Effects of Fire on Numbers of Blue Grouse

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WE HAVE STUDIED natural populations of Blue Grouse *Dendragapus obscurus* on Vancouver Island, British Columbia, almost continuously since 1950. Our main objectives have been to determine what limits abundance and regulates numbers of this species and how this knowledge may contribute to a general theory of numbers of animals.

Nutritional quality of food is often cited as a factor limiting the numbers of animals (Smith, 1966). Some workers imply that if quality of food is improved, populations will increase (Cheatum and Severinghaus, 1950; Grange, 1949; Miller, *et al.*, 1966; Swank, 1956; Taber, 1953). Cowan (1945), Cowan, *et al.*, (1950), Einarsen (1946a,b), Miller, *et al.*, (1966), and Taber and Dasmann (1958) suggest that quality of food is important for the maintenance of populations. Lack (1954, 1966) states that food is important for the regulation of numbers, but suggests that both quantity and quality may be involved. Many advocates of the nutrition hypothesis point out that animals do select the most nutritious food (Gates, 1968; Moss, 1969; and others) and suggest that animals need this high plane of nutrition. However, use and need are not synonymous and use may simply indicate preference.

Nutritional quality of plants growing on areas recently burned may be higher than on unburned areas (Gates, 1968; Miller, *et al.*, 1966; Taber and Dasmann, 1958) suggesting that if the quality of food is important to animals, fire may be important in increasing population density. Densities of Blue Grouse near Campbell River, B. C., were very high in the early 1950's and we once hypothesized that these densities resulted from a high nutritional quality of plants following a large wildfire (Zwickel and Bendell, 1967). The purpose of this paper is to examine our past data in light of more recent studies and to give evidence which indicates fire is not a necessary pre-requisite for high densities of Blue Grouse, nor can it prevent a decline.

FIRE ON VANCOUVER ISLAND

We will be discussing two types of fire. There are the controlled burns of debris that remain following a typical logging operation. These are called slash-burns and they usually occur in autumn or occasionally, in early spring. Additionally, there are uncontrolled fires that may burn either through mature forest or in areas previously logged. These are called wildfires and they usually occur in late summer. Both the slash-burn and the wildfire may be either hot or cool (Daubenmire, 1959) and the effects of temperature on release of essential nutrients may be different. Time of burning may also affect the release of nutrients differently (Miller and Miles, 1970; Taber and Dasmann, 1958).

In addition to changing the quality of plants on an area, fire may affect the gross structure of the vegetation, the successional pattern, the microclimate, and/or alter other components of the ecosystem, such as other animals living there.

Some areas of Vancouver Island have a history of several fires. For example, an area may be routinely burned following logging

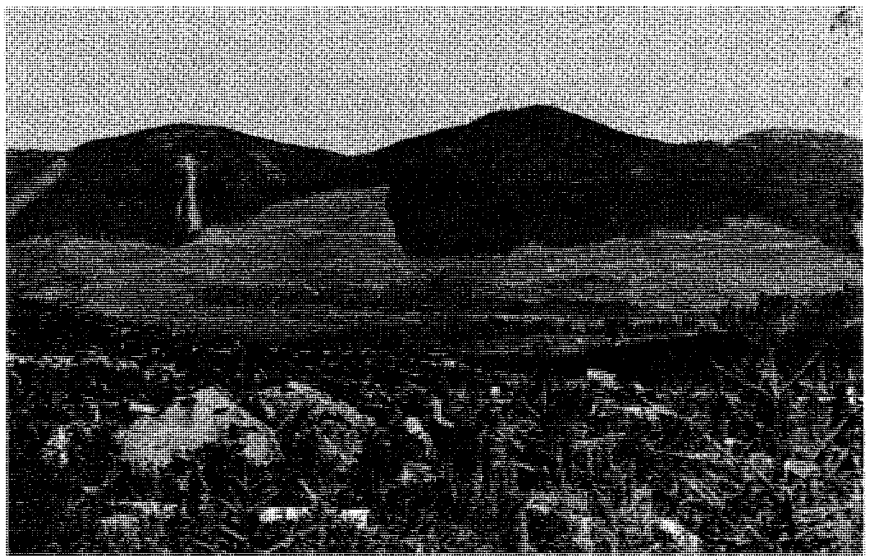

FIG. 1. Blue Grouse summer and winter range in the Ash River region of Vancouver Island. All the logged (cleared) area on the lower slopes and in the foreground is breeding habitat. The forest, especially in the higher, subalpine regions, is potential winter range. The elevation of the crest of these mountains is near 5000 feet. This clear-cut logging is typical of logging operations on Vancouver Island.

and then a wildfire may burn the area one or more times in the following years.

