DISTURBANCE HISTORY OF THE TANANA RIVER BASIN IN ALASKA: MANAGEMENT IMPLICATIONS

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ABSTRACT

The Tanana River basin in interior Alaska occupies approximately 11.9 million hectares. Forests of the basin consist of white or black spruce (*Picea glauca, P. mariana*), tamarack (*Larix laricina*), paper birch (*Betula papyrifera*), quaking aspen (*Populus tremuloides*), and balsam poplar (*Populus balsamifera*). The forests have a disturbance history that has been largely ignored in the planning process. The objective of this paper was to document the type, magnitude, and impact of disturbance on the development of the current forest mosaic. Methodology included archival research and ground truthing archival information. One case study (Tolovana River) is presented.

Documented disturbance in the basin is more extensive and varied than previously believed. Athabascan Indians and non-Athabascans used fire extensively for controlling mosquitoes and gnats, hunting, and signaling, as well as for houses, domestic heating, and cooking. Both set fires intentionally and accidentally. Wood was burned as fuel for steamboats and railroad locomotives, to produce commercial electricity, and to melt permafrost for mining. Wood was used for ties and trestles, corduroy roads, mine timbers, piling, planking, and lumber. Timber harvest often extended to the stream edge; it was often followed by burning. Smoke from fires was common during the summer. Evidence was found to suggest that timber harvest in the first half of the twentieth century greatly exceeded current levels of harvest in the interior. The importance of such disturbance is discussed in terms of resource planning and fire management.

keywords: Alaska, biodiversity, disturbance, ecosystem management, fire, fire management, fuelwood, history, mining, steamboats, Tanana River Basin, timber, transportation.

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INTRODUCTION

Disturbance, any "discrete force that causes significant change in structure and/or composition through natural events such as fire, flood, wind, or earthquake; mortality caused by insect or disease outbreaks, or by human-caused events such as the harvest of a forest" (Dunster and Dunster 1996:94), must be addressed in developing resource management plans. This paper focuses on disturbance history through the mid-1900's and its management implications for the forests and landscapes of the Tanana River basin of interior Alaska.

The Tanana River drains northwestward into the Yukon River. The basin (Figure 1) encompasses approximately 11.9 million hectares. It is bounded by the Yukon River-Tanana River divide to the north, the Canadian border to the east, and the crests of the Alaska Range to the south and Kuskokwim Mountains to the west. Extensive forests, dominated by white spruce, black spruce, quaking aspen, paper birch, and balsam poplar, form a mosaic across the landscape. The mosaic results from topography, soils, and disturbance, especially lightning- and human-caused fires, river activity, and timber harvest.

The common perception that most forests of the basin are "pristine" and largely "untrammeled" by people does not withstand scrutiny. Perusal of personal journals, U.S. Geological Survey reports, scientific or exploratory expedition reports from the eighteenth through early twentieth centuries, newspapers, and photo archives of the Alaska Polar Region Department of the Elmer E. Rasmuson Library, University of Alaska Fairbanks, reveals the magnitude and intensity of past anthropogenic disturbance. Resulting impacts substantially alter "natural" processes, including succession and later disturbance events. Present-day land and resource management plans inadequately address these impacts. Failing to recognize people's roles in the history of the forest landscape perpetuates the misperceptions of the public and professionals, including fire managers, wildlife and fish biologists, foresters, and ecologists.

The importance of disturbance is often ignored in public documents; various land management plans discuss forests, wildlife, and the landscape in detail and then use terms such as "pristine" and "natural." Little reference is made to human-caused disturbance, such as timber harvest, deliberate or accidental fire, and fire control. Managers embrace ecosystem management

