May 8, 1990
Crawford County, Michigan

DESTROYED:
76 HOMES, 125 OTHER STRUCTURES, 37 VEHICLES, 5916 ACRES

The National Wildland/Urban Interface Fire Protection Initiative

STEPHAN BRIDGE ROAD FIRE

CASE STUDY

Prepared by the

National Fire Protection Association

Sponsored by the

National Wildland/Urban Interface Fire Protection Initiative

Members of the Initiative:

National Association of State Foresters

National Fire Protection Association

United States Department of the Interior
Bureau of Land Management
Fish and Wildlife Service
National Park Service
Bureau of Indian Affairs

United States Department of Agriculture
Forest Service

United States Fire Administration

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STEPHAN BRIDGE ROAD
FIRE
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STEPHAN BRIDGE ROAD FIRE CASE STUDY

ABSTRACT

A rapidly spreading wildfire swept across 5,916 acres of a wildland/urban interface area near Grayling, Michigan beginning around 3:50 PM on May 8, 1990.

More than 76 homes and 125 other structures, plus 37 vehicles and boats, were destroyed or heavily damaged during the approximately five hours in which the wind pushed the Stephan Bridge Road fire for a distance of more than eight miles. Losses from the fire have been estimated at $5.5 million, plus another $700,000 in destroyed timber. Extinguishment costs were more than $56,000. Due to a number of circumstances, 131 structures within the fire perimeter or immediately adjacent to it survived the fire.

The fire originated from the controlled burning of a large pile of brush and timber accumulated from recently cleared land. A burning permit was issued for the controlled burn and the burning was begun while snow covered the ground. It was later assumed that the pile was completely extinguished. However, investigators determined that the remaining fuel in the pile rekindled—seven weeks after that initial ignition—and escaped undetected from the cleared area. The resulting fire spread to other nearby ground fuels and extended into the adjacent forest before being detected by a Michigan Department of Natural Resources (DNR) aircraft pilot and observer.

Nature, especially weather, played a significant role in the ignition and spread of this fire. May is typically the month of highest weather-related fire danger in the region, a time when low rainfall, rising temperatures and high winds combine to dry out the forest and ground fuels.

Further affecting the conditions for severe fire danger were the soils in the region. With a high mixture of sand, the soil is quick to drain any precipitation, making it especially difficult for the growing vegetation to find moisture.

Then, during fire suppression, weather added another major factor affecting fire control when a cold front passed through the fire area around 8:30 that night. Strong gusting winds sent the fire out of control in a new direction, placing fire crews, evacuees and more homes in greater danger. Fortunately for the firefighters, the passing front also produced rainfall that helped contain the fire.

The predominate forest fuel in the area is "jack pine," which firefighters know during the early spring has characteristics that make it relatively easy to ignite and, once ignited, produces fire intensity that results in rapid-spread crown fires—especially when driven by significant winds—and significant fire spotting. The date of the fire coincides with the seasonal time of the lowest moisture content in the needles of jack pine. In addition to jack pine fuels, dried ground fuels composed of vegetation from the previous year contributes significantly to the combustible available fuel in the area. As a result, May is annually a time of predictable high fire danger in the region. Unfortunately, the risk of similar type wildfires exists in all of the Great Lake states during other times of the year as well.

First response to this fire was by the Michigan Department of Natural Resources (DNR). Some 22 fire departments and firefighters from local and state agencies worked to eventually contain the fire. Firefighters, law enforcement personnel and state employees combined to evacuate 500 residents from the fast-moving, wind-driven fire. Fortunately there were no fatalities and only one firefighter was injured from smoke inhalation.

Findings from the analysis of this fire indicates that the initial scope and rate of spread of the fire was greater than could be controlled by human intervention. In fact, the rapid fire spread was *greater* even than the Black Tiger fire (the subject of a previous report), which had the added factor of strong up-slope winds. The Stephan Bridge Road fire burned through flat land where preheating of uphill fuels was not a factor. Up-slope winds and dry, combustible fuels are known to contribute to rapid fire spread in places such as Colorado and California, but the Stephan Bridge Road fire reminds homeowners and fire management personnel that combinations of several factors of terrain, weather, fuels and home construction can make homes susceptible to loss from wildfire in many other parts of the country as well.

This wildfire represents yet another increasingly common example of the risks of building homes in areas of scenic but combus-

More than 76 homes and 125 other structures plus 37 vehicles and boats were destroyed or heavily damaged.

tible vegetation. Northern Lower Michigan is an area with a long history of wildfires, yet people continue to build new structures dangerously close to this vegetation and too often take little or no precaution to protect themselves against known risks.

Despite increasing concern and prevention efforts by state, federal and local fire protection agencies in Michigan, and despite the mobilization of so many firefighters, this fire became the most destructive fire in Crawford County history.

Many publications offer guidance to the residents and recreational users of wildland/urban interface areas. A previous publication in this series of reports, *The Black Tiger Fire Case Study*, also provided details on the factors leading to that destructive fire. Proposed NFPA 299, *Protection of Life and Property from Wildfire* provides detailed criteria for use in any locality.* Most homeowners, however, remain not fully aware of, or are insufficiently concerned about, the problem. As for the residents affected by the Stephan Bridge Road Fire in Michigan, they have learned a new, higher respect for the power of wildfire. Unfortunately for them, the cost was also very high.

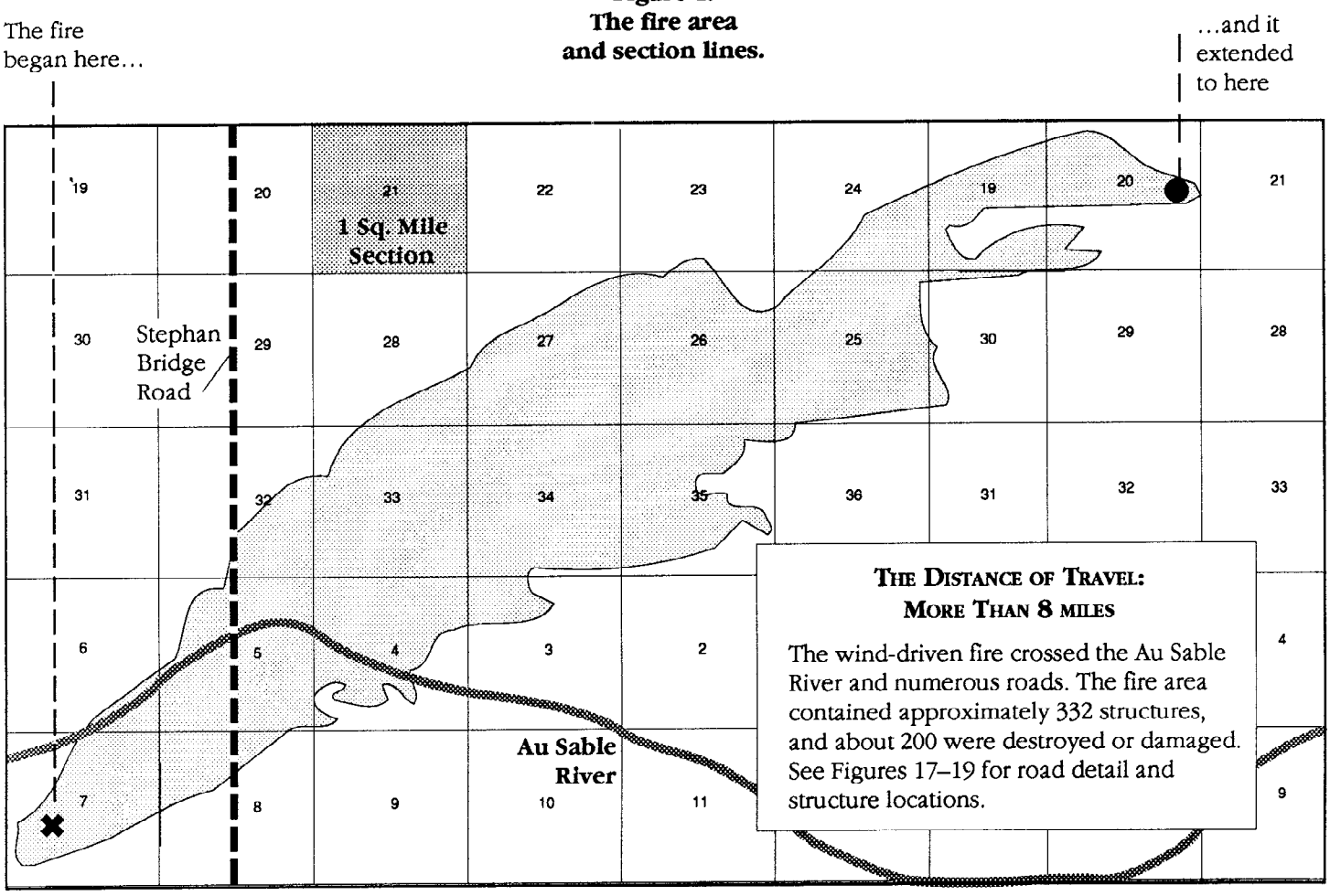
This fire became the most destructive fire in Crawford County history.

* The standard was pending adoption as of this printing.

WITNESS:

Personal accounts presented in these boxes throughout the text all appeared in local newspapers articles about the fire.

Figure 1.
The fire area and section lines.



ACKNOWLEDGMENTS

This report has been prepared by the National Fire Protection Association (NFPA) in cooperation with the State of Michigan Department of Natural Resources (DNR).

The project was sponsored by the National Wildland/Urban Interface Fire Protection Initiative to further the goals of the Initiative established in 1986. Those goals are to create general public awareness of the wildland interface problem, to encourage the formation of partnerships among problem-solvers and interest groups, and to focus on the development of local solutions to wildland/urban interface fire problems. The Initiative is sponsored currently by the U.S. Department of Agriculture Forest Service, U.S. Department of Interior, U.S. Fire Administration, the National Association of State Foresters, and the National Fire Protection Association. Contact information for each of these organizations is provided in the Appendix.

As a part of achieving the goals of the Initiative, this analysis was undertaken. The purpose of the analysis was to document the fire, determine to the extent possible the variables causing the destruction, and make recommendations on how to prevent similar occurrences. This is the second case study of this initiative. **Thomas Klem,** Director of NFPA's Fire Investigations Division, served as project manager and technical advisor. **William Baden,** Senior Fire Service Specialist, NFPA, served as the technical advisor for the project.

The information from this report is provided to assist planners, local officials, fire service personnel and homeowners in Michigan and in other parts of the country in developing firesafe homes and communities in the wildland/urban interface, a term referring to the geographical area where two diverse systems—in this case, wildland and residential—join and affect each other.

The goals of the Initiative are to create public awareness, encourage the formation of partnerships among interest groups and focus on the development of local solutions to wildland/ urban interface fire problems.

This wildland fire is only one of many that occur throughout the world each year. Under the sponsorship of the Initiative, the National Fire Protection Association will review, analyze and document additional wildland/urban interface fires that cause destruction to homes and structures.

The preparation of this report would not have been possible without the assistance of the Michigan Department of Natural Resources, particularly **Donald Grant, Arthur Sutton, Scott Heather, Ken Phillips, Lynn Mohr, Ronald Wilson** and numerous other DNR staff who contributed significantly to this report.