RELEVANT ASPECTS OF THE LIFE HISTORY OF BLUE GROUSE

Blue Grouse are found in mountainous areas of western North America from New Mexico to Alaska. On Vancouver Island, their winter range is in coniferous forests (Bendell and Elliott, 1967) and they move to more open areas for breeding (Fig. 1). Densities of breeding birds in mature forests are low but populations increase rapidly following logging or burning (Redfield, unpublished). After this initial increase, there is usually a 10 to 25 year period of relative

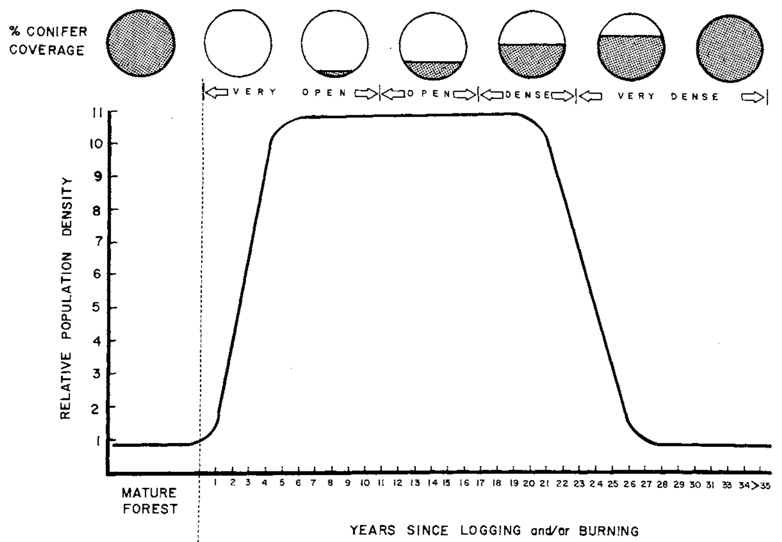

FIG. 2. A generalized curve for growth, stability and decline of blue grouse populations following logging and/or burning of the mature forest. Population density is low in the mature forest but rapidly builds to a stable density. The terms very open, open, dense and very dense refer to structure of the vegetation as outlined in Bendell and Elliott (1966). (Data for this figure were obtained from Bendell and Elliott (1966) and Redfield (unpublished). Fluctuations in the general level of the population do occur but have not been included in this diagram.)

stability, followed by a rapid decline caused by the increasing density of regenerating forests (Bendell and Elliott, 1966) (Fig. 2).

Blue Grouse maintain breeding populations in a wide range of habitats (Zwickel and Bendell, 1970). On Vancouver Island these may be classed as *very open* consisting of little more than bare earth, *open*, with up to 25 percent conifer coverage, and *dense*, with 50 percent conifer coverage. As conifer coverage approaches 75 percent, (*very dense*) Blue Grouse populations begin a rapid decline.

Adult males (2 years old and older) migrate onto breeding range in March and maintain breeding territories until early July. By August most have left the breeding range. Yearling males (1 year old) come onto the breeding range in April, but few hold territories and most have left by early July. Adult and yearling females do not hold territories and stay on the breeding range with their broods until September. Blue Grouse appear to be polygamous and breed in late April or May. Most eggs hatch in June and chicks are nearly full grown by late September, when most grouse have left the breeding range.

A more complete summary of the life history of Blue Grouse on Vancouver Island can be found in Bendell (1955a,b) and Bendell and Elliott (1966, 1967).

STUDY AREAS

We have concentrated our efforts in three regions of Vancouver Island (Fig. 3). All areas have been block-logged by clear cutting and each will be described separately.