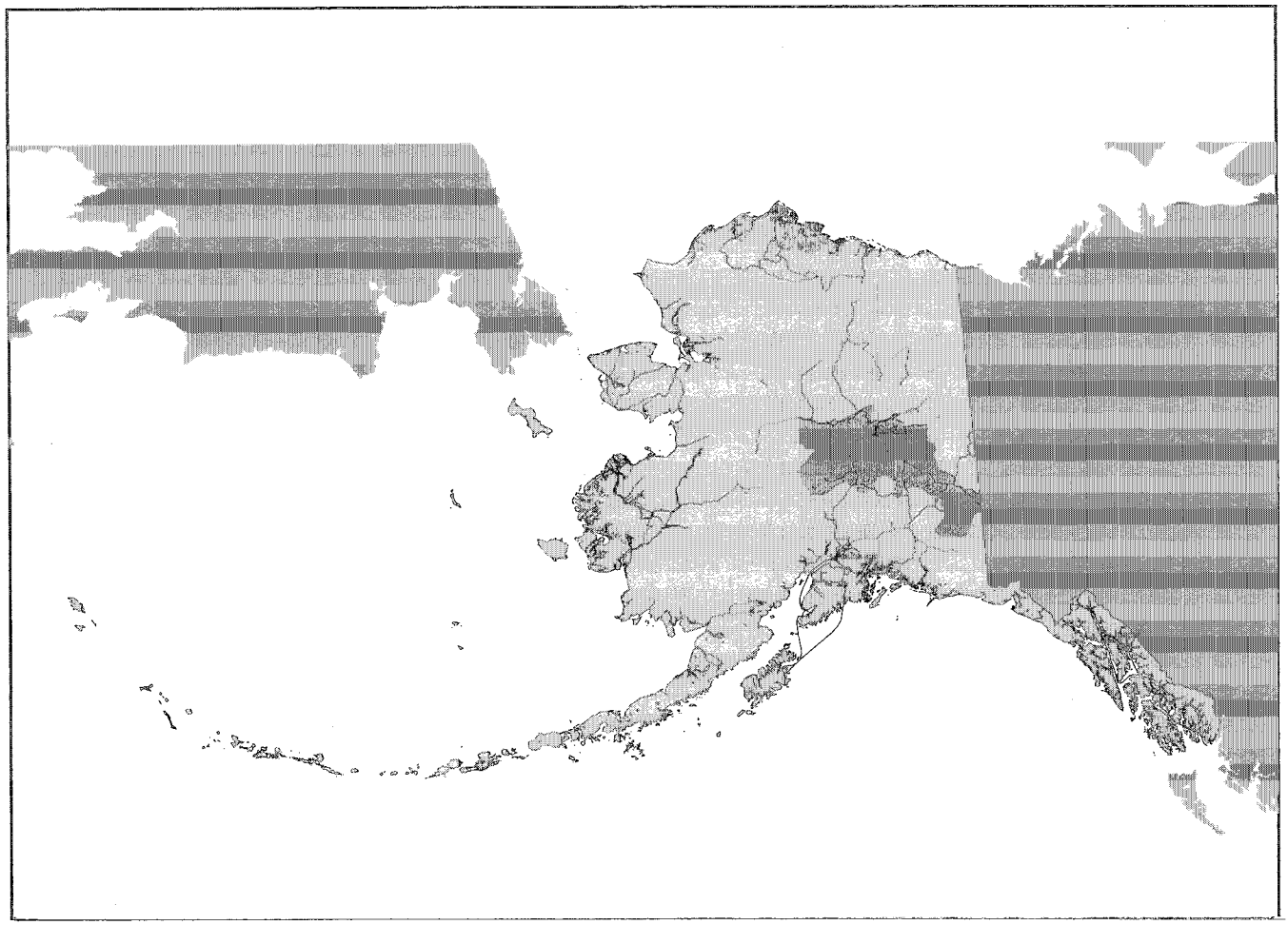

Fig. 1. Tanana River Basin in Alaska.

but fail to include in their planning the historical agents of change that contributed to the forest cover mosaic of today. Regarding past disturbances and their causes, many people ask, "So what?"

HISTORICAL FIRE DISTURBANCE

Fire in the Tanana River basin, as elsewhere in the boreal and western cordillera forests, has shaped the structure, character, and biodiversity of the forests. Fires were started by either lightning or humans. Athabascan Indians, the earliest inhabitants of the forest, were nomadic hunters, fishers, and gatherers (Rakestraw 1981). Athabascans influenced their environment through accidental and deliberate use of fire. Cooking and warming fires and fires to heat pitch for gumming birch bark canoes were abandoned while still burning. Fires were used to clear underbrush for moose drives, to kill trees to construct caribou fences or create dry firewood, and to control mosquitoes and gnats (Lutz 1959).

Fire set to combat gnats and mosquitoes probably caused more fires than any other single type of fire (Lutz 1959). The explorer Lieutenant Frederick Schwatka (1900:299) wrote of his 1883 travels: "I have never seen their equal [the mosquito] for steady and constant irritation in any part of the United States, the swamps of New Jersey and the sand hills of Nebraska not excepted. It was only when the wind was blowing and well out on a lake or wide portion of the river that their abominable torment ceased." A European ethnological collector in Alaska remarked, "No philosophy protects against the mosquito" (Sherwood 1965:14). Brooks (1903:452) observed, "While every other hardship of Alaska travel is often grossly exaggerated, it is hardly possible to do this one [the mosquito] justice. Men capable of enduring heat and cold, hunger and fatigue without murmuring, will become almost savage under the torture." George R. Adams of the Western Union Telegraph Expedition, 1865–1867, (1982:93) wrote in his journal:

> Before sleeping we put sand all around on the turned under bottom part of the canvas of our tent and folded over and tied securely the flaps of the door . . . , so that if the wind went down and the mosquitoes should come from the bush they could not get in. We slept eight hours and were awakened by the bites and buzzing of the mosquitoes, and saw many of these pests flying about the inside of the tent and on its walls. There was no opening of the

> tent that they could enter and where they came from, or how they got into the tent has been one of the mysteries of my life.

There is no wonder why Athabascans and white explorers were driven to use fire for insect control.

Evidence of the use of fire for the express purpose of controlling insects was noted in many early journals. U.S. Army Lieutenant Henry T. Allen (1887:76), a member of the party that explored the Copper, Tanana, and Koyukuk rivers in 1885, wrote:

> On June 12 we left Nandell's [east of Tetlin Lake] for Tetling's [present day Tetlin] . . . which is about 11 miles distant. The destruction of the natural carpeting of the earth by fire to kill the mosquitoes and gnats has caused a splendid growth of grass . . . The numerous lakes on each side of the trail, the meadow-like appearance of parts of the land between, with groves of cottonwood interspersed with birch, was sufficient to recall scenes of much lower latitudes . . . . A yet more pleasing fact was that there were few mosquitoes or gnats to harass us.

U.S. Army Lt. William Mitchell was sent to Fort Egbert (near present-day Eagle) in June 1903 to investigate delays in building the Alaska telegraph line. Near the Tanana River, the construction crews had serious problems with mosquitoes; mosquitoes "were nearly intolerable for both men and animals, and long smoky fires were built to keep the mosquitoes away." Animals had to be driven from the burning areas so they could feed (Quirk 1974:5). One fire burning in the direction of the telegraph line was >402 kilometers long. This is but one fire that drastically shaped the forests of the upper Tanana.

Lt. Allen (1887:78) also referred to signal fires used by the Athabascans. On 14 June 1885 on the Tanana River he noted,

> Heavy smoke caused by the extensive timber fires obscured the sun the entire day . . . The smoke had originated from signal fires which were intended to give warning of our presence in the country . . . . [As] guests departed for their different habitations each marked his trail by a signal along with us . . . In answer to the fires on the south bank new ones were started on the north, so that for nearly two days we barely caught a glimpse of the sun except through the heavy spruce smoke.

Fires were started on purpose as a way to communicate, but they were also set for no apparent reason. Adams (1982:163) wrote about an early morning activity in late May: "We 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."

Fires were set by the Indians. Captain W.R. Abercrombie (1900:581), in the Copper River basin immediately to the south of the upper Tanana basin, reported in 1898: "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 the burnt districts."

Though outside the Tanana Valley, a fire on the border between the Yukon Territory and British Columbia >161 kilometers from Juneau in mid-June 1905 was terrifying to employees of the Yukon Telegraph Line. The line went dead on 8 June 1905 and the repair crew ran into

> dozens of porcupine waddling along the trail toward us, all in such a hurry they did not trouble themselves to turn off. Then we met a colony of ants, millions of them, stepping along at a brisk pace in a solid mass about a foot wide and thirty to forty yards long . . . . Small birds also seemed panicky and were twittering and flying aimlessly around. We also met black bears who turned off the trail when they saw us and once in awhile could hear the crashing of what must have been moose . . . . [When we saw the fire], it was a regular holocaust, trees were flaming from top to bottom with a frightening roar and belching huge clouds of smoke . . . . We watched the fire sweep on, leaving only smoking ruins of the forest and our precious line which lay on the ground much too hot to touch. [My colleague, Jim Huston, joined up with me; he] had walked through thirteen miles of burned-over terrain. Muskeg was still burning in several places [as we restrung the line] and we had no doubt that much of it would go on burning even after snowfall (Lawrence 1965: 73).