In addition, the on-site assistance and technical guidance and insight provided to NFPA personnel by **James N. Gray** and **Duane D. Brooks** of Michigan DNR greatly enhanced our ability to prepare this report. Mr. Gray and Mr. Brooks were not only the primary incident commanders of this fire, thus providing valuable insight to growth spread and suppression of the fire, but also provided historical perspectives that greatly enhanced the report. Further, through their efforts and the efforts of their staff, provided the detailed fire spread maps contained within this document.

Each of these individuals has made significant contribution to the technical accuracy of the report. The methodology used for the project and the approach used in the analysis are described in the Appendix. Appreciation is also expressed for all those who reviewed the text during its development.

Finally, **Jerry Laughlin,** of Books on Fire served as technical editor and prepared the layout of the final document.

STEPHAN BRIDGE ROAD FIRE CASE STUDY

BACKGROUND

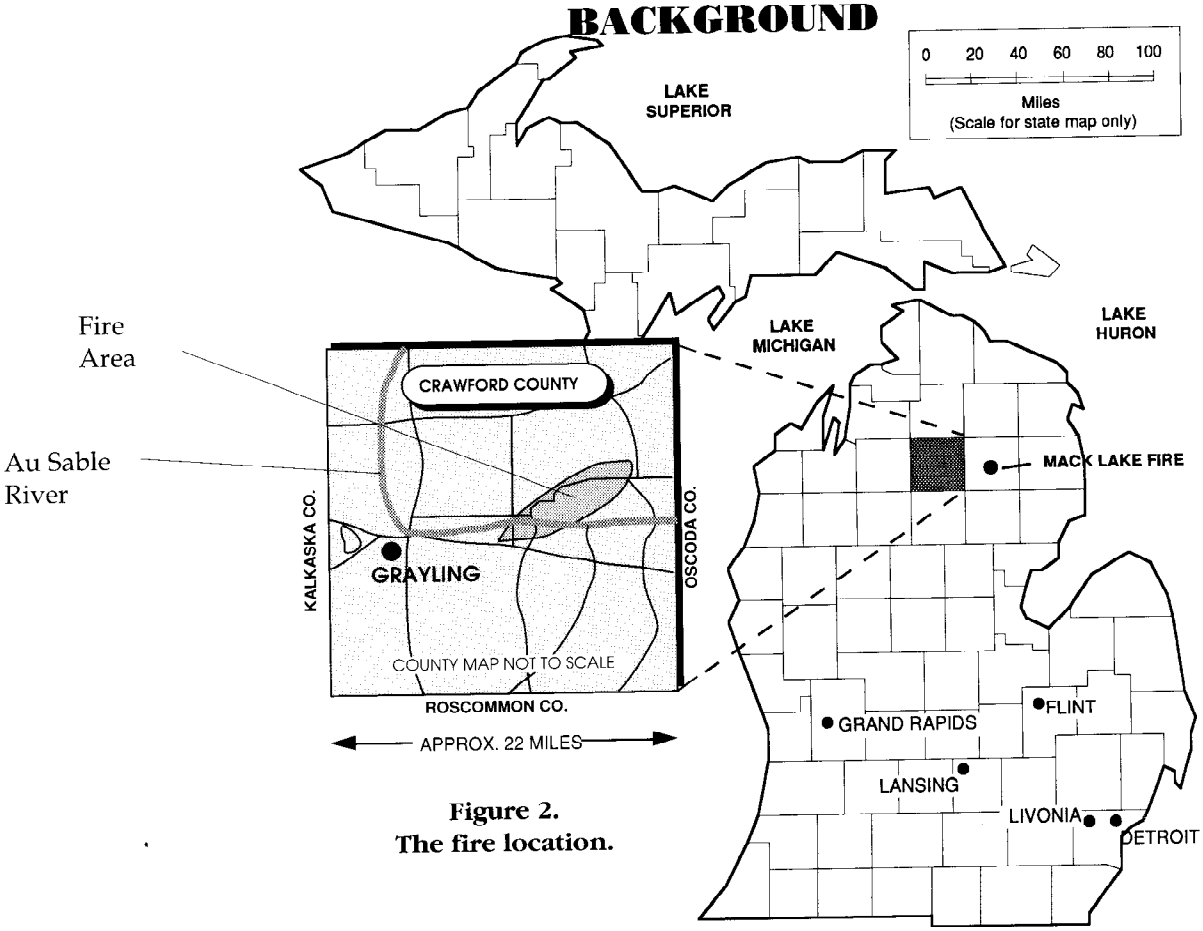


Figure 2.
The fire location.

■ The Local Landscape

The fire occurred in Crawford County, approximately nine miles east of Grayling, Michigan. Nearby state and local areas have much of the scenic beauty that is an important appeal of the wildland/urban interface. Lake Michigan lies less than 65 miles to the west, Lake Huron lies about 50 miles to the east, and the Mackinac Island resort area is less than 100 miles to the north. Closer to home, the Au Sable River, world-famous for its trout fishing, flows through Crawford County. Numerous small lakes dot the region.

Crawford County is a four-seasons recreational area. Trout fishing, canoeing, skiing, hunting, hiking and snowmobiling are popular activities for residents and tourists. The scenic forests are easily accessible, with about 70 percent of the county either state or federally owned.

In the wildland/urban interface areas of the county, about half of those who lost homes and cabins were year-round residents.

The land around Grayling is flat to gently rolling. A previous case study of the Black Tiger fire documented the affect that winds moving up sloped land had on the rapid spread of fire. This phenomenon is common in such areas as Colorado and California and is a factor determining predicted rate of fire spread by firefighters. However, slope was not a major factor influencing the spread of this fire.

Soil in the area has a high content of sand, created when the weight of ancient glaciers ground down the local rocks during the Ice Age and then left behind the particles as melting eventually occurred. A significant characteristic of sandy soil is that it quickly drains rainfall and snowmelt. Such an area becomes covered by vegetation fuels that can adapt to those soil and moisture conditions and is especially suitable for dense stands of jack pine growth.

The Au Sable River divides Grayling and extends northwest and east from the town. Many homes have been built along the river on both sides. Because the Au Sable was included in the state natural rivers program in 1987, any new (or rebuilt) structures must be moved back 200 feet from the stream's banks. About six miles east from town, Stephan Bridge crosses the river as a north-south link. State Highway 72 is to the south. North Down River Road, undeveloped wooded areas and various trails lie to the north. This connecting road is called the Stephan Bridge Road.

■ The Effects of Weather

A combination of low humidity, high winds and high temperatures contribute to dangerous fire conditions, and this area had them all.

Both 1988 and 1989 were drought years in Michigan. Until midsummer, 1988 was the driest year on record. Extended dry conditions in 1989 saw fires occurring as late as mid-November, with a four-inch moisture deficit for the year. Snowfall for early 1990 remained below normal.

About 53 percent of the state's land area is listed as forested, and these fuels are significantly affected by drought. The 1989/90 winter snowfall was about normal, but unseasonably warm weather followed and melted snow so quickly that it ran off over the still-frozen ground and into the rivers. Normally it would seep into the ground and be more available to keep vegetation moist. Consequently, the long-term moisture deficit persisted into the 1990 spring fire season.

Precipitation in April totaled no more than a quarter-inch. The area had been 14 days without measurable precipitation; the last two days presented extreme fire conditions. May is the month with the lowest daytime average humidity in Michigan.

Average monthly wind speed peaks in April (averaging 8.6 m.p.h.) but is usually still strong in May. A significant result is that evaporation during the growing season exceeds precipitation by 45 percent, and dry fuels are common.

On May 8, 1990 the weather was clear and sunny with temperatures in the 80s. This was unseasonably warm for this location at this time. For the first six days of May the average maximum temperature had been only 62 degrees. May 7 saw a 12-degree rise in temperature from the previous day, to 75 degrees.

Percent relative humidity on May 8 was in the low 20s. This mark had been trending downward during the first seven days of May, fluctuating between 39 and 14 percent and averaging just under 31 percent.

Winds during the first six days of May were fluctuating (with an average of 7.5 m.p.h.) but trending upward. Speeds were up to 13.4 m.p.h. on May 7. Early on the day of the fire, strong southwest winds were blowing between 15 and 20 m.p.h., although they gusted to between 30 and 40 m.p.h. by the time the fire started. These winds were the leading edge of a rapidly moving cold front five hours away when the fire was discovered. Winds hit a high of 60 m.p.h. as the front passed through at 8:30 PM.

STEPHAN BRIDGE ROAD FIRE CASE STUDY

The area had been 14 days without measurable precipitation; the last two days presented extreme fire conditions.

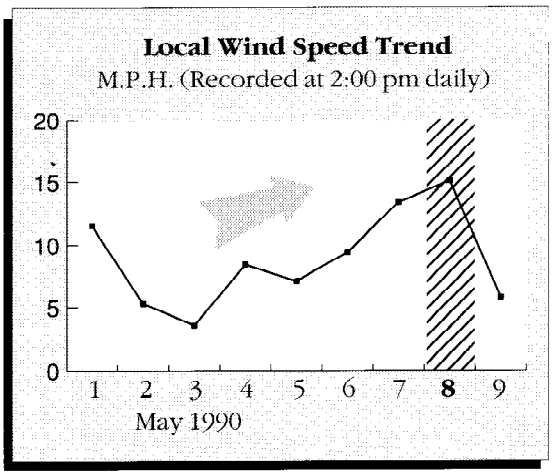
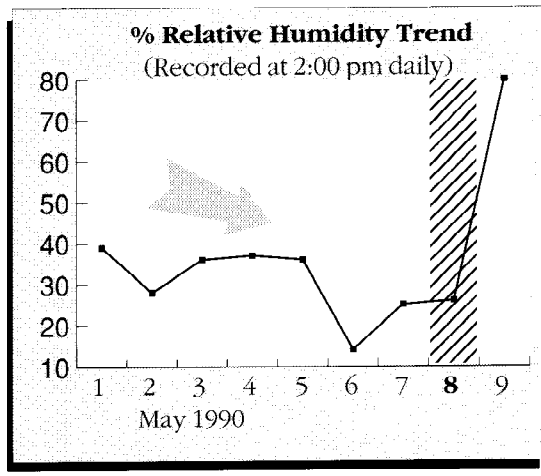


Figure 3.