Campbell River Region:—Bendell (1955a,b) studied Blue Grouse at Lower Quinsam near Campbell River from 1950 to 1953. In 1957 he reopened his earlier studies (Bendell and Elliott, 1966, 1967) but because of dense regrowing forest at Lower Quinsam concentrated his efforts at Middle Quinsam. Both Lower and Middle Quinsam are intermediate between the coastal Douglas-fir and coastal western hemlock biogeoclimatic zones (Krajina, 1965) and rainfall is about 60 inches per year. Terrain is generally flat to slightly rolling. All of Lower Quinsam and about ⅔ of the Middle Quinsam study areas are located within the bounds of a 75,000 acre wildfire that swept the area in 1938,* and most of the Middle Quinsam was reburned in 1951. Thus, about ⅓ of the area at Middle Quinsam has been burned three times (first, following logging, with the routine burning of slash).

Courtenay Region:—Zwickel (Zwickel and Bendell, 1967) started research on an area called Comox Burn near Courtenay in 1962. Comox Burn was logged and slash-burned prior to 1961. In Septem-

*According to logging company maps we have, there may have been two wildfires in 1938, a very large fire that burned the Lower Quinsam study area and a smaller fire about 5 miles west that burned part of the Middle Quinsam study area. However, we are not sure of the exact of these two fires and refer to both burns as the 1938 wildfire.

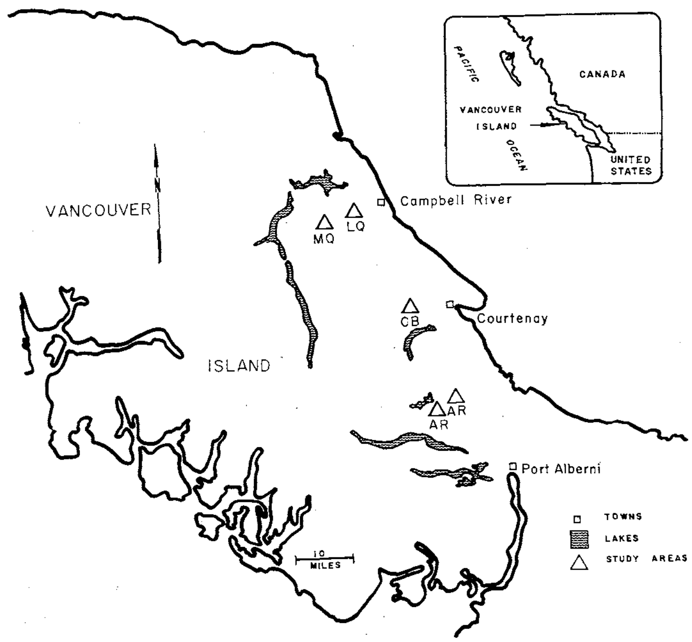

FIG. 3. Location of areas of intensive study on Vancouver Island. LQ=Lower Quinsam; MQ=Middle Quinsam; CB=Comox Burn; AR=Ash River.

ber of 1961 a 3,000 acre wildfire reburned the area. Comox Burn is also intermediate between the coastal Douglas-fir and coastal western hemlock biogeoclimatic zones (Krajina, 1965), has an average annual rainfall of near 60 inches, and is on generally northeast facing slopes. Grouse populations were studied intensively from 1962 through 1964 and again in 1969 and 1970.

Port Alberni Region:—In 1968 Redfield initiated an intensive study of Blue Grouse populations in the Ash River area near Port Alberni and this study is continuing. This region is wetter (annual rainfall over 100 inches), and steeper than either of the other areas, and it is in the coastal western hemlock biogeoclimatic zone (Krajina, 1965). There have been no wildfires in the study areas and only part of the areas logged have been slash-burned.

RESULTS

We will present data of two kinds, the first comes from our intensive field studies of marked Blue Grouse and the second from checking stations operated on the opening weekend of hunting near Campbell River from 1948 to the present. Since territorial males are the easiest segment of the population to census (Bendell, 1955a) and since there appears to be an even sex ratio, we will base many of our conclusions on census data for territorial males.