Considerable debate exists as to the extent and severity of the impact of Athabascan-caused fires in interior Alaska. One side argues that prior to contact with Caucasians, Athabascans were extremely careful with fire (Rakestraw 1981). However, the above reports document Athabascans and Caucasians alike causing frequent and large fires in the Alaska boreal forest at or before the turn of the century. Fires of such frequency and magnitude had profound ecological effects on biodiversity, structure, and resilience (Rakestraw 1981), which are manifested now and will continue to be in the future.

Forest fires, lightning- and human-caused, continued into the twentieth century. Purington (1905:213) noted that "timber fires are frequent in the Interior of Alaska and are sometimes very destructive in dry seasons. There being no system of policing the forests for purposes of fire protection, the probability is that an increasingly large amount of timber will, as the population increases, be annually destroyed by fire."

The infamous 1910 western North American fires have been widely described. In one of numerous references to fires in Alaska during that summer, Capps

(1914:14) wrote, "Along the east banks of the Nenana River an old Indian rail has been cut out and widened, but numerous forest fires during the summer of 1910 were followed by the falling of timber and much of this trail is now obliterated."

OTHER HISTORICAL AGENTS OF DISTURBANCE

Fire is the most commonly recognized agent of change. However, other forces can disturb or interrupt forest successional patterns, structures, processes, and functions. In interior Alaska, these agents of change include flood, avalanche, wind, earthquake, volcano (eruption or ash deposition), melting or formation of permafrost, retreat or surge of glaciers, insects, and human activities ranging from fire control to timber harvest and deforestation.

In forests, larger disturbances generally favor colonizing species, whereas smaller disturbances favor competitive species (Dunster and Dunster 1996). Allen and Hoekstra (1992:295) stated that "removal of a tree or two, namely the practice of selection cutting, is a community consideration, for it shifts the balance of dominance. On the other hand, a clear-cut impacts the landscape. It is clear that effects on landscapes would increase with the size of the cut." Without stand-replacement events, spruce would dominate the forests of interior Alaska; such forests provide habitat for a limited number of plant and animal species. Because of catastrophic disturbance, however, forests consist of a mosaic of grasslands, shrublands, and hardwood, mixed hardwood-conifer, and pure spruce stands that further vary with the heterogeneity of the landscape. Diversity across the landscape is greater with large disturbance at infrequent intervals than with small disturbance at frequent intervals (Dunster and Dunster 1996). Historical disturbance has greatly influenced the Alaskan landscape and species diversity of today. Hunter (1990:122) referred to large forest tracts as being essential for certain long-distance migrating birds. Kessel (1998:93) stated that "spruce ecosystems compared to deciduous ecosystems have relatively low levels of productivity and low bird densities and species richness." The spruce forests of interior Alaska, however, support the greatest densities and highest levels of species richness of permanent (year-round) bird residents.

Disturbance of Forests by Rivers

Rivers are important agents of change. Rivers are of 2 types: glacially fed with broad, braided floodplains, and non-glacially fed with distinct channels. Both are subject to annual flooding due to snowmelt and storm runoff; glacially fed streams also receive glacial melt water. Second Lt. Adams (1982:94) noted in his 1865–1867 journal, "At bends where the river [the Yukon] had a clean sweep, the rushing flood cut the banks away, and we would see large trees topple over into the river and go floating down stream." He continued:

> I now realized where the drift logs found everywhere along the beaches of Norton Sound and Behring Sea came from. For ages the spring floods of the rivers had been tearing at the banks and undermining trees, taking them to the sea. Where the action of the waves grating [them] against the ice and shores, the branches [and bark] had been scraped away, leaving the smooth logs, which had lodged on the beaches .... For building purposes there was no difficulty in selecting all of the long smooth logs required, and an unlimited quantity of fire-wood, from the beaches of Behring Sea.

In 1866, Frederick Whymper, an English artist and explorer, and William H. Dall, a scientist who came to Alaska to head the Western Union Telegraph Expedition, noted that the volume of the Yukon River was increased greatly by the Tanana River and that the largest trees brought down by the spring floods came from this river. They guessed that it must be "a very grand stream" (Robe 1943). Dall remarked that the name "Tanana" means "River of Mountains" (Robe 1943:19).

Knutson (1979:185) stated in his book about sternwheelers that "boats on the lower Yukon River depended upon driftwood found on sandbars. The entire crew of a boat would turn to and gather the needed supply for the day's run." In this unforested region, driftwood was essential for power. Knutson (1979) cited the book *Klondike,* stating that the "Thlingit" tribe on the lower Yukon River cut fuelwood out of the high windrows of driftwood piled on the sandbars. They sold it to the steamboats at $3 per cord (1 cord = 3.6 cubic meters) and "thus placed themselves beyond the reach of want and starvation."

Regarding disturbance along the Tanana River, Allen (1887:81) observed:

> In places the river-bed attained a width of a mile to a mile and a quarter and contained fields of lodged timber with roots turned to the current. Some of this timber gave evidence of having but recently been washed away from the place of its growth, the roots filled in with soil still fresh. Other of it having been barked, and having lost the small boughs, showed that it was lodged prior to the breaking of the ice. Still other, from its well-seasoned appearance showed that it had been lodged many years. These trees are known to Alaskan pioneers as sweepers, as are those which have the roots fast to the banks, with the trunks and boughs in the water.... The lodging of trees is continually creating new islands and hence new channels; the river is constantly and rapidly cutting away banks, and new ones are being formed. High banks were seen which are so recent as to be covered with a growth of very small shrubbery only, while several feet below the surface may be seen the roots and trunks of larger trees, evidently not in situ.

Though not mentioned in the journals, silt deposition on the forest floor also affects the ecosystem. Following major floods, silt deposition can range from a few centimeters to >0.5 meters. Floodplain cottonwood forests, where the ground vegetation has been covered by heavy, recently deposited river silt, are essentially devoid of bird life (Kessel 1998).

Besides the action of the water, beaver also impact stream flow. Many years after Lawrence (1965:113) had left the area, he returned to the Teslin area of the southern Yukon Territory in 1930 and noted: "It was surprising how the topography of the Teslin Trail had changed. Many of the old creek beds were now entirely dry, and where much corduroy had been used in the early days the ground was hard and firm. It is astounding what the industrious beaver had accomplished." Beaver continue to influence the character, structure, and diversity of many lowland interior forests.