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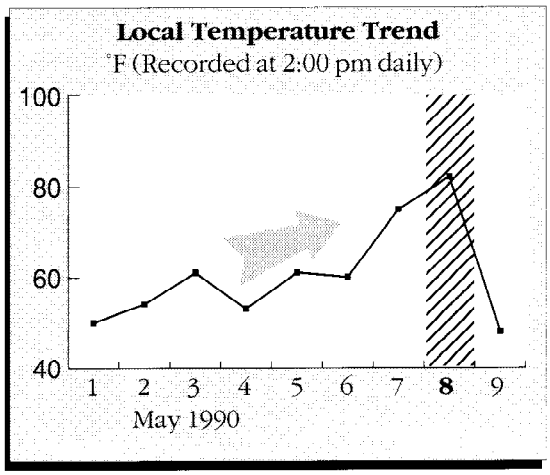

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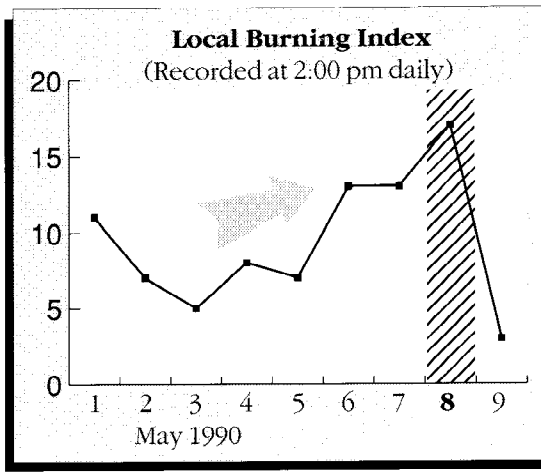


Figure 6.

■ Fuel Types

Jack pine is one of the most common forest fuels in the area around Grayling, growing in large, dense and continuous blocks. It thrives in the colder regions of this country and in Canada. It adapts well to the local sandy soils, but tends not to be a very tall species. Jack pine's significance is that it produces vegetation regarded as the most explosive (in the sense of extremely rapid ignition and spread) in all of the Lake States. Wildfire experts generalize that a running crown fire releases the energy of a Hiroshima-type atomic explosion every thirty minutes. The difference of course is that an atomic bomb releases its energy in a second rather than in half an hour, but the vast quantity of energy that wildland firefighters must face is nevertheless a dangerous power.

The chemical nature of jack pine is one factor contributing to its extreme flammability as a fuel. For example, the flammable liquid turpentine, used as a paint thinner, is obtained by steam distillation from the resin and wood of pine trees.

Another dangerous factor is the physical arrangement and growth habits of jack pine. In areas of long, cold winters and sandy soils, jack pine grows slowly, perhaps only six inches per year, but it can grow with thousands of trees per acre. It can grow so densely that a person cannot walk between the trunks, and from a fire spread standpoint this provides an abundant amount of available fuel. Young and middle-aged jack pine branches grow low to the ground, unlike some other pine species. This arrangement provides a ready path for a ground fire to climb into the crowns. Depending on the intensity of the ground fire, it is possible for it to burn under and through some trees without igniting the branches and leaves. But the lower the branches are, the easier it is for them to be heated to the ignition point. The lower branches of jack pine tend to die and fall away over time, adding to the buildup of combustible litter on the forest floor. A ground fire in such a scenario can quickly build in intensity and develop into a severe wildland fire.

STEPHAN BRIDGE ROAD FIRE CASE STUDY

Jack pine's significance is that it produces vegetation regarded as the most explosive in all of the Lake States.

Pine needles account for most of the flammability of jack pine. Needles have an abundant proportion of surface area to mass, making them especially susceptible to radiant and convected heat, resulting in their quick ignition. A branch loaded with needles can heat to the ignition point in a fraction of the time it would take to ignite an equal weight in another physical arrangement.

Jack pine is a species that regenerates after catastrophic wildfires. After the fire passes, the tight cones open from the heat and seeds are dispersed.

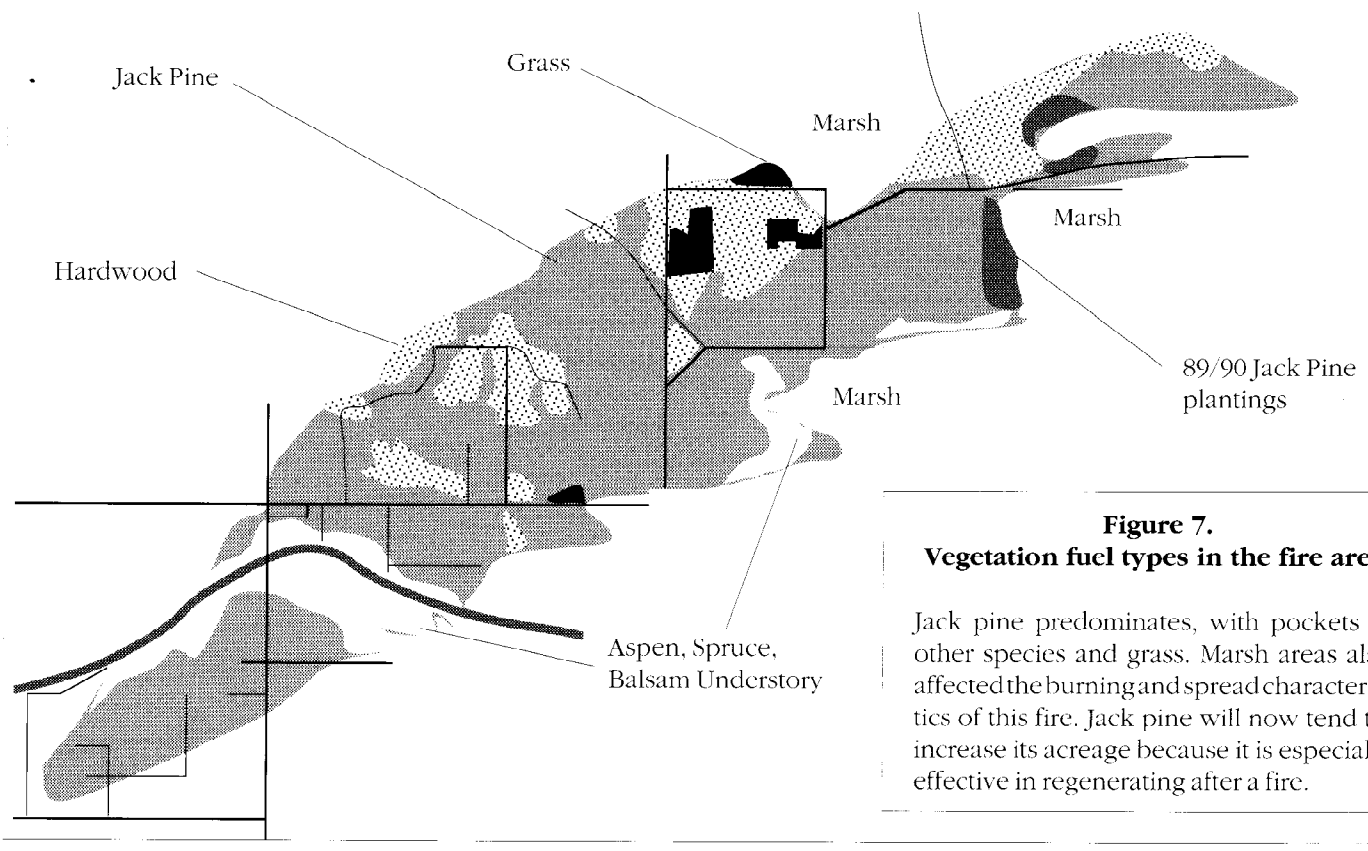


Figure 7.
Vegetation fuel types in the fire area.

Jack pine predominates, with pockets of other species and grass. Marsh areas also affected the burning and spread characteristics of this fire. Jack pine will now tend to increase its acreage because it is especially effective in regenerating after a fire.

In May in Michigan, most other types of trees do not yet have their new growth of leaves and thus are not as susceptible to a wind-driven crown fire. In May, however, evergreen pines still have the needles from the previous year, although internal moisture is greatly reduced after the winter. Early spring is a transition time for pine needles. A new growth of needles will occur and the old needles will continue to dry out and fall, independent of how much precipitation is present; it is a matter of aging rather than moisture in the soil or in the air. Eventually in this natural process the new needles, which have a higher moisture content, make the tree slightly less susceptible to fire.

A critical time in this natural process occurs in May just before the new growth period when the old growth is at its driest. Precipitation does not prevent the loss of the old needles, but drought conditions add to the flammability of the needles by drying out the rest of the tree. Unfortunately, Michigan weather tends to be at its driest in May. Winds add to the stress on the trees and needles. One 1974 study of foliar moisture reported that one or two days of high wind and low relative humidity can reduce foliar moisture content by as much as 20 percent. When the lowest fuel moistures occur, fires in jack pine are likely to produce crowning fires.

Generally, a crown fire will not occur when the ground is free of surface fuels, because the heating from a surface fire below is an important factor affecting crowning potential and also affecting sustained crown fires. Once again, jack pine contributes to the problem. Fallen pine needles and branches can be expected to add to the fuel load of an area. Falling needles from some evergreens, such as spruce, form a thick mat on the ground, holding moisture below them. Jack pine needles are more fluffy, allowing quicker drying and more surface area that aid fire spread.

Surface fuels in the area consist of the live understory, such as blueberry bushes with bracken fern, lichen and sedge grasses (carex) lower to the ground. However, in early May this vegetation consists mostly of the drying remains of the previous year's growth, since the new growth is not quite ready to bud. Other dead vegetation mentioned above also add to ground litter.

Although the jack pine trunk is covered with rough, scaly bark, it is not important from a fire consideration. The needles allow such rapid fire spread and ready crowning potential that a running crown fire usually speeds on by without lingering long enough to consume the tree trunks.

Other timber types in the area included interspersed pockets of red pine, oak, maple and aspen. Red pine supports crown fire activity in the spring similarly to jack pine. At this time of year aspen begins to leaf out and the maple buds swell, but the hardwood canopy was essentially undeveloped on May 8. A band of aspen, spruce and balsam grew on both sides of the Au Sable River and contributed to a moist microclimate that would naturally help slow the rate of spread of a fire in that area. However, the "spotting" potential of jack pine allowed the wind-blown embers of a fire to jump over barriers, such as at the river and its microclimate, and start multiple new fires spreading into additional jack pine stands.

California's chaparral has a deserved reputation for its ready flammability and fast rate of spread. Because of the frequency of television news reports of California wildfires, some homeowners in other areas may assume that the danger of flashy fuels is restricted to California and is not widespread. However, the combination of jack pine needles and other associated ground litter in Michigan and other Great Lake states, especially around May each year, also provides a fuel situation that match the flammability of the California chaparral. There are vast other regions of the country that have dangerous types of fuels, of which homeowners should be aware.

When the lowest fuel moistures occur, fires in jack pine are likely to produce crowning fires.

■ Home Construction Factors

Construction materials for the homes varied greatly. The majority were wood frame, with some having various amount of brick veneer. Home types also varied, from mobile homes to vacation cabins to larger homes for full-time residents. With perhaps half of the owners living elsewhere and visiting occasionally, maintenance of the surrounding grounds varied.

Most non-resident owners were from elsewhere in Michigan, but also among those losing property were families from as far away as North Miami Beach and West Palm Beach, Florida; Crane Hill, Alabama; and Kenly, North Carolina.

Homes were typically built or placed in areas cleared from dense stands of jack pine. Some were located on private drives along pre-existing roads, some of which were dead-end trails. Other homes were grouped more densely together along established residential-type streets.

Witness:

"It's like losing a member of the family," said Horton, a Flint carpenter who built the cabin in 1947 with his father and planned to pass it along to his sons. "We have been coming up, summer and winter, since they were little boys. Our place was like a museum. I'm a great collector—license plates, beer bottles, all kinds of antiques. There were deer hides and trophy heads.