Campbell River Region:—Density of territorial males was very high and stable at lower Quinsam from 1950 through 1953 (Bendell, 1955b). In 1957, when studies were reopened, the density of territorial males had dropped to about 40 percent of the earlier level (Table 1). This decline continued until 1962, when no territorial males remained on the census area. The decline can be explained partially on the basis of the habitat becoming unsuitable (Bendell and Elliott, 1966, 1967), but other data from samples of birds shot by hunters suggest that the decline was both too rapid and occurred over too general an area to be explained by change in habitat alone (see below).

TABLE 1. DENSITY OF TERRITORIAL MALES AT LOWER QUINSAM STUDY AREA FROM 1950 THROUGH 1962

Year	Males/100 acres
1950	26*
1951	37
1952	37
1953	22*
1954	—
1955	—
1956	—
1957	14
1958	7
1959	4
1960	2
1961	1
1962	0

* Data for these years are based on searches late in the breeding season. Other data suggest that these years were not different from 1951 or 1952.

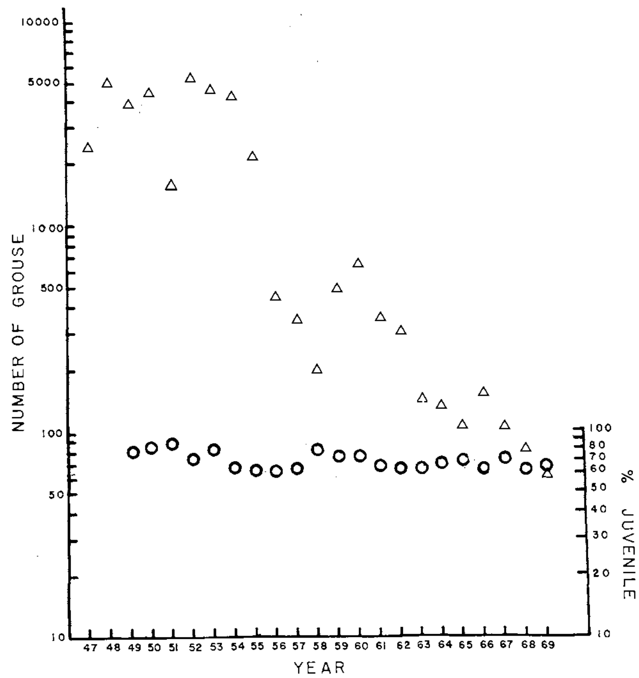

FIG. 4. Number of grouse shot (triangles)and the percentage that were juveniles (circles) near Campbell River from 1947 to 1969. Note that the decline in harvest was not accompanied by a similar decline or increase in the percentage of juveniles in the harvest.

An analysis of the number of grouse shot on opening weekend of hunting season in the Campbell River area (Fig. 4) indicates that: 1) the density of grouse in the early 1950's was high; 2) the total harvest was at least 10 times what it is today; and 3) the decline in harvest (hence, populations) was very abrupt. For example, in 1948 over 5,000 grouse were shot opening weekend of hunting season, while in 1969, less than 100 were shot, with the main change occurring between 1955 and 1956. These data are in general agreement with the breeding census data at Lower Quinsam.

We once thought that the high numbers of grouse in the early

1950's were caused by a response to an increase in nutrients following the large 1938 wildfire. If true, areas outside this burn should not have produced as many grouse as areas inside the burn, since the fire presumably had an effect only on the area burned. To test this hypothesis, we have analyzed data from the autumn harvest for areas inside and outside the burn. Because of variable hunting pressure in these areas, we have used hunter success (birds/hunter/day) as an index of density rather than total harvest. Two large areas, Camp 5 and Brewster Lake, lie outside the 1938 burn. They were mostly logged and slash-burned in the late 1930's and 1940's. Another area, Lower Quinsam Lake* (including the Lower Quinsam study area), was mostly burned by the 1938 fire. A fourth area, Middle Quinsam Lake* (including the Middle Quinsam study area), was only partially burned in 1938, but was partially burned by a 40,000 acre wildfire in 1951 (Fig. 5).