Disturbance of Forests by Timber Harvest

Many of the forests in interior Alaska termed "pristine" (Alaska Department of Environmental Conservation 1988) or "untrammeled" by people are in fact the result of humans harvesting timber for forest products—fuel wood, mine timbers, fencing, railroad ties and pilings, cabin and house logs, and lumber. During the late nineteenth and early twentieth centuries interior Alaska supported a thriving timbering industry. Even before this industry came into being, however, timber was being harvested.

Allen (1887:75) reported continuous harvesting of timber by the Athabascans. On 10 June 1885, he noted in his journal:

> Near Nandell's in the Tanana Valley near Tetling's the country in the vicinity of the lakes was covered with a luxuriant growth of grass, and countless roses were in bloom. The trails round about bore evidence of having been much used, and altogether a more civilized appearance had not been seen since leaving Nuchek. The houses were large, and constructed without the use of bark. To procure firewood even for cooking was not an easy task. The scarcity of timber showed that these grounds had been used many years. A very old native informed me . . . that during the winter wood was hauled on sleds from the hills.

This description suggests that timber was being harvested in a non-sustainable fashion around villages in interior Alaska.

The Sternwheelers

In the spring of 1869, a group of merchants set sail from San Francisco for St. Michael, on the lower Yukon River. On board the ship, in addition to trade goods, were parts of a small 15.2 meter (50-foot) sternwheel steamboat to be assembled at St. Michael. The sternwheeler was assembled, named the *Youcon,* and ready for river service on 4 July 1869. The little steamer opened a new era for interior Alaska (Robe 1943). The new demand for fuelwood exerted new pressure on the forest. By the end of the riverboat days in the 1950's, thousands of hectares and many thousands of cubic meters of fuelwood had been harvested along the Yukon and Tanana.

Allen's (1887:90) journal provides a hand-drawn picture (Figure 2) of natives felling dead timber to be used by the steamboats. Allen observed, "It is very interesting to watch the natives engaged in an industry comparatively new in their history, and to observe the skill that some of them display." He noted that the Tanana River was navigable about 275 miles (440 kilometers) upstream from its confluence with the Yukon River (U.S. Congress 1910).

Stuck (1917:306) documented that sternwheelers, contrary to common belief, did navigate the shallows into the upper Tanana. He stated that "every boat that attempts the upper Tanana has to use" her winch because the upper Tanana "is a bad river, not really navigable at all, and its course is strewn with the wrecks of boats." During the rush to the gold fields of the Chisana region in 1913, many boats set out from Fairbanks for the Chisana and Nabesna; "some of them reached their destination, more did not, and I counted up six wrecks of steamboats . . . lying here and there on the upper Tanana in the spring of 1917."

Figure 3 depicts the process of "wooding up" a sternwheeler at Circle City on the Yukon. Note the use of carts and especially the large volume of cordwood stacked along the river. Knutson (1979:185) discussed the scarcity of labor on the Yukon and Tanana rivers to cut fuelwood. He wrote that "eventually, with so many boats on the river, somewhere around two hundred and fifty steamers, the source of laborers for woodcutters diminished and later dried up. The boats then ran until their fuel was exhausted and tied up to the bank until everybody, captain, engineers, passengers and all, had cut enough wood for a day's run."

In some places, wood cost as much as $8.50 per cord (Knutson 1979). Knutson estimated that it took 440 cords (1,595 cubic meters) from 1 "wood-up" stop for 1 steamer; wood was burned at an average rate of 1 cord per hour. Steamboat companies would sign contracts specifying the number of cords of wood to be piled along the rivers at designated places. Contractors hired mostly Native Alaskans to cut, haul, and stack the wood ricks 6–8 feet (1.8–2.4 meters) high along the riverbanks; the steamboats would pull into the shore and "wood up." Much of the wood was cut in the winter with double-bit axes, which were preferred to cross-cut saws because the axes cut more effectively in cold weather. However, Stuck (1917: 271) reported that "Indians and whites often combine wood-chopping and fishing as summer avocations. Once when tied up for the night in the vicinity of such a camp . . . [in the summer] when there is really no night and conditions of labour are much the same all the twenty-four hours, [I was] unable to sleep for the sound of chopping in the adjacent woods . . ." Stuck (1917:271) stated that "Wood-camps and fish wheels

Fig. 2. "Felling timber for the Yukon steamboat."

are much more common along the Tanana than along the Yukon."

On the Yukon River in 1897, Capt. Patrick Henry Ray (Ray and Richardson 1897:504) reported that "the various parties in the vicinity quit cutting wood in the latter part of March and early April and came to Fort Yukon to await the opening of the river. Between six and seven thousand cords [21,720–25,340 cubic meters] were put up within 30 miles [48 kilometers] of the place." At 20–70 cords per acre [179–627 cubic meters per hectare], the annual harvest in this area would cover 85–350 acres (34–142 hectares) with cutting being done to the river's edge.

Land Transportation (Railroads and Roads)

Narrow-gauge (3-foot [0.9-meter]) railroads were an essential form of transportation in interior Alaska after 1904. Railroad construction required wood for ties, and pilings and timbers for bridges and trestles. Approximately 2,600 4-foot (1.2-meter) ties were required per mile of track (Purington 1905), which is equivalent to about 60 cords of wood per mile (135 cubic meters per kilometer). Wood was also used to power the locomotives and heat the passenger cars. Figure 4 shows stacked wood and "wooding up" a tender of the Tanana Valley Railroad. On Goldstream Creek, north of Fairbanks, where there was a good supply of fairly large timber, contractors delivered 4-

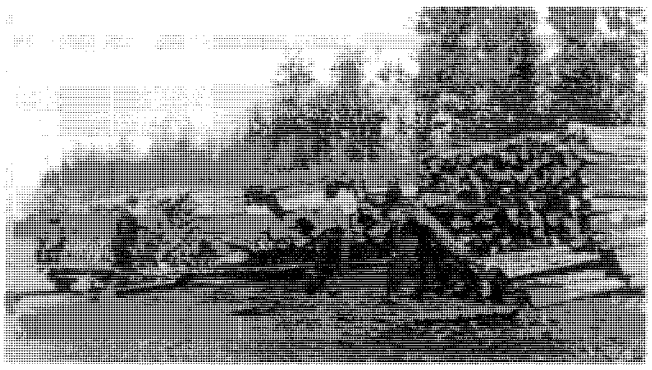

Fig. 3. "Wooding up the S.S. *Yukon* below Circle City, Alaska."