"Are we going to rebuild? Don't talk to me about rebuilding. I'm 65 years old."

—Dick Horton, remembering his cedar-sided three-bedroom cottage, one of the first to burn.
(from news reports)

This area did not feature the widespread use of wood-shake roofs, as often seen in many destructive interface wildfires. However, almost all of the structures except for the mobile homes had combustible wood exteriors and porches. Residents added to their risk when they failed to clear their roofs of pine needles, leaves and twigs or when they used wood steps connected to the home.

No local or state regulations specify the amount of clearance between the structures and the combustible vegetation in Crawford County, although fire protection agencies frequently attempt to educate all residents about the need for adequate clearance.

STEPHAN BRIDGE ROAD FIRE CASE STUDY

Local regulations specified the minimum adequate clearance between occupied structures and storage tanks for LP gas. However, wood piles are unregulated and were frequently found immediately adjacent to homes. Many home also had open wood porches and decks. Even when a structure has a noncombustible roof, wind-

OVERVIEW OF THE WILDLAND/URBAN INTERFACE FIRE PROBLEM

Why do wildfires continue to burn homes?

People continue to move to the scenic wildlands and build homes there.

Why not? Moving away from urban and crowded suburban areas to scenic rural and wildland areas generally results in lower property costs, more privacy, fewer regulations, less noise and less crime.

Few disadvantages weigh against this continuing trend. Good connecting highways allow people to retain jobs in the cities, if they choose, but escape daily to enjoy a slower pace of life. Extending outward with the highways, generally good communications and other utilities have provided important bridges from the urban world of commerce and industry to the rural foundation of land and space.

Not every person and family making up this new trend works in a nearby city. The scenic wildlands are also attractive to retirees, those who no longer want to live or work in the cities, and those who grew up in rural areas and have no desire to sample the congestion and stress of city life. However, the presence of increasing numbers of people interferes with the natural process of fire in the wildlands.

Wildfires continue to be a natural, predictable factor affecting combustible vegetation.

Fire is a fact of life in the forest. And when a fire occurs, the forest is nothing more than fuel.

Although fire is indeed destructive in the context of what it can do to public and private wildland resources, fire also serves to remove the build-up of forest litter, such as dead limbs, fallen trees and other vegetation. Natural decay does not operate fast enough to serve this function alone. Taking a naturalist view, occasional small fires—started naturally by lightning, for example—assure that fallen leaves and limbs are periodically removed before this fuel builds up to a quantity that, if then ignited, would threaten the existence of the forest itself. Burning the forest litter also recycles the nutrients stored in the fallen limbs and leaves.

Lack of good vegetative management predisposes areas to disastrous wildfires.

Public lands can be managed in a way that works with nature to prevent the dangerous buildup of forest litter. Prescribed burning is one example. Controlling the arrangement of natural fuels is an important factor affecting the type of fire that could occur in an area. This includes not only the amount of forest litter and the density of the trees, but also the heights of adjacent fuels. Grass fires do not easily ignite tree canopies, but ladder fuels allow ground flames to escalate in a step-by-step climbing manner from flat grass, to low bushes, to intermediate limbs, and eventually to tree canopies. Clearing ladder fuels is a prime objective of prescribed burning. However, prescribed burning in standing jack pine for surface fuel and ladder fuel reduction is not an accepted practice at this time.

Managing flammable vegetation on private lands is a different and difficult process. The presence of homes and other structures eliminates the techniques that work in remote areas. Controlling the vegetation still needs to be done, but the job must become the responsibility of the private landowner. For the time and expense to be committed, however, the landowner must fully understand the consequences of failure to act. Without homeowner involvement in reducing the quantity and dangerous arrangement of fuels, particularly around structures, it is impossible to reduce the threat of fire.

When vast areas of private lands are grown up with forests and ladder fuels and interspersed with combustible homes—and fire prevention measures are inadequate or ignored—the results can be disastrous. However, when homeowners do get involved in managing the vegetation on their lands (one of several possible fire prevention measures), the results, locally and nationally, can be very impressive.

These wildfires continue to have the potential for overpowering any combination of human forces attempting to suppress them.

Fire protection in rural and wildland areas is not the same as fire protection in the cities and crowded suburbs. The quantity of any public fire protection is generally related to the population density of the area to be protected. Therefore, in wildland/urban

carried embers can still fall on and readily ignite these dry wood piles and porches or a buildup of pine needles on roofs, any of which provide a convenient path for fire extension into the structures.

Note: A rural area such as that around Grayling features numerous detached garages, workshcds and other outbuildings as part of single households. For the purposes of counting the loss of structures to this fire, a conservative approach was taken: Where the home itself was burned, any associated garages and outbuildings that burned were not added to the total.

STEPHAN BRIDGE ROAD FIRE CASE STUDY

WITNESS:

I saw 14 houses burning in a single block in the Shaw Park area. There is no way to take an accurate count of the homes and cabins burned. We evacuated about 300 people.

Officer Dean Goss
(from news reports)

interface areas where by design there are fewer people (but more trees), the availability of fire protection is going to be less than many former city residents might expect. Rural volunteer fire protection forces may be as dedicated as any urban fire department, but the rural department may not have the same constant availability of personnel. Response times to fires will tend to be longer in rural areas. Another difference is that wildfires in rural areas depend more often on interagency attack and control, thus complicating the means of communications.

In theory every community could have a fire suppression army on standby to quickly detect the smallest ignition of an emerging wildfire and handle any possible spread of the fire. But this is not practical; no one would want to pay the taxes necessary to fund such as effort. Instead, fire protection agencies do the best they can with the available financial, equipment and personnel resources. One of the harshest realities facing these rural fire protection agencies is the lack of water in a network of underground pipes, under pressure suitable for firefighting purposes.

The result is that periodic, but not entirely predictable, conflagrations will ignite, spread rapidly, destroy homes and threaten lives.

Residents continue to misjudge the potential for danger in wildland/urban interface areas, and consequently fail to take proper precautions.

Whether year-round or seasonal residents, the people who move to or maintain homes in wildland/urban interface areas generally do so because they consider that lifestyle desirable. Common sense says they—the adults anyway—can understand the basics of wildland fire and the combustibility of homes. Few have not been exposed to the brochures and the newspapers and the other sources of information about the potential dangers of living in the interface. However, few have actually faced the awesome, fear-inspiring enormity of a major wildfire. For those who have, the experience is humbling and the lessons learned are never to be forgotten. Most would say there are easier ways to learn such a dangerous lesson. Yet, interviews with victims of wildfires all around the country elicit the same confession from those who have lost their homes: Yes, they knew there was some risk from wildfire, but they never believed it could actually happen to them.

These residents believe the odds are favorable that a wildfire will not start in their backyard. They believe that if it does start nearby, the available firefighters will control it. They believe that if the firefighters cannot control it, the fire will go in the other direction. They believe that if it comes in their direction, they will have time to escape. The reality is, of course, different and more ominous if precautions are not taken.

No one disputes that these assumptions, though incorrect, are basic human nature. What is happening to these people is that they are not denying the actual possibility of wildfire; they are just reacting to life's demands in their own priority order, and wildfire is not always high enough as a priority to get a reaction.

Some people do take the proper precautions and maintain their wildland property to be ready if the unlikely does occur. What makes them react when others do not is of high interest to wildland fire agency officials. Preventive action can be productive, here and elsewhere, but it needs to be guided by the experience of these wildland fire agency officials. Trying to wet down a large area of vegetation close to a home is likely to be wasted effort, yet clearing out that vegetation before the fire is of great significance to a home's survival.

Home construction features and maintenance practices contribute to the survival or loss of a home when a wildfire occurs nearby.

The location of a home on a slope or at the crest of a ridge contributes to extra risk due to the effect of up-slope winds on any fire starting below the home.

Combustible building materials adjacent to combustible vegetation is always dangerous combination. Any wildfire spreads more easily from burning vegetation to a home when the home is constructed with a wood shake roof, a wood porch or open deck, wood siding, and open eaves. These features provide an actual path for fire extension rather than a barrier.

A well-constructed home must still be maintained with fire prevention in mind. Failure to clear the roof of leaves and other combustible forest debris provides a ready fuel bed for any falling embers from a wildfire. Failure to clear the growing and dead vegetation from a needed safety zone around a home likewise provides a path for fire extension from wildfire into a home, even one with noncombustible construction materials. Homeowners live with these risk factors only when they do not understand their effects.

■ Regional Fire Activity, May 6 - 8, 1990

Fire danger conditions escalated dramatically in the region around Crawford County on May 6, when relative humidity dropped to 14 percent, the lowest reading of the days prior to the fire. On this day wind speed increased and fine fuel moisture dropped to a rating of 2 from a rating of 8 the day before, indicating that fallen leaves and other non-bulky surface fuels were very susceptible to continuous propagation from an ignition source.

The ratings soon translated into actual fires. May 7 saw the DNR responding to 21 wildfires in northern Lower Michigan. More than a third of them were in DNR District 7 alone. Staffing had been increased as the fire danger figures increased, according to established personnel policy. Equipment and personnel were at required standby stations and the fire management team members were on standby at Grayling. The DNR division office had been appraised of the fire conditions that morning. A DNR aircraft was patrolling, alert for quick detection of any fire. Everything was ready. Whatever else happened during the next several hours, neither delayed alarm nor delayed response would be contributing factors.

On May 7 a fire in the county burned within 200 yards of several large flammable liquid storage tanks. All of the fires were reported to be burning hot and fast, with excessive spotting. Winds and heat continued to dry out the fuels.

By the afternoon of May 8 there were 15 more wildfires being worked by the DNR in the region, and more personnel were involved with the careful but time-consuming mop-up needed on many of the fires from the previous day. Again, more than a third of these new fires were in DNR District 7 alone. The USDA Forest Service and local fire departments responded to many additional fires in those two days that are not counted here.

As in the major fire history of the past 25 years in the area in and adjacent to Crawford County, the multiple fires of May 7 and 8 were not ignited from natural causes. People were responsible. Debris burning was the most common single cause. Accidents involving mechanical equipment was the next in frequency.

Because of the fires and the continuing danger, a DNR airplane was on patrol May 8. At 3:40 PM the pilot detected a fire near McMasters Bridge, 14 miles east of Grayling. Similar to the area of the subsequent Stephan Bridge Road fire, the McMasters Bridge area featured dense jack pine, so several units responded, including a fire management team. Units from Mio to the east and Roscommon to the south were dispatched because this was a high-hazard zone fire with homes in danger. Some of the personnel and equipment responded from their standby location at North Down River Road and McMasters Bridge Road.

Circling in the area at 3:53 PM, the DNR airplane saw smoke from a new fire ten miles back toward Grayling from the McMasters Bridge. The new fire was a mile west of Stephan Bridge Road and just north of Michigan Highway 72. Additional personnel responding to the McMasters Bridge fire were redirected to what became the more-serious Stephan Bridge Road fire. A tractor plow also responded from the Grayling field station.