Basically, Camp 5 and Brewster Lake produced as many grouse at as high a success rate as areas inside the burn (Fig. 6). Additionally, areas both on and off the burn declined at the same time and rate. This drop in numbers of birds appears to be related to a drop in the breeding density of grouse rather than a decline in the average size of broods, since there were no changes in production of sufficient magnitude in this period to account for the spectacular drop in harvest (Fig. 4). Because densities both on and off this burn declined at the same time and rate, we conclude that the decline was caused by a general process occurring throughout the area and was not related to the 1938 fire.

Much of the middle Quinsam Lake region was burned in 1951 by a 40,000 acre wildfire but this did not prevent a decline in densities that paralleled the decline in the other areas (Fig. 6). Thus, fire at Middle Quinsam Lake did not result in an increase in grouse densities nor did it prevent a decline in those densities. Therefore, fire alone is not sufficient to explain the density of grouse.

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* Lower Quinsam and Middle Quinsam are names applied to intensive study areas, while Lower Quinsam Lake and Middle Quinsam Lake are names applied to general hunting regions.

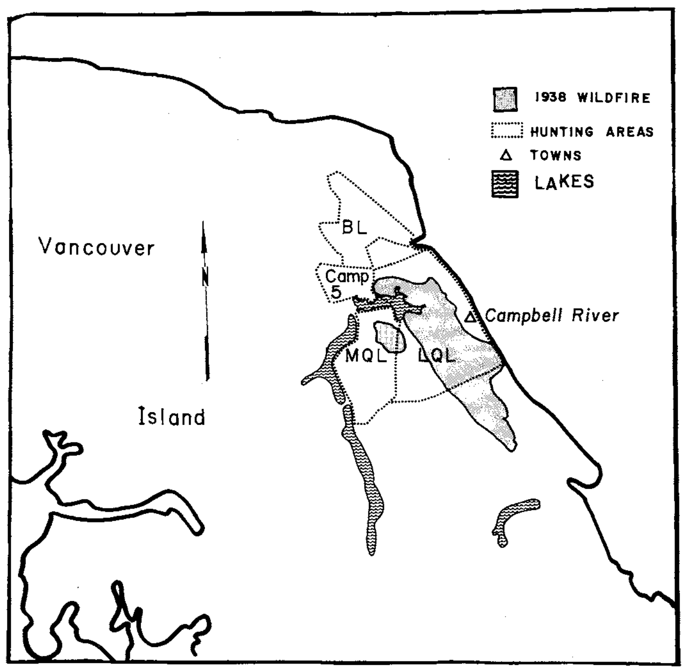

FIG. 5. Location of general hunting regions near Campbell River and their relation to the 1938 wildfire. Note that LQL was mostly burned, MQL was partially burned, and Camp 5 and BL were unburned. LQL=Lower Quinsam Lake; MQL=Middle Quinsam Lake; BL=Brewster Lake.

Intensive studies at Middle Quinsam from 1959 through 1962 showed that most population parameters were similar to those for Lower Quinsam in earlier years, except the density of breeding birds was much lower (Bendell and Elliott, 1967; Zwickel and Bendell, 1970). In these years the population was stable (Bendell and Elliott, 1967). An important question is why did the population on Middle Quinsam stabilize at 1/5 the density found at Lower Quinsam study area (and probably on the Middle Quinsam study area) in the early 1950's (Zwickel and Bendell, 1970)? If fire were important to increased densities, we would have expected similar densities at Lower and Middle Quinsam, when in similar stages of succession, but we did not find them.