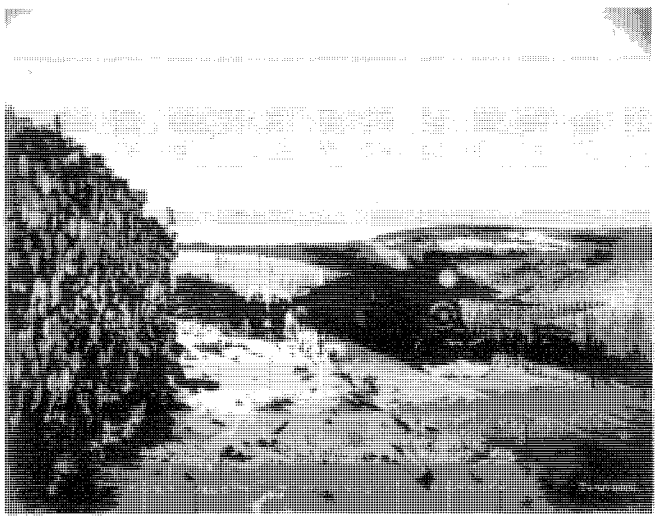

Fig. 4. Tanana Valley Railroad wooding up with No. 5 bridge in the distance.

foot spruce and birch alongside the track or right-of-way at $7.50 per cord (Wimmler 1927).

In March 1914 Congress authorized $37 million for the construction of a standard-gauge railroad to be built from tidewater at Seward to the Tanana River and ultimately Fairbanks, a distance of 760 kilometers; approximately 240 kilometers would be within the Tanana River drainage. Construction began in 1915. Eight years later, President Warren G. Harding drove the golden spike, signifying completion of the project, at Nenana on the Tanana River. (The route from Nenana to Fairbanks is considerably north of the river, ending on the north bank of the Chena River, the terminus for much of the river traffic.) The railroad used native timber much the same ways as the narrow-gauge railroads did. The railroad became the connection between the Yukon-Tanana river transportation system and the rest of the world. Sternwheelers still plied the rivers, but things began to change: the railroad brought coal and diesel fuel to replace wood and reduced the amount of freight and passenger service on the Tanana River.

The territorial Road Commission built roads in the major transportation corridors. A photo circa 1911 (Cottnair 1911–1914) showing a wooden trestle and bridge has the notation, "All timber used in construction was cut from surrounding forests." Huge volumes of local wood for bridges and corduroy roads were used throughout the valley.

Fuelwood

Capps (1916) reported that the demand for fuelwood in 1913 and 1914 was so high that nearly all trees were cut for several miles below the former timberline near the town of Chisana, in the uppermost Tanana basin. The upper Chisana and lower Chathenda Creek contained timber convenient to the mines on Bonanza, Little Eldorado, and Skookum creeks. Cordwood delivered to the mouth of Little Eldorado Creek reportedly sold for $40 a cord.

Fuelwood was used to melt permafrost to gain better access to placer gold; essentially the miners burned "their way down through the frozen ground with open wood fires" (Cole 1991:40). Later, wood-fired boilers were used to produce steam or hot water to thaw the permafrost.

Wood was essential for heating buildings of all types during the winter months when temperatures rarely rose much above −18°C for several weeks at a time and nighttime extremes plunged below −45°C. Wood was used to heat commercial buildings and homes and for cooking. Fuelwood prices in 1904 ranged from $7–$12 per cord (Purington 1905).

Fuelwood was important for electrical power. Figure 5 is a 1919 photograph that shows a portion of the $100,000 wood pile at the Northern Commercial Company's several-hectare woodyard in Fairbanks. Most of this wood was used to produce steam for electrical power generation. Note the smoke from a fire burning cutover forestland in what is now referred to as the Farmers Loop area of Fairbanks.

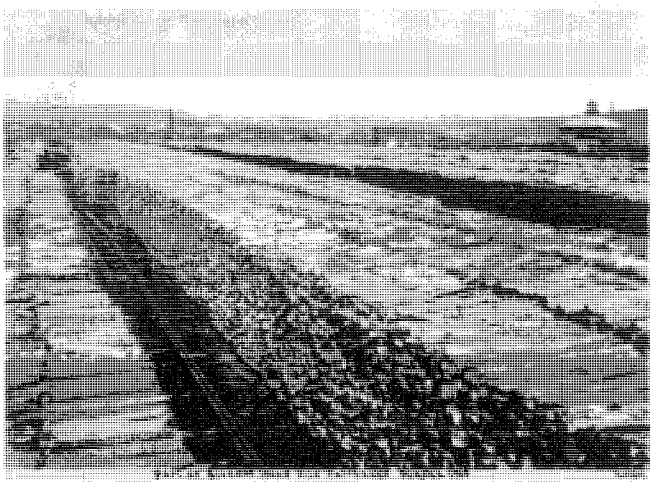

Fig. 5. "Part of $100,000 woodpile in Fairbanks, Alaska, in 1919."

Sawmills

Large sawmills, scarce or nonexistent in the Tanana basin today, were numerous in the early part of the twentieth century. During the winter of 1903, 2 men sledded a sawmill from Dawson, Yukon Territory, via the Fortymile to the Tanana, where they built a raft and floated it downstream to Chena located just downstream from Fairbanks. At the community of Chena they could not find a site available for setting up the mill so they moved it up to Fairbanks on the Chena River. By summer, they were sawing lumber for sluice boxes, flumes, mine timbers, and building construction (Robe 1943).

About the same time, a second sawmill arrived from Seattle via ship up the coast and then inland by sternwheeler. This sawmill started operation in the fall of 1903 (Robe 1943). A *National Geographic Magazine* article (Paige 1905) described the mining camp in the summer of 1904: "The continuous buzz of sawmills, turning out 50,000 [board] feet [1,000 board feet = approximately 2.4 cubic meters] of spruce lumber a day, would suggest a western logging camp. Lumber is essential in mining as is water, and with prices up to $200 a thousand the owner of a mill needs no gold mine to make his fortune."

At the town of Chisana in 1915, 2 sawmills were operating, and for a time another mill was operating at Bonanza. Price for lumber at Bonanza reportedly was $150 per thousand board feet and somewhat lower in Chisana (Capps 1916). These upper Tanana Valley mills were in what is now the Wrangell-St. Elias National Park and Preserve. To the north of Fairbanks, at Central House in the Yukon River drainage, a formerly operative sawmill was already abandoned in 1904 (Purington 1905:212). The interior logging camps usually used native timber, with prices ranging from $75–$250 per thousand board feet of lumber planed on one side. However, at Baker Creek, a tributary of the Tanana, lumber was high-priced, "most of it being shipped from the States of the Pacific slope" (Purington 1905:212).