Most of the fires in the region on May 7 and 8 were caught quickly and held to a relatively small number of acres burned. From the first moments it was obvious that the Stephan Bridge Road fire was going to be bigger than the others.

During the attack on this fire, at 5:06 PM, yet another major local fire was reported along the same Stephan Bridge Road. Named the Billman fire, it was nine miles to the south, requiring more equipment and personnel to be diverted. Here, too, homes and outbuildings were threatened, and several were lost. This fire was also to cause confusion in the radio communications because both fires were related to Stephan Bridge Road, although miles apart. The Billman Road fire eventually burned 615 acres and took five homes and 15 outbuildings. Numerous cars, boats, motorhomes and off-road vehicles were also lost.

STEPHAN BRIDGE ROAD FIRE CASE STUDY

Equipment and personnel were at required standby stations.

Witness:

In all the 37 years I've been around house fires in Grayling, I saw more houses burn today than all the other years combined.

—Sheriff Harold Hatfield
(from news reports)

Witness:

John Murray said he had been told for years that the surrounding jack pines were prime candidates for a devastating forest fire, but he told a reporter after the fire that he never believed it.

His home was destroyed...

(from news reports)

■ Regional Fire History

DNR records of 11 major wildfires—not counting the Stephan Bridge Road fire—in Crawford and three adjacent counties during the last 25 years show certain trends.

Windy afternoons in May with low relative humidity are obviously high risk periods.

Natural causes, such as lightning, caused none of the fires; people did.

The average number of acres burned in 10 of the major fires was 1,350. A football field is approximately one acre in size.

The additional notable fire in regional history, the Mack Lake fire, burned almost 25,000 acres, with the major fire spread occurring in an 8-hour period, noon to 8:00 P.M. (see Appendix).

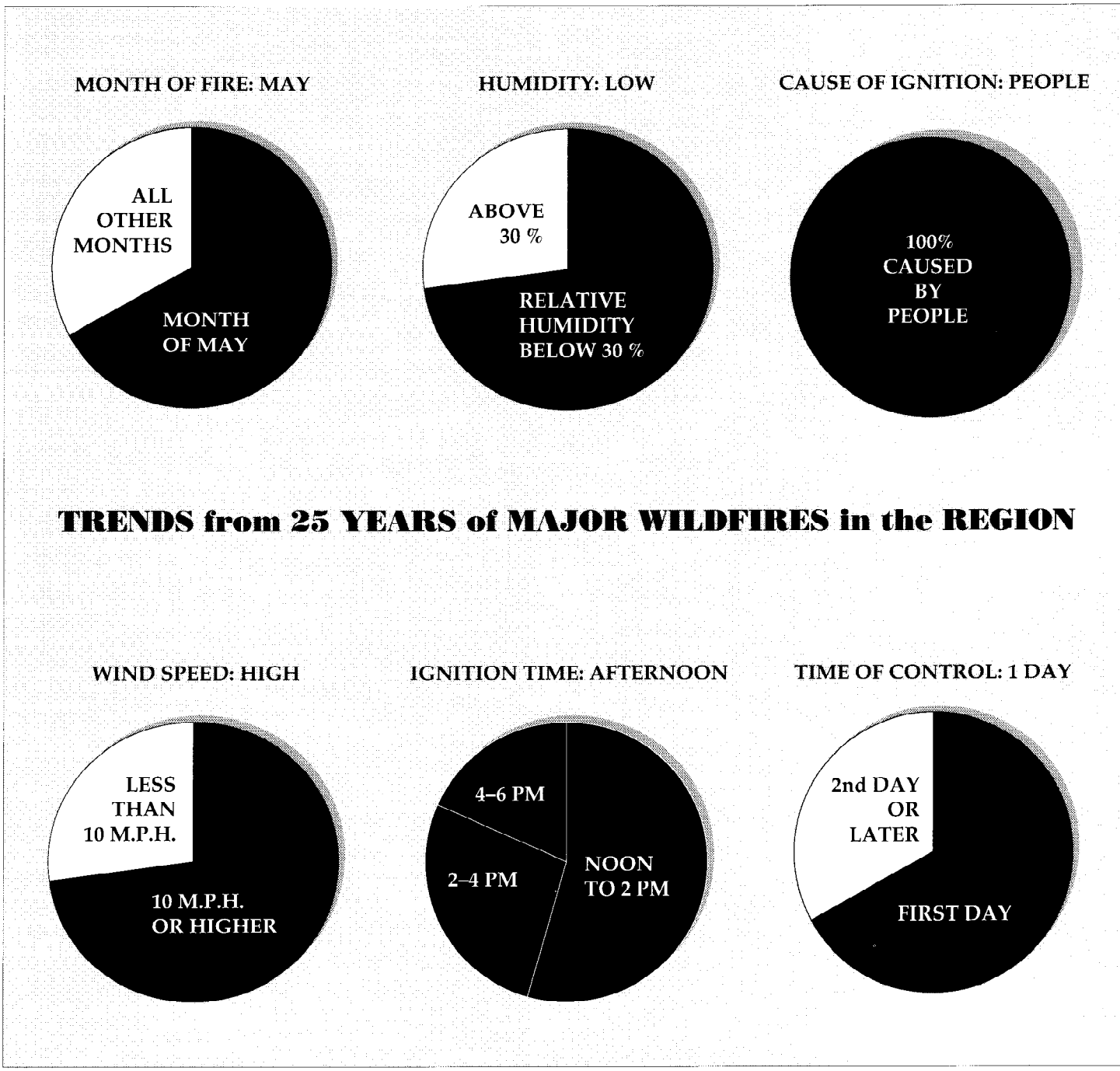
STEPHAN BRIDGE ROAD FIRE CASE STUDY

Witness:

It was the scariest fire I've ever been in. It was the most houses I've ever seen burn in my 27 years of firefighting.

—Ed Holtcamp,
Beaver Creek Fire Chief
(from news reports)

Figure 8.



■ National Wildland Fire Experience, 1990 Fire Season

The Stephan Bridge Road fire was not the only one of the 1990 fire season in which fire-conducive weather and multiple fire starts in a single region resulted in staggering losses. This combination of circumstances allows the wildfires to quickly grow beyond immediate human control and places a severe challenge on any fire agency. The development of interagency cooperation becomes paramount in these circumstances, which could occur in any part of the country.

Three groups of wildfires during the week of June 25, 1990 alone destroyed more than 600 structures and many thousands of acres of wildlands. More tragic: nine lives were lost (eight firefighters, one civilian). As in the Stephan Bridge Road fire, the concurrent major wildfires in these three groups affected the availability of resources needed for such large-area operations.

Contributing factors in the loss of structures in each of these three fires included weather conditions that dried the available fuels and allowed rapid spread, inadequate clearance of vegetation from around the structures, and the use of combustible construction materials (especially roofs). Other common factors included inadequate access for emergency vehicles and the storage of firewood and other combustibles adjacent to homes and structures.

• **Dude fire.** Temperatures over 100 degrees and relative humidities below 20 percent created conditions for rapid fire spread in Arizona's Tonto National Forest on June 25. Lightning started the fire. After one day of intense burning, a dry thunderstorm passed over the fire with strong, erratic winds, which caused the fire to make a major run. The fire burned out of control and overran a fire crew, causing six fatalities. In addition to the loss of life, 53 homes were destroyed and others damaged. More than 1,000 residents were evacuated. Fire crews contained the fire after six days and the loss of 28,000 acres.

STEPHAN BRIDGE ROAD FIRE CASE STUDY

Three groups of wildfires during the week of June 25, 1990 alone destroyed more than 600 structures and many thousands of acres of wildlands.

• **College Hills fire.** Conditions in Glendale, California also included temperatures over 100 degrees and relative humidity below 20 percent, with winds at 10 to 15 m.p.h. When this arson fire started on June 27 it went to a third alarm within eight minutes. Less than four hours later, 66 homes had been affected (46 completely destroyed, plus 20 suffering major damage). Embers spotted across an eight-lane freeway, where other residences were lost.

• **Paint fire.** On the same day a wildfire in the Los Padres National Forest north of Goleta, California caused another fatality when a person trying to escape was overrun. When the fire began, the temperature was 103 degrees, relative humidity was 10 percent, winds were at 10 to 15 m.p.h. and fuel moisture was very low. A red flag warning was in effect the day before the fire and resources were pre-positioned throughout the county. Despite this preparedness, the fire soon ran out of control. Winds later gusted to 50 m.p.h. and spread the fire into nearby subdivisions. Thousands of residents were evacuated. Property losses numbered 420 homes and numerous public buildings, mobile homes, farm buildings, apartment buildings and businesses. Many more structures were damaged. The fire burned 4,900 acres.

Figure 9.
Three sample fires from the 1990 fire season.

	Dude fire	College Hills fire	Paint fire
Temperature:	More than 100 degrees	More than 100 degrees	103 degrees
Humidity:	Less than 20 percent	Less than 20 percent	10 percent
Winds:	"strong and erratic"	10–15 m.p.h.	10–15 m.p.h. (gusting to 50)
Area burned:	28,000 acres	n/a	4,900 acres
Homes lost:	53 destroyed	46 destroyed, 20 damaged	420 destroyed, plus other bldgs.
Deaths:	6 firefighters	n/a	1 resident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THE FIRE

■ Fire Origin and Discovery

The ignition scenario leading to the May 8 Stephan Bridge Road Fire actually began seven weeks earlier.

In early March, a resident just south of the Au Sable River and west of Stephan Bridge Road—intent on clearing timber and brush from the eastern rear of his property—hired a commercial excavator to bulldoze stumps, trees and slash into four separate piles for burning. During this process and depending on how low the bulldozer blade was positioned, varying amounts of dirt were also piled up with the combustible debris. Afterwards, the rear property appeared to have been stripped of all brush except for several remaining large oak trees. In order to burn the piles, the Michigan Department of Natural Resources was contacted and they granted a burning permit on March 16, when an inch of snow covered the ground. The homeowner began burning the first two piles nearest the residence. Neighbors were told that the remaining two piles were to be left as cover for rabbits and other small game. (This is consistent with residents of wildland/urban interface areas everywhere: they want to preserve as much of the wildland habitat as possible.)

Reportedly the first brush pile nearest the residence burned and then smoldered for two weeks. The second pile away from the residence burned itself out within a week after first ignition. Also during this time storms deposited one-half to one inch of snow on March 22, 25 and 30.

On April 16 the first pile rekindled itself to the point of open burning and smoking. As a result an additional burning permit was requested for a "flaming old brush pile."

