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Bulletin No. 65

ABORIGINAL MAN AND WHITE MAN
AS HISTORICAL CAUSES OF FIRES
IN THE BOREAL FOREST,
WITH PARTICULAR REFERENCE
TO ALASKA

BY

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CONTENTS

	<i>Page</i>
INTRODUCTION	v
ABORIGINAL MAN AS AN HISTORICAL CAUSE OF FIRES	1
Use of campfires	2
Use of fire in signaling	4
Use of fire in gumming canoes	11
Use of fire in hunting	13
Use of fire in warfare	16
Use of fire in combating insect pests	18
Miscellaneous uses of fire	20
WHITE MAN AS AN HISTORICAL CAUSE OF FIRES	23
Use of campfires	23
Use of fire to provide dry fuelwood	26
Use of fire in combating insect pests	27
Use of fire in signaling	28
Use of fire in hunting	30
Use of fire to promote grass for livestock	32
Miscellaneous uses of fire	33
EARLY FIRES OF UNKNOWN ORIGIN IN THE BOREAL FOREST OF ALASKA	35
The period prior to 1868	35
The period 1868 to 1896	36
The period 1897 to 1915	37
SUMMARY	41
REFERENCES CITED	43

ABORIGINAL MAN AND WHITE MAN
AS HISTORICAL CAUSES OF FIRES IN THE
BOREAL FOREST, WITH PARTICULAR
REFERENCE TO ALASKA

INTRODUCTION

THE boreal forest of North America extends as a broad transcontinental belt from the Labrador Coast on the Atlantic Ocean, across Canada and through interior Alaska, to the westernmost limits of natural forest on the Seward Peninsula, Alaska. It is a forest that is especially liable to destruction by fire. Relatively low precipitation, long hours of sunshine during the summer period, and remarkably high air temperatures increase the fire hazard in a forest that, by its very nature, is readily flammable. The boreal forest is characteristically coniferous with comparatively small trees, often supporting a heavy growth of beard lichens. Fire carries readily in dense stands as it also does in open stands; in the latter the trees often retain their branches to the ground and the intervening spaces are blanketed with a cover of mosses, lichens, and small shrubs. In summer the mosses and lichens become extremely dry and tinderlike.

Lightning is certainly responsible for starting fires in the boreal forest but man, both aboriginal and white, seems to have been a more important cause. It is the purpose of the writer to examine the uses to which man in the boreal forest has put fire and his role in forest burning. For this purpose the examination has been concentrated on the early historical period, prior to about 1915.

ABORIGINAL MAN AS AN HISTORICAL CAUSE OF FIRES

THE general attitude of aboriginal man toward fires in the boreal forest is a subject on which there are differences of opinion. Various writers have stated that the natives were careless with fires and that they even deliberately set the forest afire. Other writers credit aboriginal man with circumspection in handling fire and hold that he recognized that forest fires damaged his environment.

David Thompson, during a trip to Lake Athabasca in 1796, observed that, "The Natives are frequently very careless in putting out the fires they make, and a high wind kindles it among the Pines always ready to catch fire; and burn until stopped by some large swamp or lake; which makes many miles of the country appear very unsightly, and destroys many animals and birds especially the grouse, who do not appear to know how to save themselves, but all this devastation is nothing to the Indian, his country is large" (Tyrrell, 1916:137). During his descent of the Yukon River in 1867, Dall observed fires in the vicinity of the Ramparts. "Large fires were burning in the forests, and on the sides of the hills. They had been kindled by some neglected camp-fire, and spread rapidly over the mossy sod and leaves dried by the mid-summer sun. The smoke hung over all the country, obscuring everything with a lurid haze" (Dall, 1870:116). Much later Brooks (1911:206) and (1953:70) also wrote that the natives were careless with fires and credited them with forest burning.

On the other hand, Bell (1889) stated that "The Indian hunter or wild Indian of the North, knowing how destructive forest fires are to the animals on which he depends for food and fur, takes all possible care to prevent them" . . . In the same paper, however, Bell remarked on the increasing frequency of forest fires in Canada and gave as one reason the fact that the Indians traveled more than formerly and did not put out their fires. E. J. Knapp, a missionary at Rampart City on the Yukon River in Alaska, thought that the Indians were less careless with fire than were the white men. He testified that "They [the Indians] say that large tracts of country are being burned over through fires being started by white men, and are being ruined for hunting purposes. The

HISTORICAL CAUSES OF BOREAL FOREST FIRES

Indians, I have found, are careful in lighting and extinguishing fires in the woods, and especially careful during the dry season. They appreciate the importance to themselves of keeping the country from being burned over, for forest fires drive away the game" (Knapp, 1904:132). George M. Mitchell prospected on Wind River, tributary to the Peel River in Yukon Territory, in 1898. He thought the Indians in that area were careful with fire, stating "They never leave a fire burning by any chance—you won't find any burned land up that valley anywhere" (Graham, 1935:218).

The present writer does not presume to know which authors are right and which, if any, are wrong. It is fair to assume that all accurately reported their personal observations and the information supplied to them by others, either Indians or white men. In the pages that follow the use of fire by aboriginal man in the boreal forest will be examined in more detail and this consideration should afford a basis for judging the role of primitive man in forest burning.

Use of campfires

In his travels in the boreal forest region aboriginal man usually had an abundant supply of fuel available wherever and whenever he camped. This was fortunate for the convenience of campfires extended beyond cooking of food and involved such things as protection from mosquitoes and gnats, protection from cold, and, during the summer when traveling by water, for heating pitch while repairing canoes. In a region of high fire hazard such as the boreal forest, general use of campfires by a nomadic people would seem to be a likely cause of forest fires. Only extreme care in locating and extinguishing the campfires could prevent forest burning.

In general the attitude toward campfires seems to have been that of carelessness. This is indicated by various writers, for example, Head (1829:314), Brooks (1911:206), and Stewart (1956:118). Head thought that . . . "it is remarkable, considering every Indian and traveller usually lights his fire against the trunk of some prostrate tree, and leaves it burning, that conflagration should not be more general and frequent." Stewart remarked that "In a very extensive search of the literature I discovered almost no reference that natives anywhere carefully extinguished fires."

Schwatka (1885:168), during his travels on the upper Yukon River in 1883, commented on the carelessness of Indian campers and credited

ABORIGINAL MAN AS CAUSE OF FIRES

them with starting forest fires. Bell (1889), whose observations on forest fires in northern Canada were outstanding, reported that "One of the reasons for the growing frequency of forest fires is that the Indians travel more than they did formerly (and thus make more fires than when they were accustomed to stay longer in one place), along with the fact that they are less careful to extinguish them when they are not on or near their own hunting grounds. It gives them some trouble to put out a fire completely when they leave a camp, or where they may have stopped to cook a meal or gum their canoe by the way, and an Indian will seldom do anything except by necessity." Low (1896:36) was familiar with conditions in Labrador and regarded carelessness of wandering Indians with campfires as a common cause of forest fires. He expressed the view that many of the fires ascribed to lightning, if closely traced, would be found to have been set by Indians.

In late August, 1907, Stefansson (1922:224) was traveling down the Bell River, tributary to the Porcupine River, in Yukon Territory. He observed smoke and went inland to discover its origin. "There had been an Indian campfire there a month or two before and since then the fire had spread to cover several acres of ground. It had not blazed up but was smouldering its way through the peat. The reason why the peat fire had not developed into a real forest fire was undoubtedly in the frequent rains. . . . Had there been a dry spell instead, and especially dry weather accompanied by a high wind, there would have developed one of those fires which so frequently destroy hundreds and even thousands of square miles of the vast forests of the North."*

Camsell and Malcolm (1919:49), writing of the Mackenzie River Basin, reported that . . . "in the unexplored portions of the country Indian canoe routes are often marked by patches of burnt forest on the portage trails and at camping places."

Beach (1923) made a trip up the Pelly River, east of Fort Selkirk, in 1921. He stated that "The custom of the Indians is never to put out their camp fires, and as the season had been particularly dry the woods about the river were spotted in almost every direction with smoke clouds from the fires. There was one fire that particularly attracted our attention, and as each day passed the bank of clouds massed and spread

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HISTORICAL CAUSES OF BOREAL FOREST FIRES

until the sky was completely covered, and the smell of smoke was strong and caused a slight smarting of the nostrils."

The weight of evidence indicates that primitive man was not very careful with his campfires. To completely and certainly extinguish a campfire in the boreal forest, even with present-day equipment, is often bothersome and occasionally difficult. The task would have been harder, and perhaps nearly impossible, for aboriginal man especially when the campfires were built against the bases of trees, against relatively large logs on the ground, or on thick accumulations of organic debris on the forest floor. There is even the possibility (Stewart, 1956:118, regarded it as a probability) that aboriginal man may have wanted some of his campfires to continue burning or smouldering for a time after he left them. To quote Stewart: "Reason suggests that the first fire users, while migrating or hunting far from home base, intentionally left campfires burning and whenever possible tried to leave them smouldering slowly, so that they might burn for days." Situations could have existed where aboriginal man found it more convenient to return to a previous camping spot for fire than to strike a new fire with his primitive equipment—or do without fire. The proportion of forest fires that originated from the campfires of aboriginal man can never be known with any degree of precision, but it must have been substantial.

Use of fire in signaling

The use of fire in making smoke signals seems to have been a widespread practice by aboriginal man in North America. Hodge (1910:565) observed that "Smoke signals by day were used over a wide area of the western country, and were reduced to a regular system by means of which many different details of information could be conveyed across miles of distance." It seems clear from the accounts of many writers that smoke signals were commonly employed by primitive man in the boreal forest to communicate news of various kinds. Hallock (1894), after commenting on the destruction caused by forest fires in Alaska, continued as follows: "Time was, I ween, when the only smokes seen in the distant view were the signals of the tribes who wished to communicate with each other; some for the purpose of barter, some to indicate the direction to be taken, or a point of rendezvous. Sometimes the signal was a big smoke, at others only a thin spiral; again there were two or three adjacent, some large,

ABORIGINAL MAN AS CAUSE OF FIRES

others small, with many variations adapted to the information to be conveyed."

The first scientist, in fact the first white man, to set foot on Alaskan soil was Georg Wilhelm Steller who accompanied Bering on his voyage of discovery in 1741. While on Kayak Island, Steller recorded that . . . "I noticed smoke some versts away ascending from a charming hill covered with spruce forest". . . (Golder, 1925:50). There is no certainty that the smoke seen by Steller was a signal fire but it may well have been for smoke signals were used by the Eyak Indians who inhabited the adjacent region (Birket-Smith and de Laguna, 1938:106).

At least one tribe of Indians in Alaska seems to have derived their name from use of fire in signaling. Hodge (1907:716) stated that the Knik Indians, dwelling near the head of Cook Inlet, Alaska, were called the "Fire-signal People." The word Knik is of Eskimo origin, meaning fire. According to Hodge the name was given to these people by the Eskimo of Kodiak . . . "because, having no seaworthy boats of their own, they signaled for other tribes across the bay to send aid."