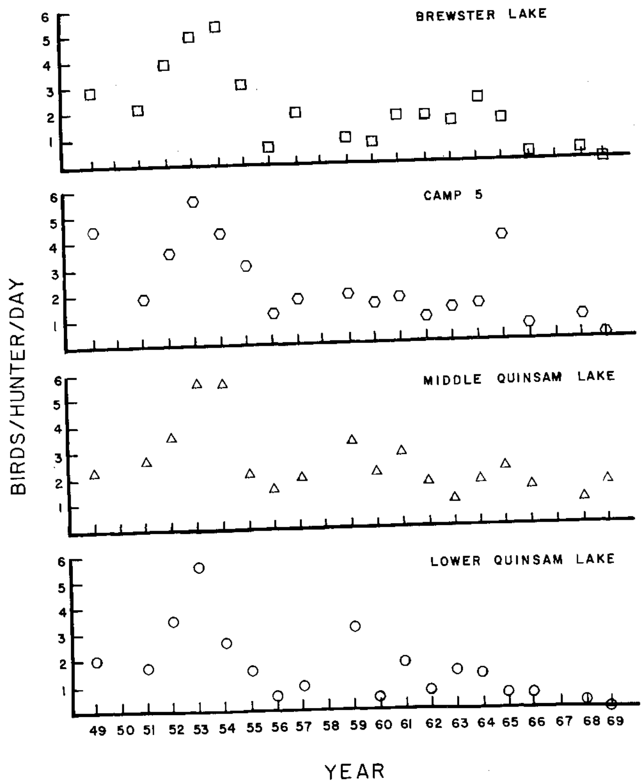

FIG. 6. Success of hunters (measured in birds/hunter/day) from the four hunting regions indicated in Figure 5. Note that the pattern of hunting success is very similar in all areas and that the major decline in harvest occurred shortly after 1954.

Courtenay Region:—In May 1962, Zwickel (Zwickel and Bendell, 1967) opened a study of Blue Grouse populations on Comox Burn, an area that had been burned the previous September. Concurrent studies were also pursued on areas nearby that lay outside the bounds of this burn. Breeding birds were found on the study area (which was virtually ash and mineral soil (Fig. 7A)) at densities comparable to those on nearby areas that had not been burned. It appears that the only major effect the fire had on the population the first

FIG. 7A. Comox Burn in early June, 1962, 10 months after a wildfire swept the area. Most of the area was devoid of vegetation like this.

year after the fire was to cause brood hens and chicks to leave the study area earlier than usual (Zwickel and Bendell, 1967). Thus, Blue Grouse can live and breed on a recent burn in spite of the harsh appearance of the habitat. Birds returned to their breeding territories at Comox Burn at approximately the same rate as at Lower Quinsam and Middle Quinsam (Zwickel and Bendell, 1970), which suggests that immediately following a fire there were no detrimental effects on the numbers of birds (Table 2).

Although there appear to have been no direct detrimental effects on the numbers of birds, one might ask, were there any beneficial effects? If so, we would expect the population to increase. Data are presented in Table 2 on density and other population parameters of grouse on Comox Burn for the years 1962-1964. The breeding density was stable throughout this period, in spite of a rapid

FIG. 7B. Comox Burn in June, 1962, showing a typical nest in the foreground under a log.

change in habitat (Zwickel and Bendell, 1970) and an almost certain change in nutritional quality of the plants following the fire (Gates, 1968). In addition, all population parameters, including annual production, closely parallel those for control areas nearby (Zwickel and Bendell, 1967).

In 1969 the study at Comox Burn was reopened and the breeding density had increased. Again, in 1970, the density had increased (Zwickel and Bendell, 1970), This increase appears to have occurred so long after the 1961 wildfire that any beneficial effects of nutrient release should have long since passed.

The conclusions we can draw from the Comox Burn study are: 1) fire had no harmful effect on the breeding population, and 2) fire appears to have no beneficial effects either, since for 3 years following the 1961 burn, neither the size of the breeding population nor

TABLE 2. SOME RELEVANT POPULATION DATA FROM COMOX BURN STUDY AREA FOR 1962 THROUGH 1964
(Data Obtained from Zwickel and Bendell, 1967)

	1962	1963	1964
Adult Males/100 Acres	5	5	5
Males : Females	1 : 1	1 : 1	1 : 1
Yearling females / Total Females	0.32	0.41	0.33
% overwinter loss[a] (Adults + Yearlings)			
Males	—	24	27
Females	—	27	37
Clutch Size ($\bar{x}$)	5.9 (n = 23)	6.3 (n = 13)	7.0 (n = 15)
Late Summer Brood Size ($\bar{x}$)	—[b]	2.92 (n = 62)	2.52 (n = 30)

[a] None of these figures are significantly different from each other.
[b] Most broods had abandoned Comox Burn by late summer in 1962 and it was impossible to get this parameter in that year.