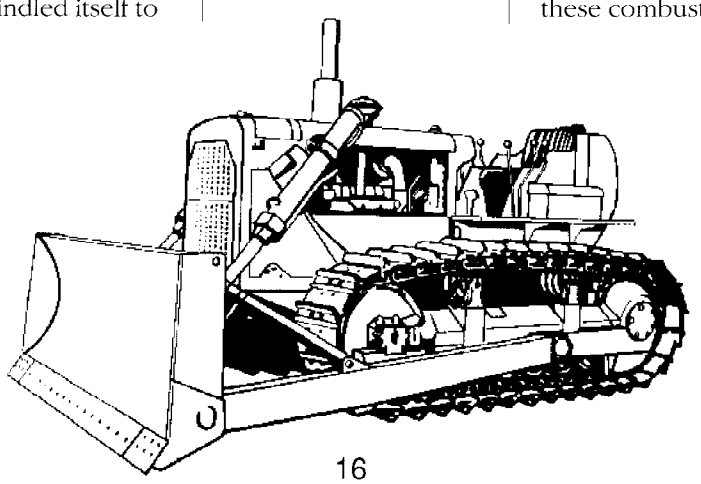
The rekindling of the first pile was cause for the homeowner to wonder about the internal conditions of the second pile. Checking it by reaching inside the debris to feel for remaining heat, the homeowner reportedly found no sign of fire, smoke or heat. In the days following, he continued to pick up leftover brush from the area and add it to the second pile for eventual burning, continuing also to check the pile for any buildup of heat.

On the day of the May 8 fire a neighbor working on his property sometime after 3:30 PM saw that two of the brush piles were burning and reported seeing no one else in the vicinity.

Earlier at 1:30 pm a Department of Natural Resources plane flew over the area while on patrol and had not noticed any smoke or fire. The same plane, working the McMasters Bridge fire east of Grayling after its 3:40 pm discovery, saw the separate smoke near Stephan Bridge and radioed the first report of the new fire at 3:53 pm.

From the time that the smoke and fire were first spotted, it took only ten minutes for the brush piles—and the adjacent forest—to ignite and for the fire to spread out of control.

Investigators believe that as the winds increased in speed the last few days before May 8, more and more of the outer sandy soil and debris, which for weeks formed part of the insulation for the smoldering fire within, were stripped away. When, on May 8, the wind fully penetrated the insulating cover, additional oxygen reached the seat of the fire. Three things began to happen: the oxygen resulted in an increase in the burning rate; the fire grew to include all of the fuels in the pile; and the winds soon carried embers beyond the initial pile. Many of the embers fell harmlessly on the adjacent cleared ground and burned out. But the winds were strong enough to carry some of the embers to the nearby combustible forest. At this point an ember cannot ignite a tree directly. Instead, an ember likely fell among the dead and dried grasses or ferns. Once ignited, these combustible ground fuels would quickly consume a larger and larger ground area until the building heat would eventually ignite the ladder fuels. Once this occurred, and in light of the other factors affecting the fuels, it was not long until the intensity of this developing fire was able to spread to the crowns of the jack pine. It was about at this point in the ignition sequence that the rapidly spreading wildfire was reported by the airplane.



■ Fire Extension and Attack

Even from the time of initial detection, fire managers knew this was going to be a major fire. The first unit to arrive reported crown fire conditions with structures already involved. This necessitated a massive evacuation at the same time as fire suppression efforts were organizing.

The fire boss for the fire developed a plan and decided suppression would be by flank attack only. Black line construction would be used whenever possible. This plan would be a standard approach for a fire of this magnitude anywhere. Firefighter's lives would not be risked to save structures at or near the head of the fire.

Individuals who have never seen the power and speed of a major wildfire might think the way to stop its spread is to mass fire crews and equipment in the path of the fire and drown it with numerous streams of water. The fire boss knew that in such rural areas, piped water was not available in quantity for massive firefighting purposes. Furthermore, the immense energy release and radiant heat make a frontal attack humanly impossible and too dangerous, anyway. The fire moves too fast at the front. Burning embers are also likely to blow overhead past the fire crews, start multiple new spot fires and trap everyone in the middle.

The alternative is to clear the fuels from a perimeter line plowed around the fire, then either starting a small burn-out to clear the fuel between the cleared line and the flame front, or eventually allowing the fire to burn out when it reaches the cleared line. By plowing lines on the flanks near the head of the fire, a pincher movement can gradually narrow the front.

The intensity of the fire and its rate of spread determined the width of the line. On a smaller, slower fire the line could be relatively narrow. Bigger fires generating more radiant heat can ignite fuels across a greater distance, so any line has to be wider.

In some areas of less dense trees, the fire would drop out of the crowns, only to burn back up the ladder fuels to the crowns within 50 feet. The crown fire ran in strips for several miles at a time.

Flame lengths above the crown were consistently observed to be in the 40 to 50-foot range. However, the gasses produced by the burning pine were igniting explosively several hundred feet into the air. A surface fire followed the crown fire, with flame lengths running four to 12 feet.

A wind-driven fire involves two extra difficulties:

- Because it spreads faster, the cleared line must be longer to extend around the growing fire. This requires more numerous personnel and equipment. In fuels conducive to crowning, as jack pine is, the fire quickly burns along the tops of the trees where the wind can accelerate it. This makes the head of a crown fire just too hot for suppression operations.
- Worse, from a fire control standpoint, is fire spotting, in which burning embers drop beyond the widest-possible cleared line to start new fire areas. At this fire many wind-carried burning embers were soon being dropped more than a quarter mile in front of the fire. Any cleared lines in between are thus wasted effort. The fire management team of this fire considered all of these variables.

If the head of the fire cannot be attacked for practical and safety reasons, it might be imagined that the wind might continue spreading the fire in the same direction for as long as fuels exist in front of the fire. The fire boss knew that, fortunately, winds tend to slow at night, humidity tends to rise, and different fuels may be reached that contribute to slower burning. These factors give firefighters new opportunities to plow lines that will hold under the reduced fire conditions existing at that time. In any event, the beginning of a massive and fast moving wildfire is a frightening thing to experience.

Fire spotting from the high winds was an immediate hazard at the beginning of—and throughout—the Stephan Bridge Road fire. Personnel and equipment were stretched thin because of other recent fires in the region, especially the nearby one at McMasters Bridge that pulled several pieces of equipment to the east that would have gone to this fire. Initial attack then consisted of one tractor plow, one 4x4 pumper plow, six township units and a fire boss. The overhead team and some pieces of equipment were soon shifted from McMasters Bridge to the larger Stephan Bridge Road fire.

■ Rate of Spread

Figures 10–15 show the growth of the fire by zonal rates of spread. The indicated zones are not necessarily distinct zones but are a way of noting when the fire extended past significant geographical points.

The initial area from the point of ignition represented the first run of the fire along a narrow band. The crown fire produced a quick run averaging 141 feet per minute through fuels almost exclusively of jack pine. From the fire's discovery at 3:53 pm, this rate of spread was maintained

—continued on page 19

STEPHAN BRIDGE ROAD FIRE
CASE STUDY

Flame lengths above the crown were consistently observed to be in the 40 to 50-foot range.

Witness:

If the rains had not come and the winds died down as they did, the fire would have probably burned through the night and taken off and run all day the next day.

—Duane Brooks, DNR fire officer
(from news reports)

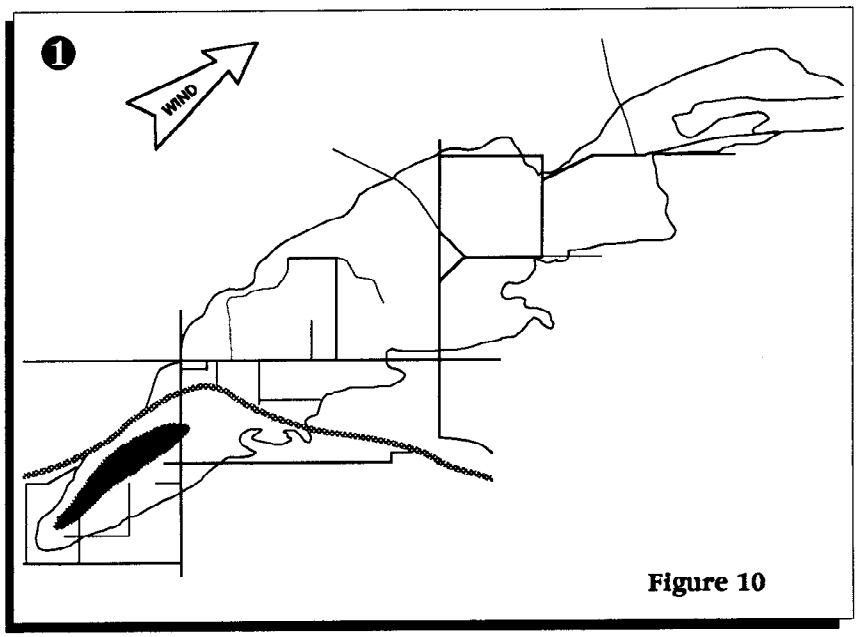


Figure 10

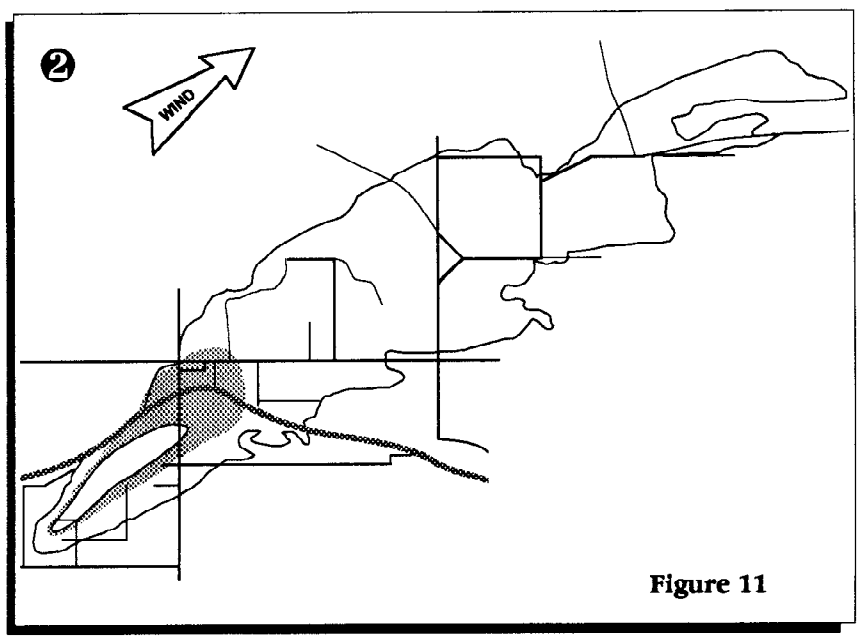


Figure 11

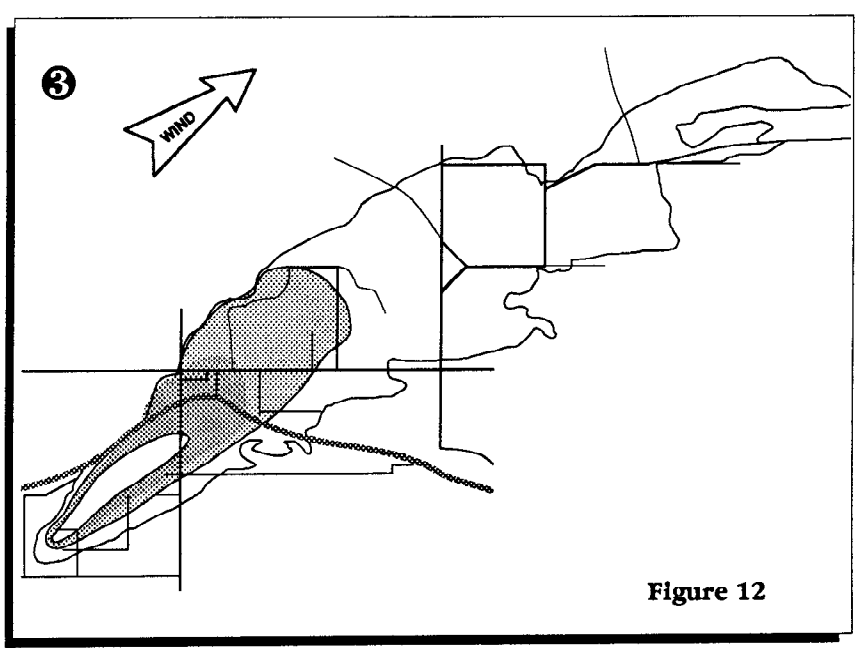


Figure 12

Zones of Fire Extension: 1-3

Figures 10 through 15 show the growth of the fire by zonal rates of spread. The indicated zones are not necessarily distinct zones but are a way of noting when the fire extended past significant geographical points.