Alexander H. Murray descended the Porcupine River in 1847 on his mission to establish a post, Fort Yukon, for the Hudson's Bay Company on the Yukon River. In a journal entry made while traveling between the Coleen and Sheenjok Rivers, Murray (1910:39-40) wrote: "A smoke discerned on the bank below, at what is called the canoe portage, to which the Indians hurried, on arriving they informed us it was a *Death Fire*. It is the custom of these Indians, when any of them die, to make a fire at a public place where they know their friends will pass, willow poles are stuck in the ground on which is hung the hair of the deceased. They told us, by what means I know not, that it was an old man that had died, and being anxious about their relations, they said they must leave us, but directed us to keep to the left of a large island we would arrive at to-morrow. At this time a thick smoke was noticed to the south, supposed to be a *signal fire*, which hastened their departure."

Allen (1887:78) recorded the frequent use of signal fires by Indians on the upper Tanana River in 1885. "Heavy smoke, caused by extensive timber fires, obscured the sun the entire day [June 14, 1885], so that an observation was impossible. This smoke had originated from signal fires which were intended to give warning of our presence in the country. When we first arrived at Nandell's [an Indian village on the Tetling River, tributary to the Tanana River] there was only an occasional smoke around,

HISTORICAL CAUSES OF BOREAL FOREST FIRES

but as his guests departed for their different habitations each marked his trail by a signal fire. The prevailing wind was from the east and carried the smoke along with us. In answer to the fires on the south bank new ones started on the north, so that for nearly two days we barely caught a glimpse of the sun except through the heavy spruce smoke."

Haskell (1898:94), during his two years in the Klondike and adjacent Alaskan gold fields, encountered the practice of smoke signaling among the Indians of the upper Yukon River. "The Indian also has a way of signaling by burning trees. When in a locality where he expects to find his friends or family, he sets fire to a tall spruce, and then calmly sits down and watches the horizon for an answering column of smoke. The wind will fan these flames into a fierce forest fire in a short time, and the Indians are too utterly indifferent to think of putting them out."

Learnard (1900) made a trip from Portage Bay (Passage Canal), on Prince William Sound, to Turnagain Arm and up the Susitna River in 1898. Learnard reported (p. 658) that "Shortly after making camp the guide pointed out a smoke about a mile away, which we first thought might be from Lieutenant Castner's fire. The guide fired a rifle and soon smoke signals told him that the party at the camp consisted of a Midnooski man and two children, and that they would soon call on us." He also observed (pp. 665-666) that "The Indians of the interior do not understand the Russian language, so that it is very hard to communicate with the various tribes that one meets while traveling in Alaska. These Indians communicate by means of smoke signals with each other, even though they belong to different tribes."

In his monograph on the ethnography of the Kutchin nation, Osgood (1936:103) wrote that "The use of smoke signals adds to our knowledge of Kutchin signs. When a party splits on a hunting trip, a successful member may make a smoke signal. To do this he chooses a hill with a bushy green spruce tree on it which he burns without cutting it down. Also a person looking for someone may do the same thing to indicate his presence."

References to the use of fire and smoke in signaling by aboriginal man in the northern forest are more numerous in the literature dealing with Canada than with Alaska. This does not mean that the practice was more common in Canada but rather that the region was penetrated earlier and by more persons who took the trouble to record their observations.

In September 1838, Thomas Simpson was traveling in the Dease River country, north of Great Bear Lake, Northwest Territories, Canada,

ABORIGINAL MAN AS CAUSE OF FIRES

where he encountered the practice of signaling with fire. He wrote: "On the 13th, seeing large smokes on the north side of Dease River, we made towards them, though a good way out of our course. Falling upon a deep part of the stream, some crossed it on a raft, others found a ford. We lighted fires in conspicuous places, which were answered; and at length we were overtaken by two Indians, who, with as many others, carrying a bag of pemican, had been considerably dispatched by Ritch to meet us" (Simpson, 1843:312).

In a paper read before the Literary and Historical Society of Quebec in 1842, Davies (1843) described the destruction caused by forest fires in Labrador. He wrote: "Notwithstanding that the Indians are well aware of the danger of so doing, they generally make use of the moss, when they wish to inform their friends that they are in any particular part of the country, and this they do by setting fire to it. I once had an opportunity of witnessing the rapidity with which the fire spreads in the moss and the ravages that are caused by it. In 1840, I ascended Grand River, for the purpose of exploring it, after having been out about ten days, I felt anxious to ascertain if any Indians were in the neighbourhood, in order to acquire information from them respecting the country in the vicinity;—I, accordingly gave orders, to a couple of Indians I had with me, to make a signal by smoke, so that if any Indians were in the neighbourhood, they might be warned of our approach, and come to meet us." The smoke signal was made as directed but the fire spread so rapidly that Davies and his men barely had time to launch their canoe, hastily throw their things into it, and reach the safety of the river, which at their point was about a mile wide. Davies stated that "The fire lasted for upwards of three weeks, and spread over, and completely destroyed, an extent of some hundreds of square miles."

Robert Campbell, in 1843, descended the Pelly River to the junction with the Lewes River. Here he found a large camp of Indians who had not previously seen white men. In his journal Campbell (1883:439) wrote as follows: "Much depressed, we that afternoon retraced our course up stream; but before doing so, I launched on the river a sealed can containing memoranda of our trip, etc. I was so dejected at the unexpected turn of affairs that I was perfectly heedless of what was passing; but on the third day of our upward progress, I noticed, on both sides of the river, fires burning on the hill-tops far and near. This awoke me to a sense of our situation. I conjectured that, as in Scotland in the olden time, these were *signal-fires*; that they summoned

HISTORICAL CAUSES OF BOREAL FOREST FIRES

the Indians to surround and intercept us. Thus awakened we made the best use of paddle and "tracking line" to get up stream and ahead of the Indian signals. On the fourth morning, we came to a party of Indians on the bank of the river opposite from us. They made signals to us to cross over; which we did. They were very hostile—bows bent and arrows in hand,—and they would not come down from the top of the high bank to the water's edge to receive us."

Sir John Richardson encountered the practice of signaling with smoke several times during his travels in the North in 1848. While in the lower region of the Mackenzie River, Richardson (1852:141) reported that. . . "we noticed a line of six or eight signal smokes, raised in succession along the hills and speedily extinguished again." Richardson. . . "knew that the smokes we saw were intended to spread the intelligence of the arrival of strangers in the country". . . On the Coppermine River Richardson's party was observed by a group of Indians encamped about six miles distant. Richardson (p. 198-199) reported that . . . "we were not many minutes in sight before they signalled their position by raising a column of smoke. This was replied to by us as soon as we could strike a light and gather a few handfuls of moss; and our answer was immediately acknowledged by them with a fresh column."

In 1880-1881, Aurel Krause studied some of the tribes of Alaskan Indians; the original edition of his work "Die Tlinkit-Indianer" was published in 1885, and an English edition appeared in 1956. Krause reported that during their annual journey to the valley of the Yukon River, the Chilkat Indians had to cover an extensive territory to collect furs from the nomadic Athapascans. To indicate their presence the Chilkats often used smoke signals.

Frederick Schwatka, Lieutenant, U. S. Army, commanded the party that engaged in the Alaska Military Reconnaissance of 1883. The results of this exploration appeared in several publications, the best known of which is perhaps that of Schwatka (1885). While traveling between Lake Bennett and Lake Marsh, Yukon Territory, Schwatka was introduced to the Indian method of fire signaling. His account (pp. 114-115) was as follows: "During one of these temporary landings on the shores of Lake Bove our Indians amused themselves in wasting government matches, articles which they had never seen in such profusion before, and in a little while they succeeded in getting some dead and fallen spruce trees on fire, and these communicating to the living ones above them, soon sent

ABORIGINAL MAN AS CAUSE OF FIRES

up great billows of dense resinous smoke that must have been visible for miles, and which lasted for a number of minutes after we had left. Before camping that evening we could see a very distant smoke, apparently six or seven miles ahead, but really ten or twenty, which our Indians told us was an answering smoke to them, the Tahk-heesh, who kindled the second fire, evidently thinking that they were Chilkat traders in their country, this being a frequent signal among them as a means of announcing their approach, when engaged in trading. It was worthy of note as marking the existence of this primitive method of signalling, so common among some of the Indian tribes of the plains, among these far-off savages, but I was unable to ascertain whether they carried it to such a degree of intricacy with respect to the different meanings of compound smokes either as to number or relative intervals of time or space. It is very doubtful if they do, as the necessity for such complex signals can hardly arise." Schwatka (p. 168) observed that "Evidences of conflagration in the dense coniferous forests were everywhere frequent" . . . and listed signal fires as one of the causes.

In 1889 Captain Billie Moore and Howard Hamilton were camped on Lake Tagish [east of Lake Bennett in Yukon Territory, called Lake Bove by Schwatka in 1883] with their cook, a native woman named Jennie. The following incident, recounted by Moore and published by Chase (1947: 162) illustrates the efficiency of smoke signals in conveying information: "Jennie next took a firebrand from the fire and found a tree with considerable brush on it. She applied the fire to it, and up went a column of smoke and fire, high in the air. Howard exclaimed, 'What is she doing that for? We are liable to get burned out.' Moore said, 'Howard, did you forget about the Indians in Montana, how they inquire as to where each other are? Just look for a while across the lake.' In a few moments, they saw a similar column of smoke go up across the lake. In about an hour a canoe beached at their camp, and out jumped four more natives."

Glave (1892) noted the use of fire signals in southwestern Yukon Territory. He observed that . . . "when announcing his approach to friends at a distance, he [the Indian] sets fire to a half-dead spruce- or tamarack-tree, and the column of thick, black smoke is the signal, to be acknowledged in the same manner by those who see it, so as to direct the traveler to their camping-grounds. In the summer everything is crisp and dry, and the timber is saturated with turpentine. The trees left to smolder are fanned into flame by the slightest breeze; the flames creep among the resinous

HISTORICAL CAUSES OF BOREAL FOREST FIRES

trees, and spread till whole forests are destroyed." Glave also reported that "Every time we reached exposed positions our Indians would set fire to trees" . . . and again that "He [the Indian Nanchay] began an incessant signalling by burning trees, and by and by the keen eyes of Tsook [his son] spied a faint curl of smoke creeping up from the wooded brow of a hill about ten miles away, which told of the whereabouts of the missing family."

During the course of his explorations on the Labrador Peninsula between 1892 and 1895, Low (1896:36) noted the practice of signaling with fires employed by the Indians as did Davies (1843) much earlier. After commenting on the widespread destruction caused by fires, Low stated "These fires are due to various causes, but the majority of them can be traced to the Indians, who start them either through carelessness or intentionally. The Nascaupsee Indians of the semi-barrens signal one another by smoke made by burning the white lichens that cover most of the ground in the interior, and these signals cause many of the fires."

