyon wren, and valley quail. Several rufous-crowned sparrows were in and about brush in the rocks. Birds were not flying from tree to tree. One chipmunk was seen.

The fire was set off at 5:10 by electrically-wired fire bombs to the east and south of us. Two minutes later a sapsucker flew out of the fired area. There was considerable fire by 5:15, but smoke was not yet dense. Bushtits and a titmouse were unconcernedly foraging in ceanothus close to us. The fire was now approaching from the west. At 5:26 a bobcat trotted by and turned toward the approaching fire, but probably took refuge in rock outcroppings. The fire was not advancing very fast, and even a person might have been able to escape through it. An acorn-storing woodpecker flew into the smoke. A bewick wren came to our rock outcrop.

At 5:35 the center area to the east and below us was fired, which is where the caged animals were located. A woodpecker began fly-catching from a blue oak, in and out of the smoke from the nearby fire. A brown towhee flew to the top of a ceanothus close to the fire, then unhurriedly flew away. At 5:47 several quail flew from the east, which was now on fire, into the burn just to the south of us. At the same time a towhee, presumably the one just mentioned, came into our rocky area.

By 5:53 the fire was close to us and a California thrasher came running into our rocky area with mouth open and panting. It was followed by a woodrat, gray squirrel, and several chipmunks. The squirrel saw us

Table 2. Comparison of animals before and after a control burn, counted at a spring during a two-hour period (4:45 to 6:45 Pacific Standard time).

Kinds of Animals	Number of Animals					
	July					Aug.
			Burn			
	16	24	26	27	31	8
Valley quail	0	2	2	107	47	0
House finch	4	20	35	41	16	24
Brown towhee	19	24	27	28	18	7
Bluebird	21	7	2	3	3	5
Scrub jay	0	6	3	10	8	1
Cottontail	1	5	2	10	1	0
Mourning dove	0	1	2	2	1	2
16 other species	5	2	2	7	12	6
Total	50	67	75	208	106	45

and disappeared to the north. At 5:58 another woodrat came into the rocks.

The smoke was thick where the woodpecker was fly-catching, and at 6:00 it flew up and out of the area. A jay followed. Six quail then flew to the north across the fire. At 6:04 a female quail ran toward us and hid in a rock crevice nearby. During the next fifteen minutes, visibility was very poor because of smoke, yet three chipmunks were venturing about on the rocks around us.

At 6:27 a jay flew into the oak tree where the woodpecker had been fly-catching. A towhee circled the rocks, and soon there were at least four of them in the area. They seemed to ignore the smoke and fire, foraging normally. By 6:50 it was too dark to observe animals more than a few feet away.

Shortly after 6:00, one of us managed to leave the rock sanctuary to get through the fire and go down hill to the east, where it had been fired at 5:35 and where the caged animals were located. Extreme care was necessary to avoid getting downwind of flaming hot spots and suffocating; otherwise, it was possible to move about through the burned area. Attention was largely occupied with avoiding hot spots and falling Digger pines, rather than trying to observe wildlife, but at 6:20 two quail were seen on a rock, and at 6:25 another, in a live oak missed by the fire. At 6:37 a pocket mouse scampered by. After observing that at least some of the caged animals in rock crevices were still alive, the observers worked their way out of the burn to avoid being caught by darkness.

Sherwin F. Wood observed the fire from the northwest boundary. Between 4:35 and 4:59 he saw three coveys of quail (20, 30, and 25 individuals), a cottontail, and a mourning dove move into the burn area. At 5:10 a cottontail, an acorn-storing woodpecker, and a scrub jay moved out as the fire was started. Two bushtits and 55 quail flew out of the burning area.

Of five cottontails observed, three remained near a pile of dead brush. As the fire moved through the grass toward them, all three waited with ears down, as if hiding. The fire reached bare ground and went out just short of them. Later, when frightened by the observer, they moved into the fire area. Even though several of the cottontails could have gone into the previously burned area, they kept moving from unburned site to unburned site just ahead of the fire.