❶

3:53 to 4:50
Rate of spread: 141 feet per minute average.
Fuels: jack pine.
Structures lost: Approximately 4. Probably all are lost to crown fire intensities.
Flat terrain and winds produce a narrow, elongated fire area. After one hour the fire has spread out very little horizontally from the area of origin.

❷

4:50 to 5:22
Rate of spread: 125 feet per minute average. This is less than half the rate of spread to come in zone 6 when the cold front arrives.
Fuels: In addition to jack pine, the Au Sable River area is lined with aspen, spruce and balsam understory. The different fuels and higher humidity along the river serve to slow the fire.
Structures lost: Approximately 9
Structures surviving: Approximately 39. Many structures are relatively protected along the river.
The fire slows at the river, but the wind carries burning embers over it to the jack pine on the other side.

❸

5:22 to 5:30
Rate of spread: 194 feet per minute average. This is a short interval of time but represents a new rate that is more than 50 percent faster than in zone 2, along the river.
Fuels: More jack pine with pockets of hardwood. The hardwoods, without the evergreen foliage that jack pine has, serves to slow the rate of spread compared to jack pine.
Structures lost: Approximately 27.
Structures surviving: Approximately 39. Many are along the river or otherwise along the fire's flanks.
Crowning continues as fire extends past North Down River Road, but fires of slightly lesser intensity, including some flanking surface burning, reach an area of concentrated homes, suburban-style, at Tubbs Trail.

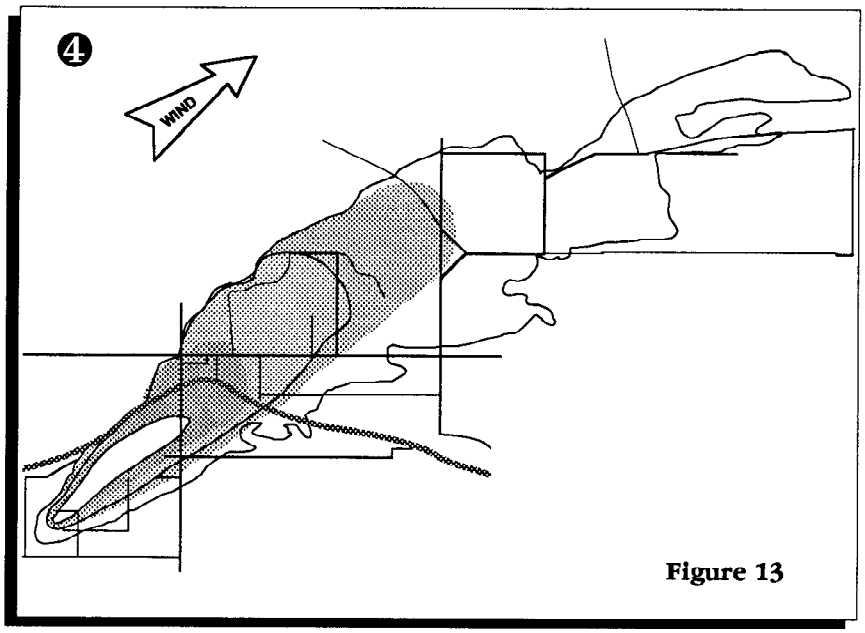


Figure 13

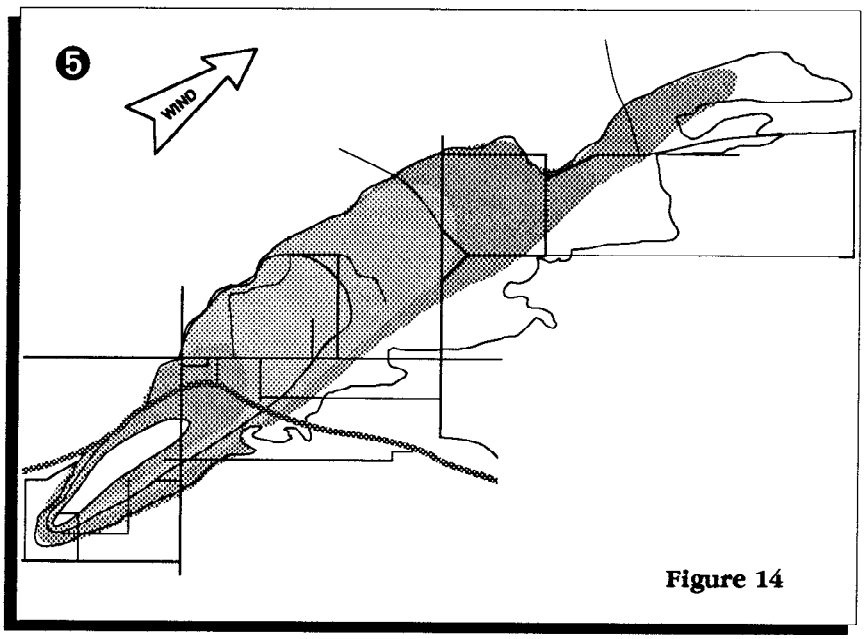


Figure 14

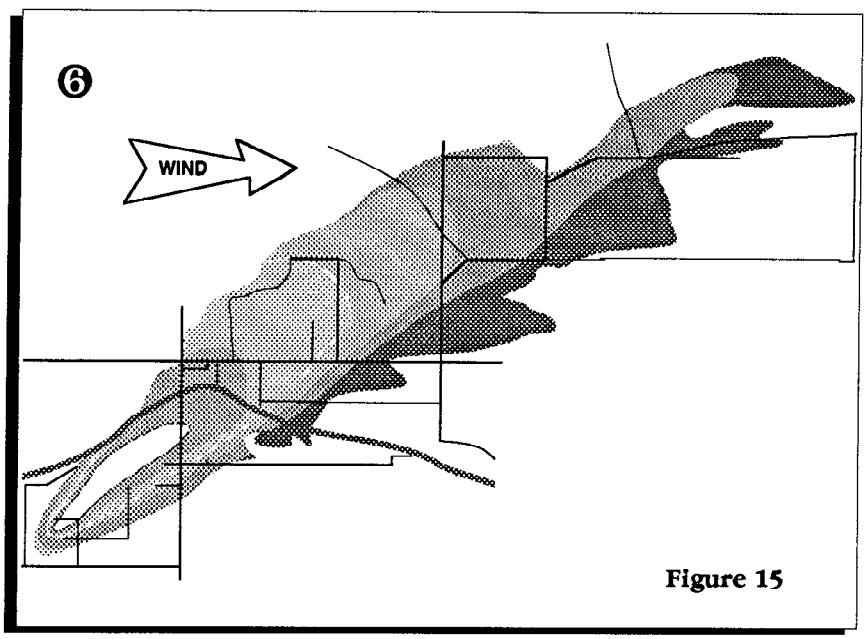


Figure 15

Zones of Fire Extension: 4-6

4

5:30 to 6:22

Rate of spread: 222 feet per minute average.

Fuels: Jack pine.

Structures lost: Approximately 16. Fire spread was rapid but homes in this area were relatively fewer in number.

Structures surviving: Approximately 7. These homes faced slower flanking fires moving north and south from the eastward wind flow.

Compared to the narrow fire front seen in zone 1, the front now is perhaps 3-4 times as wide. This increases preheating on adjacent fuel and contributes to quicker ignition.

5

6:22 to 7:30

Rate of spread: 248 feet per minute average.

Fuels: Jack pine but with relatively large pockets of hardwoods and grass.

Structures lost: Approximately 9. As in zone 4, this area was sparsely populated. Surface fires flanking from the zone 3 burned area probably were responsible for these losses.

Structures surviving: Approximately 34. Almost all of these were on the east side of the fire and faced flanking fires moving out from the zone 3 burned area. Many were along the river and concentrated in the Pappy's Trail area where there was good access for emergency vehicles.

6

7:30 to extinguishment

Rate of spread: 277 feet per minute average. This is an unstoppable rate as long as fuel is plentiful and the winds continue. Fortunately, some precipitation and decreasing winds helped in controlling the fire.

Fuels: Mostly jack pine, but the new wider fire front faced a variety of fuels.

Structures lost: Approximately 7.

Structures surviving: Approximately 22. Most were along North Down River Road where access was good for fire engines.

NOTE: The indications of structures lost or surviving is only an estimate. The indicated zones are not precise areas with actual boundaries, and many structures fall so close to the "seam" between zones that they could be counted in either zone.

STEPHAN BRIDGE ROAD FIRE CASE STUDY

until the fire reached and crossed Stephan Bridge Road at 4:50 pm. About four structures were lost during this initial run.

In the second phase the fire burned into the different fuels along the moist river zone and slowed down. However, spot fires allowed the fire to jump over the river and reach more jack pine stands, resulting in a new increase in the rate of spread. The fire front expanded to twice the width of the initial fire run. The overall average rate of spread for this second phase was calculated at 125 feet per minute. During this phase the fire reached North Down River Road at 5:22 pm. Perhaps nine more structures were lost while the fire was accelerating in this phase.

In the third phase the fire front grew to three times the width of the initial fire run while speeding to an average of 194 feet per minute. Jack pine remained the predominate fuel, with some mixed hardwoods. Perhaps 26 homes were lost during this phase. The fire reached Pine Road at 5:30 pm.

Fire accelerated to an average rate of spread of 222 feet per minute during the fourth phase. Fuel arrangement was similar to the previously burned area, but now the fire front had spread to four times the width of the initial run. As the front widened, the preheating of the adjacent fuels increased accordingly and contributed to continual increases in speed. The fire reached Wakeley Road at 6:22 pm. Approximately 16 additional structures were lost during this phase, some at the head of the fire, but some also on the sides, where the growing fire produced some dangerous flanking fire.

Fire accelerated to an average of 248 feet per minute during the fifth phase, a rate virtually impossible to suppress. Fire lines attempting to cut off the fire to the northeast were initially successful, but a separate run during this phase produced a new elongation of the fire front, as well as a significant narrowing. In this less-inhabited area the fire only claimed perhaps seven structures. During this run the fire reached Section 20 at 7:30 pm, after traveling about 7.5 miles in the three hours and fifty minutes since the fire was discovered.