George M. Mitchell prospected in the Peel River country, Yukon Territory, in 1898. In describing the habits of the Indians on Wind River, tributary to the Peel, Mitchell said "As I've told you, their fires for cooking out of doors are pretty free of smoke, but if they want a signal fire they can make it smoke right up to Heaven and can make the column of smoke veer north or south, or however they want, by fanning it with a coat, or a blanket" (Graham, 1935:217-218).

Hanbury (1904:219), while exploring the country between Dease Bay of Great Bear Lake and the Coppermine River, Northwest Territories, Canada, sent one of his companions to examine the country to the southwest. This man reported having seen the smoke of a "bush fire." Hanbury wrote "I regarded this as probably the work of Indians on the other side of the divide. My Huskies did not take this view, but thought it more probably the work of the Husky deer hunters making a fire for signal purposes."

In his account of a hunting trip in western Yukon Territory in 1912, Martindale (1913:62-64) wrote that "Early this morning we saw a great volume of dense smoke on the very top of a mountain covered with timber, and near the foot of the same elevation another 'big smoke' was in sight. The two fires were said to be signals from some Indian hunters to their squaws that they had killed a moose; or, to be exact, the top fire was to signal them to come—both they and the children—as a

ABORIGINAL MAN AS CAUSE OF FIRES

moose had been killed; the lower one was built close to the dead animal, so as to lead them directly to the carcass. As the wind was blowing a gale when the fires were started, it was not long before they spread into a fierce conflagration, which swept everything before it. The smoke of this sweeping fiery furnace was seen for two days afterwards, and it burnt over a large section of good and useful timber."

It appears to the present writer that signal fires employed by aboriginal man were one of the more important historic causes of forest fires in the North.

Use of fire in gumming canoes

Throughout most of the boreal forest region, summer travel by aboriginal man on the streams and lakes was by birch bark canoe. Although admirably suited for this use, the birch bark canoe did require frequent maintenance. A canoe in use was prone to develop leaks along the sewn seams or as a result of cracks or tears in the bark. Repairs were made at camping places or along the way with spruce gum. Application of the gum required heat and this necessitated fire. Ritzenthaler (1950) in discussing the Chippewa Indian birch bark canoe indicated that the pitch used on the seams, being brittle, was continually chipping off; daily gumming during active use was a necessity.

Whymper (1868), writing of Alaskan Indians on the lower Yukon River, near the mouth of the Koyukuk River, observed that when a birch bark canoe develops a leak. . . . "the Indian goes ashore, lights a small fire, turns his canoe over, and works in the gum in a heated state. Every canoe carries a wooden vessel, or more rarely an iron pot, containing smouldering sticks and embers. This is done for a double reason, to enable them to start a fire readily, and at the same time with the smoke to keep off the mosquitoes, the pest of early summer." The same writer in 1869, p. 240, wrote that "We hired an Indian from the Nuclukayette village [an old Indian village on the north bank of the Yukon River, near the mouth of the Tanana River; the village of Tanana now occupies this site] in place of one of those from Newicargut [on the Yukon River, about 100 miles below the mouth of the Tanana River]; and he proved a good sturdy, steady-going native, with an intimate acquaintance with the great river. Several canoes again accompanied us, each with a wooden bowl or birch-bark basket of embers on board . . . [which] enabled the travellers to raise a fire ashore at camp-time, or when their craft required repairs."

HISTORICAL CAUSES OF BOREAL FOREST FIRES

Bell (1889), who spent over 30 summers in the boreal forest of Canada, regarded the gumming of canoes as one cause of forest fires. After having built a fire at a stopping point to gum a canoe it was some bother to the Indian to put it out completely before resuming his journey, and, as Bell put it, . . . "an Indian will seldom do anything except by necessity." In fairness, it should be said that this trait is by no means peculiar to aboriginal man.

Porter (1893), writing of the Indians in the Alaska interior, stated that "Wherever a camp of these people is seen on the river bank the women will be found squatting around the upturned canoes, mending the cracks and leaks with a lump of pitch or gum, which they pass slowly over the seams while blowing upon a live coal held closely against it."

The practice of the Indians along the Anvik River was recorded by Raymond (1900:34) who made a reconnaissance of the Yukon River in 1869. He wrote: "Our journey up the Anvik River was made entirely in these boats [birch bark canoes], and I found them admirably adapted to river travel. They are light and draw very little water, and though easily injured they are quickly repaired. In the bow of each canoe a little pitch and birch bark are always kept. If a boat is injured it is taken out of the water and turned upside down. A small fire is quickly made. If the hole in the boat is small, a burning brand is held over it and a little pitch melted upon it and pressed into shape with the wetted ball of the thumb. If the damage is more serious, a patch of bark is cut and fastened firmly in the proper place by a layer of melted pitch run along its edges. The natives make these repairs very rapidly and skilfully, so that an accident ordinarily causes a delay of a few minutes only."

During his military reconnaissance in the Alaska interior in 1883, Schwatka (1900:343) observed the birch bark canoes of the natives and wrote that "A covering is then made of birch bark, fastened, wherever joints occur, with stitches made by splitting small spruce roots, which are very flexible, and the cracks are then closed with pitch, put on with a firebrand, in the same way that solder is used."

In his studies of Ingalik material culture, Osgood (1940:190-191) learned the technique used by these Indians [occupying the area between the villages of Anvik and Holy Cross on the lower Yukon River, and adjacent country] in applying spruce gum to their canoes. He wrote "In applying glue to the seams of a bark canoe, the worker first smears it on thickly and then squeezes the lumps between the thumb and index

ABORIGINAL MAN AS CAUSE OF FIRES

finger to stretch the glue out along the seam or row of sewing holes to be covered. If the gum cools before being properly spread, the Indian heats it by holding close to it the red hot end of a rotten willow that has been in a fire."

The extent to which use of fire in gumming canoes by aboriginal man led to forest fires in the boreal region can never be known with certainty. We do know that forest fires are easily started in the boreal forest during the summer period and we also know that the widely used birch bark canoe required frequent maintenance in which fire had to be employed. Under these conditions it seems that occasional forest fires were inevitable; a contrary view would necessarily attribute to aboriginal man a degree of care in the use of fire that seems quite incredible.

Use of fire in hunting

Aboriginal man, in various parts of the world, recognized fire and smoke as useful agents in hunting. The general situation was described by Hodge (1907:581) as follows: "In America, as throughout the world, as soon as men came into possession of fire the conquest of the animal kingdom was practically assured. The Indians used smoke to drive animals out of hiding, torches to dazzle the eyes of deer and to attract fish and birds to their canoes, and firebrands and prairie fires for game drives." Evidence that aboriginal man, dwelling in the boreal forest, used fire in hunting is fragmentary and, to some extent, conflicting.

The earliest report of the use of fire by aboriginal hunters in Alaska may be that of Zagoskin who was on the Kuskokwim River in 1844. Zagoskin was near the present village of Sleitmute when he observed a large forest fire in the direction of the Chulitna River. He later learned that it had been started by natives hunting beaver on the Agalitnak [Haliknuk] River, tributary to the Chulitna from the east. One of the native hunters had set fire to a spruce tree in which a young bear had retreated (Zagoskin, 1847, vol. 85, no. III:129; 1848-1849, vol. 2:95; 1849:446). The fire spread to the surrounding forest and a general conflagration resulted.

Abercrombie (1900:581) was in charge of an exploring expedition in the Copper River region in 1898. Writing of conditions in the vicinity of the Slana River, he noted that "Forest fires have destroyed thousands of acres of this timber. They were originally started by the Indians to burn out the dense undergrowth, which enabled them to see the large game while hunting as it passed over these burnt districts."

HISTORICAL CAUSES OF BOREAL FOREST FIRES

L. L. Bales, an early Alaskan guide and mail carrier, described the caribou "fences" he encountered in the Birch Creek, Charley River, Seventy Mile River and Forty Mile River country of Alaska. Fences in the form of a gigantic "V" extending out thirty or forty miles were built to turn or direct the migrating caribou and bring them to the killing grounds. Bales wrote: "This fence building is made easy, as the country is rolling foothills covered with a scattering growth of birch and evergreen timber, from four inches to a foot or more in diameter, the most of it being from four to six inches through. Every few years the natives fire this timber, which usually stands on damp, moss-covered ground and is only deadened by the fires. It does not rot quickly and is very tough and strong and runs from twenty to thirty feet long. These dead trees are easily pulled up or pushed over after being fire killed as they are not deep rooted" (Bales, 1904).

Osgood (1936:27) reported that previous to contact with white men the Kutchin Indians. . . . "did not fire the country to drive game but sometimes accidental fires burned over wide regions with the same result." The general territory occupied by the Kutchin involved the Mackenzie River flats, Peel River, the upper Porcupine River, the Crow River-lower Porcupine River, Black River, Chandalar River, Birch Creek, and the Yukon flats. Osgood (1937:32) also reported that "The Tanaina do not set fires. One man said that animals smelling smoke would never come back." The territory occupied by the Tanaina is the region about Cook Inlet, Alaska. The present writer hesitates to accept these statements as an accurate indication of the practice of the Kutchin and Tanaina Indians. It should be recognized that a feeling of guilt is, at least occasionally, associated with the use of fire in hunting. When this situation exists, informants, whether Indians or white men, may be hesitant to admit practices that may be regarded as incriminating.

The use of fire by Indian hunters in the boreal forest of northwestern Canada is suggested by some writers and denied by others. W. F. Wentzel, in a letter to the Hon. Roderic McKenzie, written at the Forks of the Mackenzie River, March 27, 1807, stated that "The banks on both sides are high and barren, which is supposed to be occasioned by the great fires made in the spring season by the inhabitants to clear the country of underwood, in order to enjoy more ease when hunting" (Masson, 1889:77-78). Writing of the Cree Indians, Maclean (1896:78) stated as a fact that "The natives were in the habit of burning the prairie and the woods, the former in

ABORIGINAL MAN AS CAUSE OF FIRES

the spring to destroy the old grass and secure tender and early grass for their horses, and the latter for the purpose of driving the animals they were hunting into the water, where they could be more easily captured." On the other hand, Russell (1898:9), who had hunted moose with Cree Indians near the mouth of the Saskatchewan River, presented an opposite view. Russell wrote, "I suggested fire-hunting to my companions [Creeps], who declared that they would immediately leave the neighborhood, if we attempted it, and that the Indians never resorted to this method of hunting."

Keele (1905), writing of the country between the Pelly River and McQuesten River in Yukon Territory, observed that the vestiges of ancient Indian camps were often encountered in the district; he stated that Indians were apparently quite numerous long before the coming of white man. Keele thought that "It is probable that the Indians burned large areas of forest for hunting purposes, for in the clearings thus made the moose is easily seen and stalked."

McKenna (1908:28-29) quoted John Semmens relative to conditions along the Burntwood River, a tributary to Nelson River which drains into Hudson's Bay. "The very name of this river [Burntwood] suggests the historic fact that the natives of the country deliberately and habitually set the woods on fire, their object being to attract the deer which are known to be fond of the sweet grass which springs from the ashes of a fire swept surface. The result is that large tracts of country are denuded of their rich first growth of trees, and young forests are just coming into the middle stages of growth, while many of the hills stand bald and bare, giving silent evidence of the severity of successive visitations of the devouring flame." Stefansson (1913:10) went down the Athabasca River in 1908, traveling for days in smoke from forest fires. He stated that some of the fires were intentional, started by Indians to improve hunting; by clearing the land they could see game from greater distances.