Many of the larger hydraulic mining companies owned sawmills (Wimmler 1927). Most lumber and mine timbers were native spruce. In some remote mining districts, whipsawn lumber was produced by hand at a cost of $100–$150 per thousand board feet, which was cheaper than shipping in lumber from a distant sawmill. Freighted lumber landed at the property could cost as much as $200–$250 per thousand board feet. The cost of whipsawed lumber, however, may not have been so low; "some lumber is whip-sawed along Baker Creek in the winter, which costs about 20 cents a foot, board measure. [Hence a] small sawmill operated through a portion of the year would be a paying investment, as there is said to be plenty of timber along Baker Creek for local needs" (Purington 1905:212).

An electric sawmill and planing mill operated in Nenana in 1917; the woodyards and railroad tie yards suggest a busy forest products town (Johnson 1917). Observing 2 sawmills on the Goodpaster River in the early 1930's, Tweiten (1988:54) wrote:

> Hiring of more men to saw timber and boards for the mill building. He found plenty of timber at the mouth of Johnson Creek on Tibbs Creek. John Hajdukovich had brought up his sawmill and he let me use it. Louis Grinsmore ran the sawmill. He sawed logs on three sides for cabins. John Hajdukovich traded with the Indians up the Tanana and built his main post at what we called Tanana Crossing. John had a sawmill at Big Delta that Louis Grinsmore ran for him. He also set a sawmill up on the upper Tanana.

Construction of the Alaska Highway during World War II required piling and planking. Sawmills were established near major river crossings to provide materials for the bridges. Mishler (1986) recorded a mill at Goodpaster Village that sawed the lumber to build Fort Greely near Delta Junction. This mill closed in 1944, and the Alaska Road Commission hauled away the machinery; much of the site has been eroded by the Tanana River.

Timber harvesting after World War II continued to far exceed what is being harvested currently from interior forests. Though not limited to the Tanana basin, 69 sawmills were operating in interior Alaska forests in 1949. The U.S. Department of Interior Office of Territories (1951:113) reported that "these portable sawmills have capacities of 5,000 to 20,000 board feet per shift and are moved from stand to stand as logging progresses. The mills are cutting white spruce for lumber, dimension stock, squared house logs, and other forms. Commercial sales from public lands in past years have varied from 24 to 49 million board feet annually."

Furthermore, there is strong evidence of timber harvesting in riparian or bottomland spruce stands. Evidence also suggests that after harvest, slash fires, deliberate or accidental, occurred. Harvest has extensively impacted the landscape, and many stands today owe their existence to timber harvest.

Mines

The first reported prospectors to enter the Tanana Valley came from Fort Yukon in 1873. In 1874, Arthur Harper spent the summer prospecting, presumably near the mouth of the Tanana. Between 1874–1878, he and an Englishman descended the Tanana River in a small skin boat from near present-day Dot Lake; later he and another person ascended the river from the Yukon to near present-day Fairbanks (Robe 1943). Prospectors and miners who followed depended upon the forests for their livelihood and survival. They used wood for building cabins, for heating cabins and tents, for cooking, for flumes, and for thawing permafrost. The use of wood for thawing permafrost was extensive.

At the mining camps near Fairbanks (present-day Goldstream and Ester areas), miners thawed permafrost at a rate of 2 feet (0.7 meters) per day using wood fires, hot rocks, hot water, or a combination of these (Robe 1943). Wood was also burned to sink mining shafts and extend tunnels. To thaw permafrost required large quantities of wood; Wimmler (1927) reported that nearby forests were largely stripped and that it was often necessary to bring wood from distant points. In some areas the new railroad brought coal from the Nenana coal fields to supplement the wood supply (Robe 1943).

Cole (1991:40) described the activities of 2 prospectors working above Discovery on Pedro Creek:

> They . . . were sinking four holes at a time, burning their way down through the frozen ground with open wood fires . . . . After the muck and tundra on the surface had been cleared away, a small fire with about one-twentieth of a cord of wood was set off with paper or kerosene soaked rags. When the wood was completely burned, about one foot of ground beneath the fire was thawed. The dirt was then shoveled out of the hole and another fire was built.

Describing a mining scene in the Yukon Territory in 1897, the mining engineer T.A. Rickard wrote: "In the early days of mining in the Klondike, when the frozen ground was conquered with wood fires, 'creeks' must have looked liked an inferno" (Cole 1991:41). Such burning was very primitive. Soon small wood-fired boilers were added to the effort. Steam points were attached to the boiler; the points were then hammered into the frozen ground to be thawed by the steam. The thawing effort consumed considerable amounts of wood; photographs of the day show burned forests and early successional vegetation in the hills adjacent to the mining effort.

Large dredges were also common during the early mining. It took 4–8 cords (15–29 cubic meters) of wood per day to run a typical Tanana Valley dredge (Wimmler 1927). Many dredges used electricity; power was generated by wood-stoked steam boilers and later coal or diesel.

such depredations as this and attacks on children which are reported from time to time. Incorporated towns now have the power to regulate the keeping of dogs and the new law will apply to territory outside of incorporated towns. Whose dogs killed the pigs is of course not known, but there are plenty of dogs running loose and hungry who will attack anything they can get away with.

SAWMILLS FOR THE TOLOVANA

Will Be Erected On the Tolovana at Mouth of Livengood.

THIS SUMMER SURE

Large Timber Permits Are Taken Out by Prominent Operators.

A timber permit was applied for today in the United States land office by J. W. McCord for 2,000,000 feet of saw timber to be cut upon land lying along the Tolovana river beginning two miles below the mouth of Livengood creek and extending up the river ten miles. Dave Cascaden now has an application on file in the land office for a similar amount to be cut upon twelve miles of river land lying along the Tolovana river, beginning two miles below the mouth of Livengood river and extending down river twelve miles.

A special agent of the land office field service will visit the Tolovana camp within a few days to inspect the ground and report upon the applications.

Should they be granted a sawmill or perhaps two sawmills will be erected near the mouth of Livengood creek. Walter Fisher is making arrangements to put up a mill just as soon as navigation opens and he can obtain the machinery and boiler on the upper Tanana and get it up to the Tolovana.

our delegate has been compelled to neglect his interests here and stay in Washington winter and summer, on the job. Now comes a pause in the day's occupation which is known as the "Congressman's Hour," and he has time to come home and connect up the threads of home and business life again. For that purpose he is coming.