TABLE 3. NUMBER OF TERRITORIES, NESTS, HENS WITH YOUNG BROODS, AND HENS WITH OLD BROODS ON BURNED AND UNBURNED AREAS ON THE ASH RIVER STUDY AREAS. APPROXIMATELY 65% OF THE AREA STUDIED IS BURNED AND 35% IS UNBURNED. O = OBSERVED; E = EXPECTED

	Burned			Unburned		
	Number		Percent	Number		Percent
	O	E		O	E	
Territories	38	38	65	20	20	35
Nests	7	7.8	59	5	4.2	41
Young Broods	51	47.5	67	22	25.5	33
Old Broods	65*	51.4	82	14*	27.6	18

* These values are significantly different (p = 0.05) from an expected 65% to 35% split using a chi-square goodness-of-fit test.

other population parameters changed systematically. If fire were important to Blue Grouse, we would have predicted that within this time period there would have been changes in at least some population parameters, since this is the period when the effects of fire should have been greatest (Daubenmire, 1959; Taber and Dasmann, 1958).

Port Alberni Region:—In the Ash River area, breeding habitat is being created every year by logging. About 35 percent of the logging slash is unburned, which presents a mosaic pattern of burned and unburned areas from which birds may select (Figs. 8 A, B). This situation offers an opportunity to study habitat selection in relation to burning, by grouse first colonizing newly logged areas. This also allows us to look at the effect of burning on numbers in areas once they are colonized. If fire were important to grouse, we would predict that burned areas would be colonized in preference to unburned areas and that more birds would be found on burned than unburned areas.

First, we examined the selection of burned and unburned areas by birds first colonizing. Within 4 years after logging all areas appear to have been colonized, but as can be seen by the following figures, there does not appear to be any preference for burned or unburned areas:

	Burned		Unburned	
Years Since Logging	No. of Areas Inhabited	No. of Areas Uninhabited	No. of Areas Inhabited	No. of Areas Uninhabited
1	0	1	1	2
2	1	1	2	1
3	4	0	—	—

If male grouse select burned areas we would expect a proportionally higher number of territories on burned than unburned areas. We calculated the percentage of territories on burned and unburned areas and found it to be the same as the availability of these two types of habitat (Table 3). Thus, territories of males appear to be distributed at random with respect to slash-burning.

Although these data suggest that burning does not affect the distribution of territories of males, it may affect the distribution of females. We examined the distribution of females by counting the number of nests, the number of hens with broods younger than 15 days of age and the number of hens with broods older than 15 days of age on burned and unburned areas. We used these categories because: 1) prior to nesting hens may associate with cocks(Bendell and Elliott, 1967), 2) during laying and incubation the nest may represent the center of activity for a female (Lance, 1967), 3) hens with young chicks may not have moved far from this center, and 4)

FIG. 8A. Unburned logging slash in the Ash River region in late August, 1970, 3 years after the area was logged. This is in the Ash River region.

after the critical age of 15 days (Zwickel and Bendell, 1967) there may be more opportunity for hens with chicks to select given habitats. Hens on nests and hens with young broods appear to be distributed at random with relation to burning, but hens with older broods appear to be selecting burned areas (Table 3). In summary, the only segment of the population that appears to be utilizing the burned areas more heavily than would be expected are hens with older chicks. Males and hens with young chicks were distributed randomly over the habitat.

DISCUSSION

We have not been able to show that fire is of any significance to numbers of Blue Grouse with respect to: 1) causing high breeding densities, 2) maintaining these densities, or 3) increasing annual production. The general population trends we have seen seem to be

FIG. 8B. Burned logging slash in the Ash River region in late August, 1970, 3 years following logging and burning. The effect of burning on a gross level is to clear an area of smaller twigs and debris.

related to some more general process. If nutritional quality does increase following burning, yet populations do not respond to this increase, then we may have to reconsider some of the current views concerning the effects of nutrition on animal populations in general.