Use of fire by Indians hunting caribou is reported by House (1909:389-390). In 1907 House, with a Taltan native guide named MacClusky, hunted in the country some 30 miles east of Dease Lake, in the Cassiar Mountains, northern British Columbia. House wrote, "We immediately started up the mountain in the direction of the feeding caribou, with the wind blowing directly over our backs toward the game. At this point Mac adopted what were to me new and startling tactics. Every few yards he rapidly lighted a small grass fire. Then enveloped in, and pre-

HISTORICAL CAUSES OF BOREAL FOREST FIRES

ceded by, a drifting haze of thin blue smoke, we steadily climbed up toward the caribou. The Indian claimed that his people always used this method of approaching caribou down wind, and that the odor of the grass smoke killed the human scent. To my surprise, there was no sign of alarm among these animals" Auer (1916:36-37) mentioned a different use of fire in hunting caribou. In 1914 he hunted in the Dezadeash River country, southwestern Yukon Territory, and saw some of the old "fences" employed by Indians in hunting caribou. Auer described the method used by the natives in making a caribou drive, as follows: "Then with much noise and even igniting trees, they would close in slowly on the caribou herds, which inevitably took the apparently easiest course between the 'fences' and were driven to slaughter by the hunters in the blind canyon."

Both Martindale (1913:115-117) and Auer (1916:132-136) describe moose drives in the Yukon Territory in which fire was employed. In each case natives were in the hunting parties, serving as guides. It is not clear, however, whether the natives or their white employers were responsible for the decision to use fire. About all that can be said is that there is nothing to indicate that fire-hunting was new to the natives or that they objected to it. The present writer has chosen to regard these two instances as examples of the use of fire in hunting by white man.

Camsell and Malcolm (1919:49), writing of conditions in the Mackenzie River basin, Northwest Territories, stated that much valuable forest had been destroyed in past years through the deliberate starting of fires by the natives so as to improve hunting.

In summary, aboriginal man in the boreal forest of America used fire at least occasionally in his hunting. In some instances, at least, these hunting fires spread and became forest fires. Statements by certain writers imply that fire was commonly and generally used by aboriginal man in his hunting in the boreal forest but the evidence for this view seems to be largely circumstantial and presumptive.

Use of fire in warfare

In the general literature one occasionally encounters allusions to the use of fire in warfare by aboriginal man. However, only one record has been found by the present writer where this practice was employed by aboriginal man living in the boreal forest.

Philip H. Godsell, fur trader, explorer, and one-time inspecting officer for

ABORIGINAL MAN AS CAUSE OF FIRES

the Hudson's Bay Company, spent three decades with the primitive Indian and Eskimo tribes of the Canadian Northwest and Arctic Coast. He recorded an account, by Chief Montaignais, a Beaver Indian, of a great battle that took place on the banks of the Peace River when the Cree Indians and their Sauteaux allies threatened to drive the Beavers from the valley of the Peace. Godsell (1938:203-207) placed the location of the battle in the vicinity of Battle River, a tributary to the Peace River, about forty miles west of Fort Vermilion. The date was thought to have been around 1760, or somewhat earlier. The Beavers and their allies occupied the north side of the river and the Crees and Sauteaux were on the south bank.

To quote Godsell: "But the fight seemed in danger of being prolonged indefinitely, or until one side or the other ran short of dried meat and provisions, when a nondescript and ragged Slavey hunter bethought himself of a ruse. Taking a flint and steel, and tying them in his long hair, he crawled through the underbrush until he reached a bend of the river out of sight of the contending factions. Slipping into the water, he swam stealthily across, and, reaching the southern shore unseen, clambered out among the willows. Cautiously he made his way towards the battleground occupied by the invading Crees. Reaching an area covered with brule and deadfall, to the west of the enemy, he struck his steel against the flint until a shower of sparks caused the punkwood beneath it to smoulder and redden. Blowing upon this, and nursing the small flame, he ignited some shreds of resinous birch-bark and tossed them into a mass of dried wood he had hurriedly gathered together. Fanned by the wind, the flames soon leapt to the overhanging boughs, and within an hour a terrific holocaust was raging through the woods, driving the terror-stricken Crees and their Sauteaux allies before it. Vainly they sought to out-distance the Great Destroyer, but the smoke and flames bore swiftly down upon them, urged forward by the fierce wind generated by the fire itself."

Godsell observed that the account of Chief Montaignais corresponded in many points with incidents reported by Sir Alexander Mackenzie, and that without doubt it had a strong foundation in fact.

Aboriginal man was certainly aware of the highly inflammable nature of the boreal forest and it is equally certain that he appreciated the destruction that a forest fire could cause. Evidently this knowledge was applied, at least occasionally, in conflicts between the Indian tribes dwelling in the northern forests. It may well be that Indians were more ready to employ

HISTORICAL CAUSES OF BOREAL FOREST FIRES

fire in warfare when in the territory of their enemies than when on or near their own hunting grounds.

Use of fire in combating insect pests

Mosquitoes and gnats are scourges in the boreal forest region during the summer. An abundant literature records the cruel punishment of both man and beast by these insect pests. The credibility of some of the accounts relating to the severity of the torture inflicted by mosquitoes is sometimes questioned, but only by those whose experience does not include at least one summer in the northern forest. It is not at all surprising that during the summer season aboriginal man employed fire and smoke in his incessant fight against his insect enemies. Neither is it surprising that this practice led to many forest fires.

During their travels, whether by water or by land, Indians of the northern forest frequently made use of smudge fires to combat their insect enemies. The carrying of smudges in canoes has been reported by various writers. Whympers (1868; 1869:240) noted the practice among Indians on the lower Yukon, stating that they carried the smouldering material in a wooden bowl, a birch-bark basket, or, more rarely, an iron pot. Emmons (1898) observed that the Indians of the Alaska interior. . . . "paddle with a smudge on a square of turf in the bow of the canoe." Rickard (1909:260) observed the practice on the Tanana River. Morice (1910:441) also reported the custom, as follows: "As their [mosquitoes'] company is anything but pleasant, some tribes, like the Yukon Dénés, will occasionally be found travelling with bowls of embers in their canoes to keep them off. In ancient times, when the starting of a new fire was quite an operation, this precaution was also intended to obviate the tediousness attendant upon each repetition of the process. Some sort of twisted strings of the inner bark of a few trees, which smouldered without getting extinguished was also made to serve a like purpose."

With burning material being thus carried about, aboriginal man had a ready means of starting fires ashore whenever he desired. It seems likely that, at least occasionally, some of these fires spread back from the river bank or lake shore into the forest.

The use of smudge fires during land travel must have been a much more prolific cause of forest fires. Glave (1892), with John Dalton, landed at the head of Lynn Canal and crossed the Coast Range, traveling in a northwesterly direction. Considerable of his travel seems to have been in the Alsek River drainage. He reported that "Miles and miles of blackened

ABORIGINAL MAN AS CAUSE OF FIRES

stumps marked the ravages of forest fires. The Indian, when resting on his journey and suffering from mosquitoes, sets fire to the twigs and leaves around him, creating a smoke which keeps the pest at a distance, and, when refreshed, he straps on his pack and moves along the trail, of course without extinguishing his fire." . . .

Cothran (1897), on a trip in the Lake Iliamna region, observed the use of fire by Eskimos to gain relief from the mosquito plague. "As fast as we could wipe them off and lift our hands another black, blood-sucking brood settled and clung to every part of bare skin. The knowledge of the wild native here came to our relief. The two Eskimos quickly cleared a lot of moss from the ground and made a ring of fire. Piling moss upon this and getting within the circle of dense smoke, we were free from our tormentors."

Haskell (1898:94), writing of conditions in 1896 stated that "Good timber, however, was not plentiful at Lindeman [a lake near Chilkoot Pass, in the upper Yukon drainage basin], even at this time. Much of it had been burnt off. In the summer, we are told, when the Indians are resting on their journeys and are pestered by insects, they set fire to the leaves and twigs about them and then sit in the dense smoke which keeps a few of the mosquitoes at a distance. After his rest the native goes forward without extinguishing his fire, and as the vegetation is rank and inflammable in the long summer days, the fire quickly spreads to the trees and to the forests."

The importance of smudge fires as a source of forest burning is indicated by Kellogg (1916). He wrote, "Smudges are built to keep away the mosquitoes; in fact it is commonly said by the residents [of Alaska] that mosquitoes cause more fires than any other one thing."

In combating the insect hordes, aboriginal man did not limit his operations to small-scale smudge fires. He deliberately burned extensive forest areas in an effort to get rid of mosquitoes. Schwatka was engaged in a military reconnaissance of interior Alaska in 1883. In writing of the upper Yukon River, in Yukon Territory, he observed that "Evidences of conflagration in the dense coniferous forests were everywhere frequent" and that Indians were credited with deliberately starting fires . . . "with the idea of clearing the district of mosquitoes" (Schwatka, 1885:168).

During the course of his epic journey down the upper Tanana River valley in 1885, Allen (1887:76-77) recorded that "June 12 we left Nandell's for Tetling's [old Indian villages, on Tetling River, tributary to the Tanana from the south], which bore NNE, and which is about 11

HISTORICAL CAUSES OF BOREAL FOREST FIRES

miles distance. The destruction of the natural carpeting of the earth by fire to kill the mosquitoes and gnats has caused a splendid growth of grass between the two points just named."

Alfred H. Brooks, of the U.S. Geological Survey, spent many years in Alaska and was both a careful observer and accurate reporter. Writing in 1906 (p. 42) he stated that, "Large quantities [of forest] are annually destroyed by fire, for which the natives must largely be held responsible. The writer has remarked again and again that the Alaska Indians are utterly careless about forest fires. It seems probable that they deliberately burn over large tracts in order to somewhat reduce the insect pest. That this indifference to forest fires was not learned of the white man is shown by the fact that many tracts are found which must have been burned over long before the appearance of any foreigner." Later the same author, Brooks (1911:206), in writing of the destruction wrought by forest fires in the Alaska interior, again observed that "This burning of timber is in part done purposely by both whites and natives in order to get rid of insect pests or to improve the growth of grass near their habitations. . . ."

It seems certain that the efforts of aboriginal man to combat mosquitoes and gnats with fire and smoke was a frequent cause of fires in the boreal forest.

Miscellaneous uses of fire

Fire was employed by aboriginal man for various purposes in addition to those previously considered. Some of these uses, by their very nature, must have resulted in forest fires.

Primitive man understood that fire was an agent that could be used in clearing away the forest growth. Petitot (1876:44) mentioned that the northern Athapaskans of Canada found travel easier after the forest had been burned. Seton-Karr (1891:95) met a prospector who . . . "said that the inland tribe was burning off the timber, so as to form a trail from the divide down the Altsehk [Alsek River, in the Mount St. Elias region] in anticipation that the advent of white men would deliver them from the oppression of the Chilcats." De Windt (1904:230) while traveling on the Yukon River, between Rampart and Circle City, in 1902, observed that the natives were constantly engaged in clearing and burning the woods with the result that the atmosphere was smoky most of the time.