Just how long it will take the stage leaving McCarty today to reach Fairbanks is a question, but when it comes Delegate Wickersham will be on that stage, and the people will unite in saying: "Welcome Home."

OLNES BUSY ON NEW ROAD

Wire Suspension Bridge to Be Erected This Week.

OVER THE CHATANIKA

Funds Raised for Improvement of the Olnes Road to New Camp.

J. L. White, the Olnes merchant, stated over the phone today that his town and the surrounding district was raising a road and bridge fund to be used in improving a road into the Tolovana camp.

Cable will go out on the train today for the construction of a suspension bridge over the Chatanika river and it is expected that it will be completed within a week. This bridge will be 250 feet in length and will be substantially built. Between it and the town of Olnes the road will be bettered at once and the trail shortened and placed on higher and dryer ground.

As rapidly as possible the work of improvement will be continued, small streams bridged and heavy grades cut down by cutting new trails. Olnes means business and is going after road improvement by itself trusting to secure greater help later on. Many are donating team and hand work and those who can

Proposition.

THEIR MONEY LOST

Tried to Buy Coal Lands at a Fraction of Their Worth.

SEATTLE TIMES — Forty-seven Alaskan coal claims yesterday afternoon were added to the already long list that have been disallowed by the government. A decision of Receiver Frank A. Boyle and Register C. B. Walker, of the general land office at Juneau, canceled the claims entered by the Pittsburgh, Youngstown and Cleveland companies, aggregating 7,000 acres. More than $70,000 was paid to the government for the property, and in addition a large sum was expended in development work. The applicants for the property also expended about $200,000 on a projected railroad from the coast line of the Bering River coal field.

Of the 1,100 original coal claim-

Clark

Ho

Hilda Ba

Lunch - - 50c

Lunch and Dinner,

Dinner by the mont

Meals served at 8 a. m

Furnished Rooms.

4th Ave. Between

Fig. 6. *News-Miner* article from April 1915, "Sawmills for the Tolovana."

A CASE STUDY: THE TOLOVANA RIVER AT LIVENGOOD CREEK

The Tolovana River area, in the Tanana Valley, provides an in-depth view of timber harvest effects (Roessler 1997). This case study begins with a curious news item from the *Fairbanks Daily News-Miner* of 23 April 1915: "Sawmills for the Tolovana—Will Be Erected On the Tolovana at Mouth of Livengood Creek—This Summer for Sure—Large Timber Permits Are Taken Out by Prominent Operators" (Figure 6). No other reference to these sawmills has been found, however. Neither resource management plan for the area, the Alaska Department of Natural Resources' (1991) *Tanana Basin Area Plan for State Lands* nor the Alaska Department of Environmental Conservation Division of Environmental Quality's (ADEC) (1988) *Tolovana River and Livengood Creek Basin Use Attainability Analysis,* makes mention of any timber harvest activities or associated disturbance. No acknowledgment or consideration was made concerning the disturbance factors that resulted in the landscape mosaic of paper birch and white spruce throughout the valley. The *Use Attainability Analysis* proposed that the Tolovana Basin be classified as "high value resource management habitat" (ADEC 1988:112). For practical purposes, both documents considered the forests to be "pristine," suggesting an original state or only minimal impacts by humans.

The 2 government documents cast doubt on

Fig. 7. Photograph taken from a helicopter 60 meters above treetops at Livengood Creek, AK.

whether the timber harvest ever took place, yet the newspaper column from 1915 stated that a timber permit had been applied for at the U.S. land office for 2 million board feet of saw timber. The timber to be cut would extend from 2 miles (3 kilometers) below the mouth of Livengood Creek for 12 miles (19 kilometers) upstream along the Tolovana River. According to the newspaper story, 1 sawmill, or possibly two, would be erected near the mouth of Livengood Creek if the permit were granted. During a helicopter visit to the proposed timber harvest area in mid-September 1996, no obvious evidence of timber harvest was noted from the air. The area since 1982 has been in "full protection" from fire, meaning that all wildfires are aggressively suppressed. The fall color of the paper birch contrasted with the dark green of the spruce and gave the impression of a "pristine" forest (Figure 7). The large patches of birch suggested disturbance because birch is an early successional species. Since there was no evidence of roads, the likely suspect was fire.

The helicopter landed on a sandbar near the mouth of Livengood Creek near one of the large, single-cohort paper birch stands. Inside the stand, there was no obvious evidence of human disturbance. The ground surface had a unique characteristic: frequent, low humps covered with vegetation and leaf litter. Inspection revealed that these humps were remnants of white spruce stumps—and they were everywhere. The stump surfaces were uniformly flat, indicating that they had been cut. The timber sale had indeed occurred. On further examination of the site, charred stumps were found. Not only had the site been harvested, but it had also been burned.

The patches of birch are a second-growth forest resulting from the 1915 timber sale and subsequent harvest. Harvested stumps in the area averaged between 46–61 centimeters in diameter, suggesting a high-quality spruce stand. One mature, white spruce approximately 28 meters tall that had escaped the harvest effort and fires, was about 64 centimeters in diameter at breast height and 126 years old. This tree was probably too small to be considered for harvest and was left; being released from competition, it grew

Fig. 8. Tent camp at mouth of Livengood Creek, AK, in 1915.

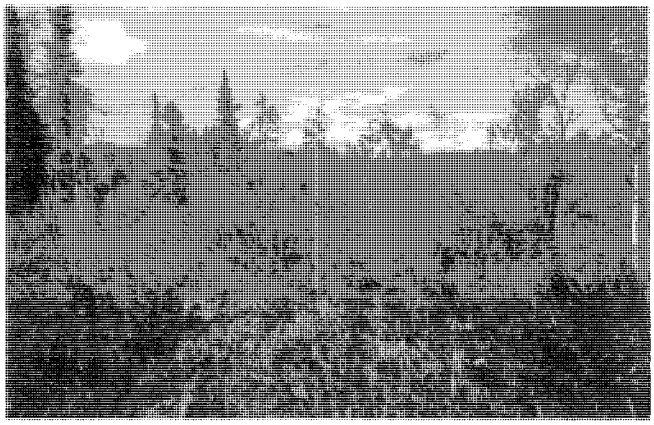

Fig. 9. River area immediately adjacent to 1997 wildfire, unburned area.

rapidly. It is in an area that also escaped the fires that loggers set to get rid of slash.