Our results conflict with those of Miller, *et al.*, (1966), who feel that rotational burning of heather in Scotland is essential for continued production of Red Grouse (*Lagopus l. scoticus*). We note, however, that they chose to ignore two of their study areas in order to show significant differences in their data. Also, Miller and Miles (1970) have shown that cutting of heather is as good as if not better, than burning for producing nutritious young heather.

There are, undoubtedly, increases in the nutritional quality of some plants following some fires (Cowan, *et al.*, 1950; DeWitt and Derby, 1955; Einarsen, 1946a; Taber and Dasmann, 1958). This increase in quality is generally considered to be a direct result of fire and to be of benefit to animals (Cowan, *et al.*, 1950; Moss, 1969). Although there is an increase in the quality of some plants following fire, nutritional levels are usually back to the unburned levels in a few months, or, by 2 years (Taber and Dasmann, 1958). Gates (1968), working on logged and burned areas of Vancouver Island, was unable to show any nutritional changes in plants on areas from 4 to 14 years after burning. If these results are representative, the quality of plants increases immediately after burning but rapidly declines to pre-burning levels and stays relatively stable for an extended period. Thus, any nutritional effects of fire on animal populations should be manifest in the first few years following burning. We have found few changes in population parameters following fire and the changes we have seen are so latent that they cannot be attributed to burning.

It is fair to ask, if indeed, fire is not beneficial to animals, then why do populations of some species increase following burning? Fires open the habitat (Vogl, 1966) or set back succession and this seems to be the crucial point for many species (Bustard, 1969; Tevis, 1956a,b; Zwickel and Bendell, 1970). Animals that do well on areas that are burned seem to be those adapted to early stages in succession. Although fire can be used as a tool to stall succession (Schroger, 1962), it is not the only way to create these conditions (Blaisdell and Mueggler, 1956; Miller and Miles, 1970). In fact, fire may have long-term detrimental effects on the ecosystem and we would be well advised to heed Kayll's (1967) caution that ". . . *the long term influence of repeated . . . burning on soil fertility . . .*" is not known. We caution, also, that this is especially true in Pacific coastal regions of North America, where repeated burning may be harmful. The terrain is generally rugged, topsoil is thin and is usually held in place by a carpet of moss. Burning of logging slash usually occurs in late summer or early fall, at the start of the rainy season. Thus, valuable topsoil and many nutrients that are released immediately after fire (Gates, 1968; Daubenmire, 1959) may be washed away by winter rains. Fire also causes a number of drastic effects on the soil (Isaac and Hopkins, 1937).

We do not believe that burning is bad for Blue Grouse populations, in the short-term view. In fact, our data suggest that burning has no significant effect on the birds over and above clear-cut logging. We do suggest that although burning may not be harmful, it is not necessarily, good. Other means of opening the habitat may be equally productive (Miller and Miles, 1970) and better from the long-term view for the ecosystem. Certainly, within the limits of our observations this seems to be the case. In Pacific coastal regions of North America, clear-cut logging appears to be enough to stimulate an increase in numbers of Blue Grouse.

CONCLUSIONS

1. High densities of Blue Grouse found near Campbell River, B. C., in the early 1950's do not appear to be related to a large lowland wildfire that occurred there in 1938. Densities of grouse appear to have been as high on areas that had been logged and slash-burned only. Thus, large wildfires in lowland areas are not a necessary prerequisite to high grouse populations.
2. A second large wildfire near Campbell River in 1951 did not prevent a spectacular decline in grouse populations. Clearly, large wildfires and a subsequent set back in plant succession are not sufficient to maintain densities of grouse.
3. Another wildfire near Courtenay, in 1961, was followed by a period of relative stability in grouse populations. Therefore, the immediate effect of wildfire may be inconsequential to Blue Grouse populations.
4. Areas near Port Alberni that are logged and slash-burned support no more grouse than nearby areas that are merely logged. Hence, clear-cut logging is sufficient to stimulate increases in grouse populations.
5. We caution that the long-term effects of repeated burning in Pacific coast regions may be harmful to the ecosystem.

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