The stone axe possessed by aboriginal man was not a particularly good tool for cutting down trees. It is not surprising that fire was used for this operation. During his travels in Canada, de Charlevoix

ABORIGINAL MAN AS CAUSE OF FIRES

(1761:126) observed that, "These people [Indians], before we provided them with hatchets and other instruments, were very much at a loss in felling their trees, and making them fit for the uses they intended them for. They burned them near the root, and in order to split and cut them into proper lengths, they made use of hatchets made of flint which never broke, but which required a prodigious time to sharpen." Morice (1895:47) reported a similar practice among the Western Dénés in Canada, "It must be noted also that, among the Carriers, such instruments [adzes] were possessed by the notables and a few wealthy heads of families only. The common people had recourse to fire to cut their provision of wood. After having freed the main roots of a tree of the earth adhering thereto by means of slight excavations underneath, they would light there a small fire with vegetable matter with the result that the tree would inevitably topple over at the latest on the morrow thereafter." Tree felling by the Ingalik on the lower Yukon River in Alaska, as reported by Osgood (1940:97), involved use of both the stone axe and fire. Quoting Osgood, "In order to cut down a tree with the ax, a smooth-grained spruce is found by peeling off the bark. The worker then gets down on both knees and cuts into the trunk close to the ground with his ax. The blows of the ax on green spruce wood really only smash the fiber to about one inch in depth. The pulp fibers are then burned with blazing sticks. The process is repeated until the tree can be pushed over."

Fire was also used in "cutting up" trunks of fallen, or felled, trees. This was sometimes necessary when preparing fuelwood or when timbers of certain lengths were needed, as for making rafts. Morice (1895:47) described in some detail the "cutting up" of trees after felling: "Then the smaller limbs were trimmed off either with a hard stick, with a stone club if any was at hand, or, among the Babines, with a bone or horn implement specially fashioned for the purpose. Smaller trees were next crossed over the trunk at the proper intervals to give the desired length to the pieces of wood, after which a fire was started at each point of intersection and maintained by the children or the women until both the larger and smaller trunks were burned asunder." A similar practice was employed by the Athabascan Indians in the Alaska interior, according to the late Alfred H. Brooks. In an account, published posthumously, it is recorded that "When a river had to be crossed in summer, a raft was built. Fallen spruce was used before the days of axes and was fashioned into right lengths by burning if necessary" (Brooks, 1953:120).

Aboriginal man, like white man, preferred dry fuel to green fuel and

HISTORICAL CAUSES OF BOREAL FOREST FIRES

obtained it in the easiest way possible. By burning the forest he not only provided a source of seasoned, dry wood but he also reduced, or eliminated, the work of cutting the trees down. Spruce in the boreal forest is characteristically shallow rooted and following a fire many of the trees, with roots burned off, either fall to the ground or may easily be pushed over. Petitot (1876:43) reported that the Athapaskan Indians did not hesitate a moment in firing the forest to provide a source of dry wood. The fact that the fire might ravage the forest over a distance of several miles was not, according to Petitot, a matter of any concern to the Indians.

The use of fire by Indians to burn off the ground around caches as a protection against damage by animals was observed by Krause in 1881. At that time the Chilkat Indians annually journeyed to the upper Yukon region to trade with the Athapascans. Krause (1956:135) stated that "Part of the food carried along is deposited in caches. To protect it from bears the grass is burnt off around the cache. The burnt smell is supposed to keep them away, and, as a matter of fact, our deposits were untouched in spite of the numerous bear tracks round about." No other reference to this practice has been seen by the present writer so there is no basis for regarding it as at all general.

The use of fire by Indians to encourage the growth of blueberries (*Vaccinium* spp.) or other wild fruits is occasionally mentioned by writers concerned with conditions in regions to the south of the boreal forest. For example, Bigsby (1850:207), writing of the Lake Superior region, noted that "The Indians burn large tracts of pine barrens in order to favour the growth of very useful autumnal fruits." The present writer has encountered no evidence, however, that would suggest that aboriginal man in the boreal forest used fire for this purpose.

Perhaps the most incredible of all uses of fire by aboriginal man was the deliberate burning of the country occasionally "just for fun." During his studies of the Ingalik on the lower Yukon River, Cornelius Osgood was told by a native informant that "People burned the country . . . sometimes just for fun . . . but not for game."

Fire and "burning stones" were commonly employed by Indians of the boreal forest in shaping various wooden tools, such as wedges, mauls, boxes, wooden eating dishes, canoe-bailing spoons, digging sticks, etc. Most of this manufacture probably took place in the villages or camps and did not, except rarely, lead to forest fires.

WHITE MAN AS AN HISTORICAL CAUSE OF FIRES

WHITE man enjoys the unenviable reputation of having been a major cause of forest fires in the North. No single class of men can be singled out as being primarily responsible for this reputation, nearly all walks of life are represented. The list of "fire-setting travellers" given by Bell (1889) is reasonably inclusive: "These include fur traders, missionaries, surveyors, explorers, prospectors, etc. and, nearer to civilization, railway builders, common-road makers, lumbermen, bush-rangers, and settlers."

Carelessness with fire seems to have been the rule rather than the exception. This is indicated by the frequency with which carelessness is mentioned in the literature (Hallock, 1894:55-56; Shaw, 1899; Knapp, 1904; Emmons, 1905; Keele, 1905; Brooks, 1911:206; Bennett, 1921; Morton, 1939; and many others). Shaw, writing of the Copper River region in Alaska, remarked that "There is no doubt that in many cases the fires which destroyed them [the forests] were purposely set, and during the late gold fever flames were to be seen in the summer months on all the mountain sides, where they looked at night like the outpost lamps of a great city." In 1686, on June 25, Captain John Abraham and four others were sent out from York Fort to explore the Churchill River, tributary to Hudson's Bay, from the west. Morton (1939:105-106) reported that these explorers started a fire that burned the forest for eight days.

Carelessness with fire in the boreal forest was also well known in Europe and Asia. Acerbi (1802:229, 280) and Clarke (1824:381) both observed it in the Scandinavian countries and Pohle (1917) stated that in northern Russia as well as in Siberia, forest fires burned year after year everywhere that people occurred.

The role of white man in forest burning will be examined more closely in the pages that follow.

Use of campfires

Indications are that white man was anything but careful in his use of fire when he stopped to camp in the boreal forest. Head (1829:314) observed this during his early travels in Canada, noting that camp fires

HISTORICAL CAUSES OF BOREAL FOREST FIRES

were usually lighted against the fallen trunk of a tree and left while still burning.

The earliest report of a forest fire in Alaska resulting from carelessness with fire seems to be that of Zagoskin who traveled on the Kuskokwim River in 1844 (Zagoskin, 1847, vol. 85, no. III:32; 1848-1849, vol. 2:73; 1849:462). He reported that the country adjacent to the old Russian trading post of Kolmakof, on the north bank of the Kuskokwim River, had been deforested by fire in 1843. The fire was started by a Russian who smoked some beaver hams and did not consider it necessary to extinguish the fire, even though the weather was very dry at the time. A huge forest fire developed that raged for three days.

During 1885 Cantwell explored the Kowak (Kobuk) River in northwestern Alaska. He recorded an incident that illustrates how easily fires spread in the North. "At our noon halt a lighted match was carelessly thrown down on the dry moss of the tundra, and shortly after leaving we saw it had set fire to the inflammable stuff. When we stopped to camp at night I climbed a neighboring hill and saw that the fire had spread until it covered acres and acres of ground. Nowhere in the world probably will forest fires spread so quickly as here, and I felt considerable anxiety to know where this conflagration would end" (Cantwell, 1887:36).

Occasionally travelers in Alaska were victims of their own carelessness with fire, or of the carelessness of others. Pierce (1890:127-128) first went north in 1877 and spent thirteen years in travel and exploration in Alaska. He reported that near the mouth of the Stewart River, in Yukon Territory, "We embarked and went to the mouth of the river, where we had cached the supplies for our return, only to find the most of the provisions destroyed by fire. The fire had got out from the camp fires of the men who had gone before, and had destroyed fully two-thirds of the provisions and badly damaged the remainder. The situation was unpleasant." While ascending the Yukon River, between the Stewart and Pelly Rivers, more trouble was encountered by Pierce's group. "The parties ahead of us had done us a great deal of injury in being so careless with their camp fires. They had not only burnt our provisions, but had allowed their fires to get out all the way up the river. This had scared away the game; and where there was game when we came down, and we expected to get some when going back, there was not a track to be seen."

Stratford Tollemache ascended the Stikine River in 1898 and while camped on Quiet Lake, in northern British Columbia, nearly lost his pro-

WHITE MAN AS CAUSE OF FIRES

visions and supplies when a forest fire swept the area. He wrote as follows: "Two Americans who had arrived at the *portage* [from the Nas-kutla River to Quiet Lake] a couple of days previously were transporting their supplies to the lake, and having made a camp-fire to cook their mid-day meal had omitted to extinguish it before leaving the place. The fire must have spread to some dry brush, and as practically no rain had fallen for a considerable period, the brush had become as inflammable as tinder, so that forest fires would commence very easily. The next morning we packed our supplies in the boat and started down Quiet Lake. The fire, which had spread rapidly during the night, now extended over a considerable area, and was blazing and roaring and crackling, the sky being shrouded with dense smoke" (Tollemache, 1912:49). Later, while prospecting on a side stream of the Big Salmon River, about 80 miles below Quiet Lake, Tollemache's party burned up their own camp through carelessness. One evening on returning to their camp they found it completely burned away. In the words of Tollemache (p. 51) "This particular spot happened to be covered with deep moss, which is always very treacherous, as a fire will occasionally work along under the moss in smouldering condition, without showing any indication on the surface, and may break out again some distance away. In northern regions the moss is extremely abundant and may extend for a couple of feet or more in depth. In this case we had apparently extinguished the camp fire by pouring water over the spot, but some sparks must have been smouldering underneath, and had gradually extended until they reached the tent and supplies. . . . After separating what was eatable, we could only collect enough for about three meals, the remainder being too burnt and scorched for purposes of food, while our tent, blankets, spare clothes, etc., had all gone up in smoke."

In 1898, while enroute from Lake Laberge to Dawson, Price (1898: 148-150) was impressed with the number of forest fires. He recorded that . . . "on one occasion we appeared to be passing through a positive zone of fire, and for two whole days smoke obscured the sky to such an extent as to give the impression of a dense fog, through which the sun, completely denuded of its rays, shown a deep dull red. All this immense and irretrievable amount of destruction of fine timber is, without any doubt whatever, caused by the thousands of prospectors and others who have passed this way since the beginning of summer. They stop to camp or cook a meal, light a fire, and, when they have done, off they go,

HISTORICAL CAUSES OF BOREAL FOREST FIRES

leaving the glowing embers on the ground, where the slightest breeze blows them amongst the dry moss; and in an incredibly short time a big blaze ensues, which spreads from tree to tree with a rapidity that must be seen to be believed, and which never stops until it has completely burnt itself out."