None of the three observers saw animals that had been singed or burned by fire. They mostly seemed to display an

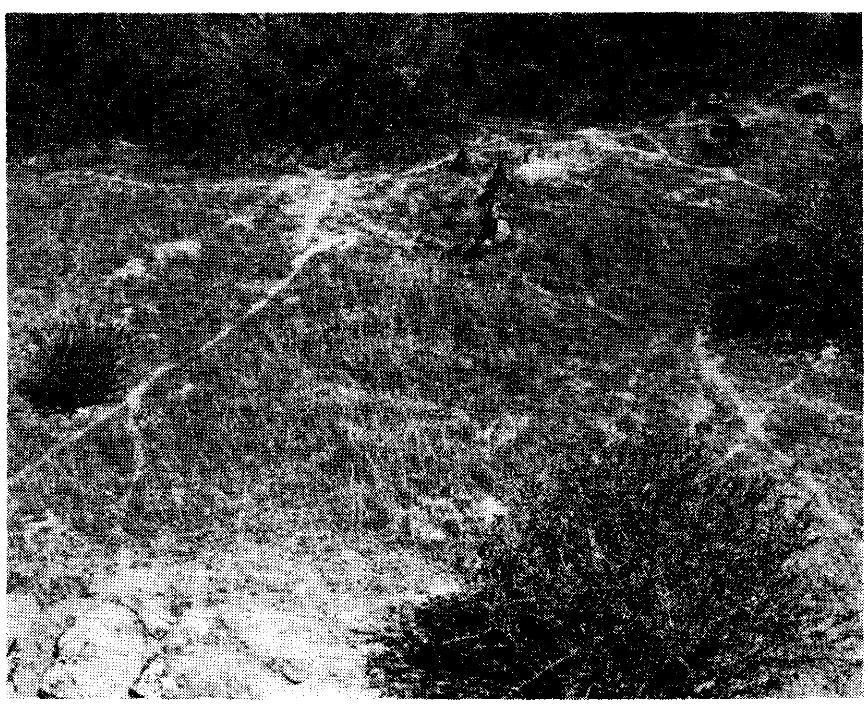

FIGURE 3. Examples of fire breaks constructed primarily by kangaroo rats, cottontails, crown sparrows, valley quail, and brown towhees. There is very little grass present, especially near the ceanothus, even though this area has not been grazed by cattle for more than 20 years. Natural Area, San Joaquin Experimental Range.

amazing calmness, and all managed to avoid hot spots.

Discussion

Control burning of certain brushlands has proved to be a good range-improvement tool as far as forage, soil, and water is concerned. In this study, we were able to verify what our other observations had already indicated—that most range fires are not directly destructive to wildlife. The principal way such fires may adversely affect population densities of some animals is by altering the habitat—not by killing. The habitat more than anything else determines the species and their densities in an area. Most vertebrate animals manage to escape the heat of fires by flying or running away, going below ground a few inches, hiding in rock outcrops, or seeking islands missed by the fire. Once an area has been burned, however, population densities may markedly change because of alterations in habitat conditions.

In general, the opening up of dense stands of brush benefits game animals and most other species of vertebrates. In most instances, brush control consists more of opening up, rather than converting completely to grasslands. When dense stands of brush are burned, an occasional mammal or bird may become encircled by fire. On the other hand, solid stands of brush seldom support many vertebrates.

In trying to burn stands of brush that require grass as fuel between clumps of woody vegetation, the effects of wildlife may present quite an obstacle to successful burnings. Birds, rodents, and cottontail rabbits frequently make trails and remove the forage from around woody vegetation, such as ceanothus (Figure 3). This effect also often occurs around piles of brush that have been bulldozed the previous year. The reason is that these animals do much of their feeding and loafing in the immediate proximity of good cover. In the control burn we observed several instances of such wildlife-constructed "fire breaks" protecting stands of woody vegetation from fire.

Summary

Information on wildlife survival of prescribed (controlled) brushland fires was obtained by three methods: (1) 37 rodents and snakes in cages with temperature recording devices were placed in different habitat situations, and the area was control burned; (2) the number of birds and mammals drinking from a spring was counted both before and after the area was burned; and (3) the behavior of wild animals was observed from an observation point within the fire.

The cage temperature lethal to rodents was somewhere between 138° and 145° F. Results indicate that there was little chance of wild vertebrate animals getting caught in a situation that would lead to their death during such fires. Most species of vertebrates benefit from control burns, because the habitat then becomes more favorable.

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E. J. Woolfolk to Edit Journal

E. J. Woolfolk, Chief, Division of Range Management Research, Pacific Southwest Forest and Range Experiment Station, Berkeley, California, will become editor of the Journal of Range Management, effective with the January 1960 issue. Woolfolk has been serving as assistant editor of the Journal this year and has been a member of the editorial board of the Journal for the past three years.

All manuscripts, correspondence relating to manuscripts, and items for publication in the 1960 issues of the Journal should be directed to the new editor at the following address:

E. J. Woolfolk, Editor
Journal of Range Management
Pacific Southwest Forest and Range Experiment Station
P. O. Box 245
Berkeley 1, California