Photographs provide documentation that logging did occur. Figure 8 shows a tent camp or logger camp near the mouth of Livengood Creek and was taken in 1915 in the same direction as Figure 7, made in 1996; note the similarity of the hill in the background. Another photograph (John Zug Collection 1908–1915) shows a log cabin with the sign "Lake City Road House" at the mouth of Livengood Creek. The lack of roads suggests the trees were moved to the river in late fall or winter when the ground was frozen and covered by snow. Most likely, horse-drawn sleds were used.

Photographs taken after a fire in July 1997 about 5 kilometers south of Livengood Creek on the Tolovana revealed another possible means of transporting timber. Figures 9 and 10 are pre- and postfire photographs; the fire exposed a long-abandoned narrow-gauge railroad or tramway bed paralleling the Tolovana River that may have transported the timber from the 1915 timber sale as well as from others.

This case study shows the need to scrutinize the past land use of an area. It demonstrates that forests, even the reputedly slow-growing ones of the north, are resilient and can hide evidence of people's activities quite rapidly. This example also demonstrates that harvesting followed by fire is a valid prescription that works.

DISCUSSION

Today much debate and conflict center on forest management policies and objectives for forested landscapes; Tanana Valley forests are no exception. Many people believe the present-day landscape of the Tanana Valley is largely pristine and relatively untrammeled by humans. Evidence provided here refutes that belief. Many see only a snapshot of the landscape today and believe the forest will stay that way. The snapshot must be explained as only a temporary state and the result of past disturbances.

The public and resource managers should know the type and extent of disturbance agents responsible for the present forest landscape. During the planning process, people often ask, "What have we missed?" For the Tanana Valley, the evidence now suggests that much has been missed; humans have had a much greater impact on the landscape mosaic than previously believed. The material presented here is intended to encourage planners to seek a better, more complete history as a prelude to developing the resource plan and presenting it to the public.

Editorials, letters-to-the-editor, and public debate and pronouncement by people who demand that the forests of the Tanana Valley remain "natural" must be questioned and challenged. "Natural" is often defined as conditions existing prior to the activities of humans who disturbed the system (Jorling 1976). Are actions of Athabascan Indians any different from those of the non-Athabascans who cut wood for cooking and warming fires or burned the forest to rid themselves of the torment of mosquitoes and gnats? Jorling's (1976) definition of "natural" is flawed (Shrader-Frechette and McCoy 1993), both because it excludes humans, a key part of nature, and because there are probably no fully natural environments or ecosystems anywhere. The landscapes of the Tolovana and throughout the Tanana River Basin fit Schama's (1995: 9) conclusion that "even landscapes that we suppose to be most free of our culture may turn out, on closer inspection, to be its product."

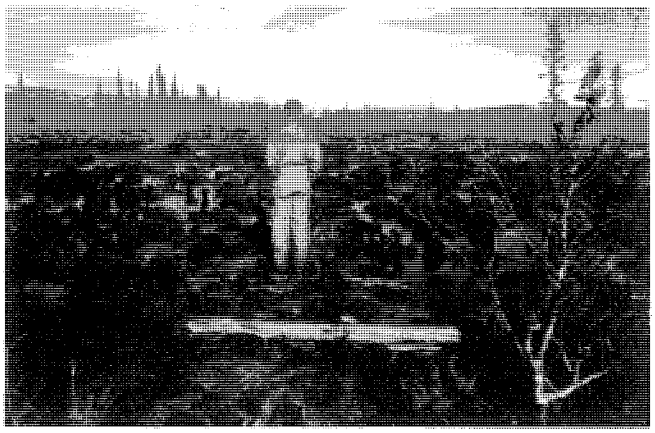

Fig. 10. Exposed narrow-gauge rail bed and ties (behind Figure 9, 180 degrees).

Disturbance is responsible for much of the variability across the landscape of the northern forest. The present-day mosaic of stands of different species, ages, and stocking levels results from a series of disturbances. The disturbance-driven patterns contribute greatly to biodiversity by creating a variety of habitats (structures, processes, and functions), which support different species. Thus management for biodiversity requires inclusion of past disturbance. Kotar (1997:270) stated, "In order to implement management strategies that accommodate a variety of natural forest development processes and community structures, an understanding of the forest history of specific regions is necessary."

Our findings suggest that if the diversity of the landscape of today is to be continued, then disturbance, whether timber harvest and/or fire, must be reintroduced into the landscape. The public and most resource managers have missed much; they have ignored the importance of disturbance in maintaining the supply of timber, wildlife, and recreational experiences for present and future generations. They have ignored the use of disturbance for maintaining forest health. They have ignored the essential role of disturbance in fire control in the urban-suburban forest although they have recognized its use for wildland areas since the early 1980's when the objective of fire control changed from suppressing fires at all costs to allowing remote wildfires to burn. Unfortunately, the rationale was to reduce fire suppression costs rather than to manage ecosystems. Commonly overlooked are the impacts of past disturbance events on fuel loadings and stand structures, which affect fire risk, severity, and control. Early successional stage hardwood forests in the subarctic are semi-barriers to wildfire. This could be one of the most important benefits arising from looking at past forest use.

Historical land use information is absolutely necessary to develop cost-effective fire management plans. This requirement does not suggest that existing fire plans for Alaska must be discarded. Current plans are far better than the full-suppression approach of the past. By including historical evidence of disturbance, fire plans can be refined and justified and control efforts improved. Timber and wildlife managers must work with fire management specialists in order to better emulate ecosystem processes. Forest managers who attempt to harvest white spruce or seral species to mimic ecosystem processes without using fire are missing an important ecosystem component.

Without considering historical disturbance in disturbance-driven ecosystems, resource plans are flawed. The public must be fully informed of historical disturbance and the implications of such disturbance, particularly when addressing such debates as harvest versus no harvest in perpetuity, areas provided full fire protection, or areas that are the result of past logging. The 3 sawmills in the Chisana created a landscape—a landscape certainly not pristine—that is now within a national park and wildlife preserve. How do resource managers manage for such conditions in the future?

We believe that "nature" will be what we humans make it to be. Botkin (1990:193) insightfully addresses this prediction: "The question is the degree to which this molding of the future will be intentional or unintentional, desirable or undesirable." In terms of natural resource management, the public and resource managers need to look to the past for answers for today and the future. The past is prologue!

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