At the peak of the gold rush a tremendous amount of forest burning occurred. One writer, who was on the upper Klutina River, above Klutina Lake, described the scene in 1898 as follows: "At night camp fires were visible in almost any direction one could look. The moss and brush by this time had become very dry, and as a result of the carelessness of campers in leaving their fires, forest fires began to rage along the valleys. Even the green tops of the spruce trees would burn like tinder, and the flames would shoot upward into the sky for a hundred feet above their tops" (Margeson, 1899:117). Abercrombie (1900:569-570) was in this same region in 1898 and . . . "noticed that in many places the moss was dead and dry as punk, so that when a fire was started for camping purposes it was impossible to put it out. The small, dry roots of the moss would smolder for days and weeks, until a favorable opportunity would fan it into a blaze." To Abercrombie "The entire valley seemed to be on fire, which made travelling through the timber very dangerous. . . ." Three hundred miles to the north, that same year, forest fires were also common, and their cause was the same. Along the Yukon River, above Circle City, Hitchcock (1899:92) wrote that "Smoke on all sides fills the air, as camp-fires are built and not extinguished, and the flames slowly climb the mountain-side, destroying the much-needed wood, and spoiling the picture otherwise so beautiful."

The preceding accounts indicate clearly that white man was most careless with his camp fires and was an important historical cause of numerous and widespread forest fires. Further evidence, if wanted, can be found in the writings of Brady (1902:34), Witten (1904:88), Keele (1905), Moffit and Stone (1906:50), Camsell and Malcolm (1919:49), and Davis (1933:83).

Use of fire to provide dry fuelwood

It was not uncommon for fires to be set deliberately in order to provide a supply of dry fuelwood. Forest fires in the North usually only kill the trees, not consuming them. The standing boles season and are usable for fuel for years.

Knapp (1904:132) described the situation as follows: "In the immediate neighborhood of a mining gulch a forest fire is, in a way, a distinct advan-

WHITE MAN AS CAUSE OF FIRES

tage to the miner, for it does not completely destroy the trees, but it chars and kills them and causes them to dry, and the wood thereby becomes better suited to burn and more useful for carrying on mining operations."

The practice of setting the forest afire to gain a supply of dry fuelwood was observed by Erdmann (1909:105) in the Circle City district and he regarded it as a shocking evil. Coming from Germany where forest protection and forest management had long been practiced, Erdmann found the deliberate destruction of the forest incomprehensible.

Brooks (1911:206), too, deplored the wasteful practice, noting that "Many a white man has deliberately started a forest fire which swept over miles of country, solely that he might obtain a few acres of dry wood for winter use. If this willful waste does not stop, the time is not far distant when there will be a scarcity of timber even for local use."

In 1915 the so-called Kennecott fire, presumably set on a windy day by one man using oil-soaked rags, burned all the timbered country between the Kennicott and Nizina Rivers. This fire was reportedly set to kill the timber so as to provide fuelwood for sale at the Kennecott mine; about 64,000 acres were burned (Lutz, 1956:15).

The full extent of forest destruction by fires deliberately set by white men to gain a supply of dry fuelwood can never be known but it must have been very great.

Use of fire in combating insect pests

White man in the boreal forest suffered no less from mosquitoes and other insect pests than did aboriginal man. Like aboriginal man, he employed fire in his efforts to combat the pests.

Knapp (1904:132), who lived at Rampart City on the Yukon River in Alaska for four years, noted that "It is no uncommon occurrence for white men during the summer season to start forest fires to obtain relief from the mosquitoes." Witten (1904:88) recognized that forest fires were of very frequent occurrence in the Alaska interior during the summer months and thought that . . . "they originate largely through camp fires, as has been suggested, possibly from a desire on the part of prospectors and others to drive away mosquitoes, which are such a pest throughout all the river regions of Alaska." On the Kenai Peninsula, Moffit and Stone (1906:50) saw extensive areas that had been swept by forest fires and stated that in some areas the burning . . . "was done purposely to kill the moss and destroy the breeding places of mosquitoes and flies."

HISTORICAL CAUSES OF BOREAL FOREST FIRES

Brooks (1911:206) remarked that "It is no exaggeration to state that hundreds of square miles of timber have been burned off in the Yukon basin during the last decade. This burning of timber is in part done by both whites and natives in order to get rid of insect pests or to improve the growth of grass near their habitations, and is in part due to carelessness." Deliberate setting of forest fires in Alaska to get rid of mosquitoes was also reported by Moffit (1912:17). In 1935 Moffit observed that in the Ton-sina district in Alaska "Many square miles of this timber was burned by the early prospectors and travelers, who were . . . annoyed by the myriads of mosquitoes and flies which it harbored." Kellogg (1910:22) stated that "Smudges are built to keep away the mosquitoes; in fact it is commonly said by the residents that mosquitoes cause more fires than any other one thing."

The practice of combating mosquitoes in the northern forests with fire and smoke was common in other parts of the world. Clarke (1824: 381-382) reported the custom in Scandinavia stating that the Laplanders . . . "leave large fires burning in the midst of woods, which they have kindled to drive away *mosquitoes* from their cattle and from themselves: therefore the conflagration of a forest, however extensively the flames may rage, is easily explained." In his narrative of an expedition in Siberia in 1820-1823, Wrangell (1844:12-13) wrote of conditions along the Lena River. "These forest-fires often desolate hundreds of wersts, and almost always originate in the carelessness of hunters or travellers, who neglect to extinguish the fires which they have lighted to dress their food, or to drive away the clouds of mosquitoes which darken the air, and are an almost insupportable torment."

Use of fire in signaling

When white man penetrated the boreal forest he quickly adopted aboriginal man's custom of using fire signals. They were used to communicate with the natives and for communicating between the white men themselves.

During the course of Captain George Back's expedition to the mouth of the Great Fish River and along the shores of the Arctic Ocean in 1833-1835, fire signals were used more than once. While in the vicinity of Lake Aylmer, Back (1836:142-143) wrote: "The men not making their appearance, I raised a dense smoke, by firing the moss, to apprise them of my situation; and returned to the tent, passing, on my way, a white

WHITE MAN AS CAUSE OF FIRES

wolf, which was sneaking towards a deer. A smoke seen to rise from behind the sand-hills announced, shortly afterwards, the approach of the men; and at a late hour, the Indian first, and afterwards the others, came in." On a later occasion Back wrote that (p. 277) "As the Indians did not make their appearance by the following noon, the men were sent to light large fires with the moss, which by that time was dry on the neighbouring hills; a well-understood signal, which, if they were within sight, would immediately bring them in." Fire signaling was employed by Davies (1843) during his explorations on the Labrador Peninsula in 1840. He knew that the Indians used this means of communication and he caused signals to be made to determine if there were any natives in the area. Davies' signal fires unexpectedly spread over the country, burning hundreds of square miles and lasting upwards of three weeks. Richardson (1852:319) reported that while on Bear Lake River, in the Canadian Arctic, one of his men became lost; they . . . "set fire to some trees that the smoke might be seen from a distance." On other occasions, too, Richardson used fire signals to communicate with natives and observed signals that these people made.

Until his death on May 13, 1866, Robert Kennicott was associated with the Western Union Telegraph Co. Expedition to Alaska, as leader of the Scientific Corps. The manuscript diary of a member of the Kennicott party, covering the period September 26, 1865 to March 23, 1866, contains an interesting reference to fire signaling. Under date of November 4, 1865, this diary (the name of the author is unknown) contains the following entry, made enroute to Nulato on the Yukon River: "Major [Kennicott] and I went out afterwards, we ascended a high mountain, from the top of which we could see a long distance up and down the valley. About dusk we started back for camp but lost our way and we had to go on another mountain and wait until a dry tree near camp which the Major had given orders before we left to have set fire to after dark, had been lighted. We waited on the mountain until we saw the blaze and without any trouble reached camp" (Anon., 1865-1866). Another instance of the use of signal fires to guide lost men to camp is given by Seton-Karr (1887) who reported their use in the vicinity of the St. Elias Range in Alaska: "The fires we had made along its banks to guide the lost one back to camp had set the small forest ablaze."

Margenson (1899:161) recorded the use of signal fires in the Tonsina Lake region of Alaska in 1898. "We felt sure that this camp belonged to our

HISTORICAL CAUSES OF BOREAL FOREST FIRES

boys, and tried to attract their attention. We made a large fire on the beach, and also set on fire the tops of several large spruce trees, which flamed up a hundred feet or more into the air. We waited some time, but they gave us no sign that they had seen our signal fires." . . .

In 1901-1902, David Hanbury was exploring in the Great Bear Lake and Coppermine River country in northern Canada. His account makes it clear that signal fires were in common use and that this primitive means of communication was effective. On the Dease River, tributary to Great Bear Lake, Hanbury (1904:233) wrote that, "My men had received instructions to signal their position at noon by making smoke". . . "Noon came, and up went a dense column of smoke away down the river." . . . "At 3 P.M. another column of smoke showed that my men were making good headway; at 5 P.M. they showed me they had camped. Smoke signals are very useful, and a number of things can be said by a good arrangement of them." The repeated use of signal fires during the day was not unusual. Hanbury established a definite schedule for his men to keep (p. 234). "After we were loaded up I left my men to get on as best they could. They had instructions to make smoke at noon, 3 P.M., and 5 P.M. and to set the nets directly they camped, for we had nothing to eat."

Hanbury was evidently expert in reading smoke signals, discriminating between authentic signals and smoke arising from abandoned camp fires. This is indicated by the following extract (p. 235): . . . "on arriving at the height of land from which I commanded a view of the whole of the valley of Dease River, I sat down, lit my pipe, and awaited the hour of 5 P.M. for the smoke signal from my men. Smoke was to be seen to the northeast, about the place where we had camped the previous evening. To this I paid no attention. Punctually at 5 P.M. I could just discern a faint column rising through the spruce trees about where I judged the men ought to be. To this place, therefore, I bent my steps."

The evidence, fragmentary though it may be, points directly to the conclusion that white man, like aboriginal man, often used signal fires in the boreal forest and that this practice was an important cause of forest fires.

Use of fire in hunting

It is certain that white man has at least occasionally employed fire in his hunting in the boreal forest and it seems equally certain that this has led to

WHITE MAN AS CAUSE OF FIRES

forest fires. Anything like an accurate evaluation of the importance of this practice as a cause of forest fires, however, is impossible with present knowledge.

The account of Martindale (1913:115-117) is one of the few known to the writer in which the practice of fire-hunting was described by a participant. The region was the western Yukon Territory, and the year was 1912. A moose-drive was arranged and in Martindale's words, "There were many fir trees standing by themselves whose lower branches were dead, and these when touched with a match would burn and quickly snap almost like firecrackers. The flames would then rapidly shoot to the tops of the trees, making a brilliant fire accompanied by a dense smoke. There was no danger of a forest fire, as the trees that were fired were always old trees and were for the most part dead at the bottom, and then nearly always stood alone. The crackling of the lower branches could be heard from afar, and the scent of the burning wood would soon be caught by the sensitive nostrils of any moose that might be in the vicinity. Each man was to watch out so that the tree that was fired should be on a line as nearly as possible with his companion's tree. Thus they slowly worked their way towards our rendezvous. We soon could see from afar the pillars of smoke ascending to the sky, but it was some time before we saw the fire. . . . The Chief said that the wind had turned just enough to drive the moose across the river, rather than straight down to us. But my companion . . . had brought down a fair-sized moose which had come within easy rifle shot of him. The next day we crossed the river and in the same manner "drove" the other side. But once again the wind changed and nothing was accomplished." With a wind blowing both days it would seem that the assertion that "there was no danger of a forest fire" . . . might be questioned.

A similar moose-drive was described by Auer (1916:132-136) who, in 1914, hunted on the St. Clair River, tributary to the White River, in Yukon Territory near the Alaska boundary. The drive was conducted in a timbered area about a mile and a half wide and six miles long. After the guides and the hunters had reached their stations . . . "we heard a distant rifle shot as a signal, and at once, where Dixon and Albert were posted on the flanks of the plateau, a standing dead tree flamed to the heavens and then began to smoke, while Jim Baker began to ignite trees in between the flanks held by Dixon and Albert. Then the flankers and Baker began to move forward, lighting trees every two hundred yards as they progressed; and as we, who were to do the

HISTORICAL CAUSES OF BOREAL FOREST FIRES

shooting, watched the flaming torches come nearer, it became obvious that the plan was absolutely perfect for the extermination of moose."

In the opinion of the present writer these two examples of the use of fire by white man in hunting are unique only in the fact that they are recorded. Two conclusions seem justified, (1) that at least occasionally white man has employed fire in his hunting in the boreal forest, and, (2) that, barring miracles, the practice must have led to forest fires.

Use of fire to promote grass for livestock

Before the first roads were built in the Alaska interior, and for a long time afterwards, overland transportation in the summer employed pack animals. Forage for pack stock was an important consideration to early-day explorers, miners, and hunters. These men found forage abundant in areas where past fires had destroyed the forest and they proceeded to deliberately create new ones.

Powell (1900) carried out exploratory work in the Alaska interior in 1899 and wrote of conditions on Tanana Creek, tributary to the Copper River, as follows: "The prairies here were covered with good feed for the horses. In 1898 they were burned with a view of improving the quality of the feed and, in my opinion, the feed was much better on the burned portion of the prairie." He remarked that "In parts of the valley [Copper River], where the soil is sufficiently dry and where the moss and timber has been burned, is found a very heavy growth of nutritious bunch-grass."

Moffit and Maddren (1909:19), writing of the Kotsina-Chitina region of Alaska, observed that . . . "good pasture is usually found at lower elevations [below timberline] after the timber has been burned off a number of years. Some of the prospectors have provided their stock with fine feed by following this practice of burning off the timber."

Brooks (1911:206; 1953:70) was also familiar with the practice of burning the forest to obtain grass, especially in the Yukon River basin. After mentioning several reasons why forest fires were set in the Tonsina district, Copper River basin, in Alaska, Moffit (1935:8) added, "Another reason for burning the timber and especially the small brush was that the grass was given an opportunity to grow and provide forage for stock. This result may be seen in many places. Yet in spite of any benefits that may have been involved in the practice, it is true that much of a valuable resource was destroyed beyond the hope of early replacement, for trees in the north country grow slowly." Again, in the Nutzotin Mountain sec-

WHITE MAN AS CAUSE OF FIRES

tion, near the headwaters of the Tanana River, Moffit (1943:111) learned that "Many prospectors believe that it is better to burn some of these areas so as to give the ground a chance to dry out and the grass to grow. Without doubt this has been the source of many fires in former years."

Miscellaneous uses of fire

Land clearing for agricultural use was not a frequent cause of forest fires in Alaska in the period prior to about 1910; subsequently it became important. Greenfield (1893:117) made brief mention of the prospects for agriculture in the Yukon District and suggested that "The long and severe winter season and the frozen, moss-covered ground are the chief obstacles to be overcome in the raising of crops and stock. The former can never be changed, but the latter, by gradually destroying the mossy covering by burning and opening the soil to the influence of the sun and air in summer time, can be brought under cultivation in very limited areas. Many large stretches of burnt country have undergone a complete change of vegetation after two burnings within the recollection of white men now in the country."

Bennett (1921:74) made a reconnaissance of the soils of the Kenai Peninsula in 1916 and observed the destruction wrought by fires set by homesteaders to clear the land. Bennett thought that "Homesteaders should be brought to see the wastefulness of burning over more ground than is actually needed for cultivation in their clearing operations. At present the area burned is too often limited to the area favorable to the ravages of an unchecked forest fire."

Up to 1910, or thereabouts, clearing of mining claims probably resulted in more forest fires than did clearing for agriculture. Keele (1905), in a discussion of the forests of Yukon Territory, in Canada, observed that many forest fires resulted from miners who took no precaution against the spread of fire when clearing their claims.

Forest cover with a heavy growth of mosses, lichens, and shrubs made prospecting difficult, especially prospecting for lode deposits. There is no doubt that the vegetation cover was regarded by prospectors as a hindrance in their work, and, that on occasion they burned it off (Moffit, 1935:8). Graham (1935) recorded the experiences of George M. Mitchell who was prospecting in the Peel River country, Yukon Territory, in 1898. In commenting on the technique of prospecting for lode deposits, Graham (p. 132) observed that "Prospecting for this stuff [auriferous quartz veins] means hunting the veins through the rock with pick and

HISTORICAL CAUSES OF BOREAL FOREST FIRES

dynamite, after having first burned down the forest to let the surface of the rock be seen."

The travel journals of the Russian priest John Bortnovsky for the years 1896 and 1897 both refer to setting of forest fires by prospectors on the Kenai Peninsula, Alaska.

Some forest fires were set deliberately, for no better reason than just to see them burn or "for fun." Lieutenant George R. Adams was one of the men who brought the body of Major Kennicott down the Yukon River from Nulato in 1866. Adams kept a diary of the trip and made the following entry on May 28, 1866. "We then stopped and had tea on top of a hill near by we saw a lot of dry trees close together. We went up and set them afire they burned very fast and spread to some green ones and it looked as if the whole country was on fire. We could see the smoke for a good many miles after we started. . . . Passed the mouth of the Chagalook [Shageluk] river about sunset" (Adams, 1866). Another example is furnished by Chase (1947:138) in his reminiscences of Captain Billie Moore. The year was 1887 and the place was the Fortymile River, in the vicinity of O'Brien Creek. "About a half a mile from the mouth of the creek, Blanchard lit a match and thoughtlessly set fire to some dry branches lying at the foot of a spruce tree. The flames shot high up in the air, igniting the tree. The flames aided by a slight breeze blowing down the creek, began to spread rapidly. They hurried to get down to the camp. After they reached the camp and remained there a short while, Blanchard sallied forth to see just how bad the fire really was. He saw that the brush on both sides of the creek was afire. Forty Mile Creek at that point was all of fifteen hundred feet across, but the wind had scattered the fire and blown it across to the other side and came on down towards their camp."

With the beginning of road and railroad construction in Alaska, a new and prolific cause of forest fires was added to the already long list (Lutz, 1956). Writing of conditions as observed in 1916, Bennett (1921) reported that "Recently, with the widespread activities accompanying railroad construction and mining, it is generally possible in dry seasons to see from an elevated point many fires burning through the Cook Inlet lowlands and adjacent mountain slopes." Many of the large forest fires in Alaska originated on or adjacent to rights-of-way of roads and railroads; this fact is well known and the evidence still can be easily read in the vegetation cover of the landscape.

That smokers were responsible for some fires in the boreal forest cannot be doubted. However, this cause is rarely mentioned in the literature.

EARLY FIRES OF UNKNOWN ORIGIN IN THE BOREAL FOREST OF ALASKA

APPRECIATION of the extent of occurrence of forest fires in the interior of Alaska in early time requires consideration of those whose cause is unknown as well as those of known origin. Many of the authors who wrote of conditions in the boreal forest observed fires, or effects of fires, but did not record their origin. Were the causes of these fires known, most would, in all probability, be referable to aboriginal man or white man and the rest to lightning. Following is a chronicle of forest fires of unknown or uncertain origin in Alaska.

The period prior to 1868

While at Redoubt St. Michael, in Norton Sound, Bering Sea, Zagoskin made the following entry in his meteorological observations: "Foggy horizon, smell of burnt forests" (Zagoskin, 1848-1849, vol. 2, table 1). Zagoskin, in 1843, noted a burned forest on the Yukon River, below Nulato, near the present village of Kaltag (Zagoskin, 1847, vol. 83, no. III:162; 1848-1849, vol. 1:91; 1848:552). Enroute to the Unalaklik River, Zagoskin reported having walked all day through burnt forest (1847, vol. 83, no. III:162; 1848-1849, vol. 1:91). The same explorer, on the Kuskokwim River near or above the present village of Aniak, reported a burn and noted that following a fire in the spruce forest, birch came in (Zagoskin, 1847, vol. 85, no. III:127; 1848-1849, vol. 2:93; 1849:443). In the summer of 1851 a Russian mining engineer, Doroschin (1867), ascended the Kenai River with a prospecting party. He reported that he was unable to complete his work on a creek flowing into Skilak Lake because of a forest fire.

P. M. Smith, a member of Major Robert Kennicott's party, made the following entry in his diary on May 31, 1866, while on the lower Yukon [Kvichjak] River, above Holy Cross Mission: "Saw a big fire on the other side of the river. Sudarku said it was indians back on the lakes have got to lay up on account of strong head wind which the indians can't pull against" (Smith, 1866). In 1867, Theophil, a missionary at the Nushagak Mission, recorded in his travel journal that "During June and July forest fires destroyed several native villages. The air was so filled with smoke that fish died in the river" (Theophil, 1867:143).

HISTORICAL CAUSES OF BOREAL FOREST FIRES

The period 1868 to 1896

William H. Dall headed the scientific corps of the Western Union Telegraph Co. Expedition, 1866-1868, exploring the Yukon River and adjacent territory. While in the vicinity of the Ramparts on the Yukon he recorded that "Large fires were burning in the forests, and on the sides of the hills" (Dall, 1870:116). Palmer (1938), writing of the Kenai Peninsula, stated that "There were three fires, the first occurring in 1871, the second in 1891, and the third in 1910" (Palmer, 1938).

On July 9, 1881, while at sea near St. Michael, Muir (1917:117) noted heavy smoke from burning tundra southwest of St. Michael. During his remarkable journey of exploration in 1885, Henry T. Allen repeatedly encountered forest fires. On a tributary of the Tozikakat [Tozitna] River, tributary to the Yukon from the north, entering below the village of Tanana, he observed that "Surrounding our camp was an extensive flat that had comparatively recently been burnt over" . . . (Allen, 1887:95). While descending the Tanana River, above Cathedral Rapids, the following meteorological observation was recorded on June 15, 1885: "Air smoky; large fires to the west" (p. 169).

Elliott (1886:408-409) wrote that "The forests of the Kuskokvim and the Nooshagak mountains and uplands are frequently swept by terrible conflagrations, which utterly destroy whole areas of timber as far as the eye can see." In the summer of 1890, while enroute from the Fortymile River district to the Tanana River, Wells (1891) entered a burned forest area . . . "where meadow grasses grew luxuriantly and the soil was firm and rich." According to Remington (1939:153), forest fires were also common in the "Quartz Creek settlement and district" during the summer of 1890. The "Quartz Creek" referred to by Remington was in the Copper River Region, presumably tributary to the Chisna River in the Chistochina country.

Bennett (1921:72) stated that "At Kenai we were told that a big fire went over the country from the head of Tustumena Lake to the mountains in 1890. This area we were told had been previously burned, probably by the Russians, but there had been substantial reproduction at the time of the big fire in 1890. There was another big forest fire about the lower end of Tustumena Lake in 1911. Since these fires, aspen and birch have taken possession of probably more than 100 square miles of burned-over land between Tustumena Lake and Kenai River and Skilak Lake." A fire near the town of Knik, on Knik Arm at the head of Cook

EARLY ALASKAN FIRES OF UNKNOWN ORIGIN

Inlet, burned about 135,000 acres in 1893 (Lutz, 1956:15). In 1896 Spurr encountered a forest fire between Fortymile River and Sixtymile River, tributaries to the upper Yukon (Spurr, 1900b). During the same years fires burned along the entire length of Canyon Creek, on the Kenai Peninsula, covering some 34,000 acres (Lutz, 1956:15).

The period 1897 to 1915

This was a period in which the tempo of forest fire destruction was greatly stepped up. After the discovery of gold in the Klondike in 1896 there followed the great movement of prospectors and miners into the North. With the turn of the century, railroad construction and road building activity began. Forest fires became more numerous and tremendous areas of forest land were burned and reburned.

Spurr carried out a reconnaissance of southwestern Alaska in 1898. Three members of the party made the portage from the Kuskokwim River to the Yukon River and at a point about midway between these waterways noted that "Shortly after arriving at the lake we passed a large area of tundra that had been burned over during the summer—evidently in the rainless season of June and July the surface of the Tundra had become quite dry" (Spurr, 1900a:97). After a trip up the Yukon River, Hitchcock (1899:76) reported that on July 16, 1898, at a point below the village of Tanana they observed . . . "the gradual approach of a heavy fog, as we thought it, until the air become laden with smoke, and, as night came on, we saw that the mountains on all sides were on fire." On the upper Yukon the situation was similar, for on July 23, after leaving Circle City, Hitchcock (p. 92) noted that "Smoke on all sides fills the air, as camp-fires are built and not extinguished, and the flames slowly climb the mountain-side". . . Still farther up-river, in Yukon Territory, fires were also spreading over the landscape. Heilprin (1899: 215) climbed Dome Mountain but was disappointed because, "I was unfortunate in not getting the full benefit of this view, as at the time of my first crossing the atmosphere was very cloudy, and on the second [August 1898] it was so surcharged with smoke from forest fires in the valleys of Gold Bottom, Quartz, and Sulphur Creeks that hardly more than the foreground was visible."

Powell (1910:42) reported fires in the vicinity of Klutina Lake (Copper River basin) in 1898. Describing conditions enroute to the interior from Valdez, he wrote "This camp was surrounded by a heavy forest

HISTORICAL CAUSES OF BOREAL FOREST FIRES

of spruce that was on fire. At night the flames would leap to the treetops with a roar, then calm down, and presently another tree's foliage would repeat the roaring, cracking and popping. This red glaring night scene was wild and enchantingly beautiful." Schrader was in this same region in mid-August, 1898. According to his report, "The trail during much of this distance meanders over foothills, some of which are pretty rough. At the time of our passing it was much obstructed by fallen, partially burned, and burning timber. West of the head of the lake [Klutina] the obstruction from this cause—the burning timber—became serious" (Schrader, 1900: 357).

During Mendenhall's reconnaissance from Resurrection Bay to the Tanana River in 1898 he repeatedly encountered forest fires. Traveling from Kenai Lake up Quartz Creek to Sunrise, Mendenhall (1900:276) recorded that "Much of the district had been burned, and dead and blackened alder snags impeded our progress and made much of the journey very laborious." Leaving Turnagain Arm, Mendenhall crossed the divide and descended Eagle River to Knik Arm. "On the second day of travel along Yukla Creek [Eagle River] we entered a region of forest fires, whose smoke obscured everything until we reached the coast" . . . (p. 279). Later, while traveling down the Delta River, Mendenhall again encountered smoke that obscured the view (p. 286). On his return trip Mendenhall crossed a burned tract in the Matanuska River valley, between Hicks Creek and Caribou Creek.

In 1899 large areas of burn were seen by Herron (1909) in the upper Kuskokwim River country. Tundra fires burned large areas on the Seward Peninsula in 1900 according to reports by Mendenhall (1901) and Brooks, Richardson and Collier (1901).

The year 1903 was noteworthy for the large number of fires in Alaska. On the Seward Peninsula smoke from tundra fires during August made topographic mapping almost impossible at times (Moffit, 1905:12-13, 72). Prindle (1905:16) wrote that "The summer of 1903 was very dry in the Fortymile region, and the hot days of June and July, hazy with the smoke of many forest fires, hardened the trails and lowered the streams till the conditions were unusually favorable for travel." Topographic work in the Fairbanks region was, however, interrupted by a dense pall of smoke from forest fires (p. 14). Dunn (1907) reported numerous fires in 1903, first in the region west of upper Cook Inlet (p. 46), again on the upper Kuskokwim River drainage (p. 125-126) and on the north side of the

EARLY ALASKAN FIRES OF UNKNOWN ORIGIN

Alaska Range (p. 134). Wickersham (1938:221) observed a burned forest on the Kantishna River during his travels in 1903; this tract had been burned in 1902.

Thousands of acres of old burn were reported in the Tonsina River valley by Abercrombie (1904). During an overland trip from Fort Yukon to the Chandalar River in the winter of 1905-1906, Stuck (1914:26) passed for miles and miles through a forest that had been swept by fire. In 1910 while traveling along the Tanana River, some 20 miles below Tanana Crossing, Stuck passed through another burned-over forest, remarking on the obstacle it presented to travel (p. 261). Eakin (1913) reported that during most of the summer of 1911 a number of forest fires were burning in the Rampart district. He estimated that fully four-fifths of the timbered areas had been burned over in the previous ten years. Brooks (1911:204-205) observed evidence of past forest fires on the piedmont plateau to the north of the Yanert Fork of the Nenana River. Much of the Tanana lowland was also reported to have been previously burnt over. On a journey from McCarthy to the White River in 1912, von Bergen (1928:204) traveled most of the time through burned forest.

Eakin worked in the Yukon-Koyukuk region in Alaska in 1913. He reported that "During the first half of the season the conditions for work were decidedly unfavorable. Smoke of forest and tundra fires obscured the landscape for weeks together, and much of the time it was impossible to discern objects more than half a mile distant" (Eakin, 1916:13). He also stated (p. 19) that "Forest fires have swept over large tracts in recent years, and in places repeated burnings have cleared the land completely. Probably half the area between the Yukon and Koyukuk rivers was burned over in 1913."

During 1915 there were many big fires in the Tanana River valley and other parts of Alaska; it was a notably bad year for fires. One fire in the Copper River basin burned from Chitina to the Kennicott River and from the Chitina River to the mountains on the north, covering 384,000 acres (Lutz, 1956:15).

This section may well be closed with the observations of Stuck (1917: 131): "Forest-fires have done vast destruction throughout the interior. Dall found large forest-fires burning in 1869, and I suppose there have been few summers since when the waste has not continued. Should the season be a dry one, the traveller is almost certain to encounter them some-

HISTORICAL CAUSES OF BOREAL FOREST FIRES

where along the course of the Yukon, and at times the journey down the river is made an almost continuous evidence of their activity, near and remote. Sometimes the whole river reeks with smoke from Whitehorse to Anvik. Immense areas have been burned over; once started, the fires sweep on until they burn themselves out or some opportune rain-storm extinguishes them."

SUMMARY

THE boreal forest of North America is especially liable to destruction by fires. It is a region in which forest fires have been extremely common and wide spreading. Lightning is certainly one of the causes of fires but man, both aboriginal and white, has been an even more prolific source.

The general attitude of aboriginal man toward fire was that of carelessness. Campfires were in general use and the evidence is that they were not carefully extinguished but frequently started forest fires. Use of fire in signaling was widespread and must have been a major source of forest fires. Wherever the birch bark canoe was used, frequent gumming of sewn seams was necessary along with repairs of cracks or tears in the bark. This necessitated making a fire for heating and applying the gum; the evidence is that this use of fire at least occasionally led to fires in the forest. Fires were at times used in hunting but this practice probably was not an important source of forest burning. On some occasions, at least, aboriginal man seems to have employed fire in warfare but evidence on this use is scanty. In his efforts to combat mosquitoes and gnats, aboriginal man generally employed fire and smoke and this led to frequent forest fires. Of the miscellaneous uses of fire by aboriginal man that occasionally must have led to forest burning the following seem most worthy of mention: clearing away of forest growth, cutting down trees, cutting up of trunks of fallen, or felled trees and killing trees for a supply of dry fuel. It seems certain that even prior to contact with white man, aboriginal man was responsible for frequent and widespread fires in the boreal forest.

White man was, without doubt, the cause of even more fires in the boreal forest than was aboriginal man. He was generally careless and possessed easier means of striking fire. Campfires left without being extinguished resulted in a tremendous amount of forest burning. The frequent practice of setting fires to provide a supply of dry fuelwood likewise led to much forest destruction. Fires set to combat the mosquito pest were so frequently a cause of forest burning that it was commonly said that "mosquitoes cause more fires than any other one thing." Use of fire in signaling was not confined to the natives; the practice was also employed by white man and is known to have resulted in extensive forest fires. White man also adopted, at least occasionally, the practice of using fire in hunting.

HISTORICAL CAUSES OF BOREAL FOREST FIRES

He burned off the forest to promote the growth of grass for his livestock, and he employed fire in clearing land. Prospectors were known to burn the forest to remove the vegetation mantle and expose the surface rock. Incredible as it may be, white man is also known to have set the forest afire just to see it burn or "for fun."

In the boreal forest there were many fires whose causes are unknown. Some of these must have resulted from lightning but it is likely that most of them were caused by man, either aboriginal or white.

It is probable that there have been fires in the northern forests ever since there were forests to burn. Destruction of timber and other values has been enormous but the boreal forest has generally shown a remarkable capacity to recover, to rise again, phoenix-like, from its own ashes.

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