The arrival of the cold front brought a change in the previously steady wind direction (originally from southwest, then from the west) and began the sixth and final phase of the fire. Gusting winds boosted the average rate of spread to 277 feet per minute. These extreme conditions caused new fingers of fire front to break out in an uncontrollable fashion. Perhaps 15 structures were lost during this abrupt wind change.

All arriving mutual-aid fire units were assigned to clear lines along the flanks or were placed at the rear of the fire, from where they could move up the flanks behind the wave of crowning and highest fire intensity. Where possible without jeopardizing crew safety, units were placed around homes.

Homes in the direct path of the wind-driven, crowning flame front were usually doomed due to the high fireline intensity, regardless of the quantity of personnel and equipment available for suppression.

Typically this high-intensity flame front was relatively narrow. When it burned through a section, subsequent flanking fires spread out laterally at a slower rate of spread. Many homes were nevertheless lost to these slower flanking fires when fire crews could not move in fast enough or in large enough numbers behind the flame front with portable water supplies to hold off the flames. Homeowners were not available to try their own suppression measures against the flanking fires because they were of necessity evacuated from the life-threatening danger of the flame front itself.

Where fire crews were able to follow the flame front more closely, they were fairly successful in saving many threatened homes. Area volunteer fire departments had much of this duty.

By 6:30 pm personnel and equipment were arriving from across the state. A request for all available units, including private dozers, had been made to DNR district headquarters.

Until this time the DNR airplane had performed important overview and fire intelligence duties. Suddenly the radio erupted with *"Mayday! Mayday! Mayday!"* from the pilot. "Got to set it down on the road!" His engine had quit from a broken fuel line.

Anxious moments passed as dispatchers asked for more information on which road the pilot meant. A long silence followed, until finally the pilot reported, "North Down River, but there is too much traffic." Then moments later: "I got it going again. I'm heading for the Grayling Airport." A few more minutes and this episode concluded safely as the pilot reported, "Air 7 is on the ground at the Grayling Airport."

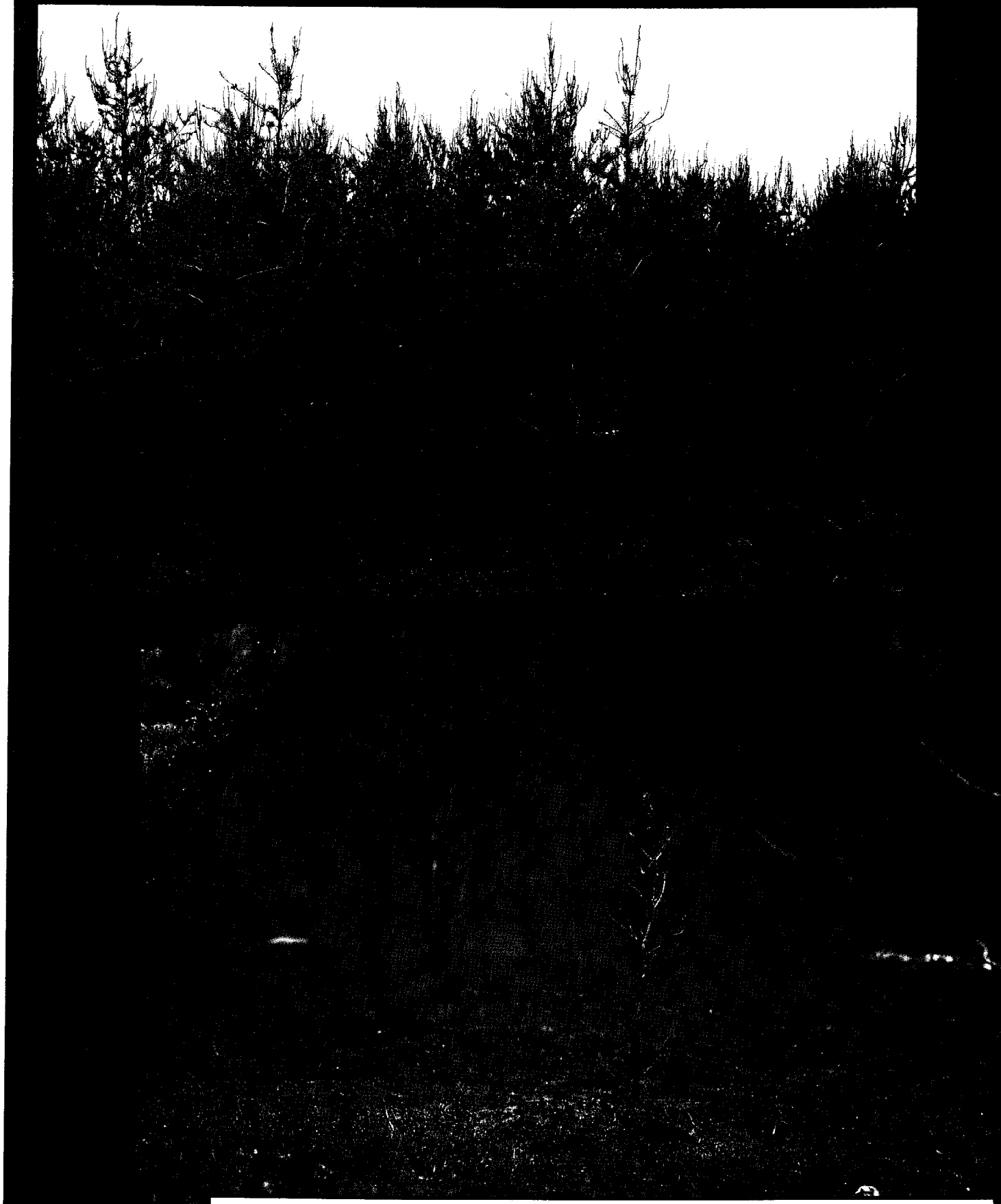
By 7:15 pm the Stephan Bridge Road fire had jumped Bald Hill Road and was more than seven miles long and one mile wide.

Changing weather conditions became of greater concern to the fire suppression management team. The cold front was expected to arrive by 8:30 pm, bringing winds gusting to 60 m.p.h. Those winds previously from the southwest now changed directions

WITNESS:

I never believed a fire could move that fast. The smoke was so thick the sun was just a dim, red ball.

—Julie Gates, wife of Rusty Gates, owner of Au Sable Lodge (from news reports)



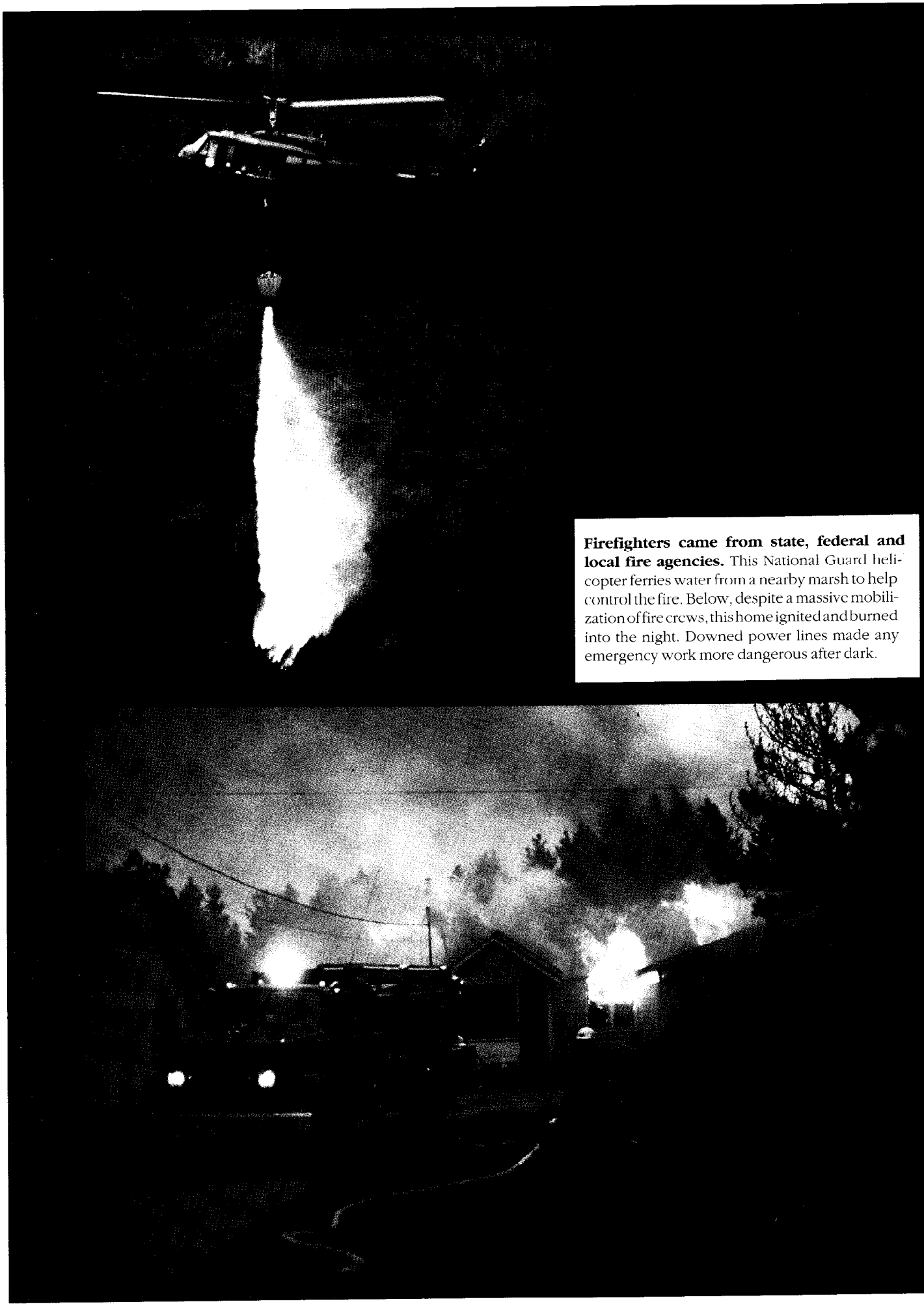
Jack pine, before and after. This species was the most common type of tree in the fire area, producing vegetation regarded as the most explosive fuel in all of the Lake States. It grows in poor, sandy soils where other trees cannot thrive, and it makes dense stands too thick to walk through. Below, very little remains after the fire, but jack pine regenerates quickly. Heat actually helps the cones to open and disperse their seeds.

Fire crosses Stephan Bridge Road. This occurred at the end of the first hour, as firefighting crews and equipment continued to arrive, but already the smoke column indicates a massive fire that can easily extend across the barrier of the road. At this stage, the fire front was spreading at an average rate of about 50 yards every 60 seconds, and evacuation was a major concern. The distance traveled so far was about 1.5 miles, with another 6.5 miles to go before it could be extinguished.

Homes were quickly and continuously overrun by flames. Approximately 200 structures burned, including 76 homes. As more fire crews responded, more homes could be protected, and about 131 structures inside the fire's perimeter were saved. Homes away from main roads were at a greater disadvantage.

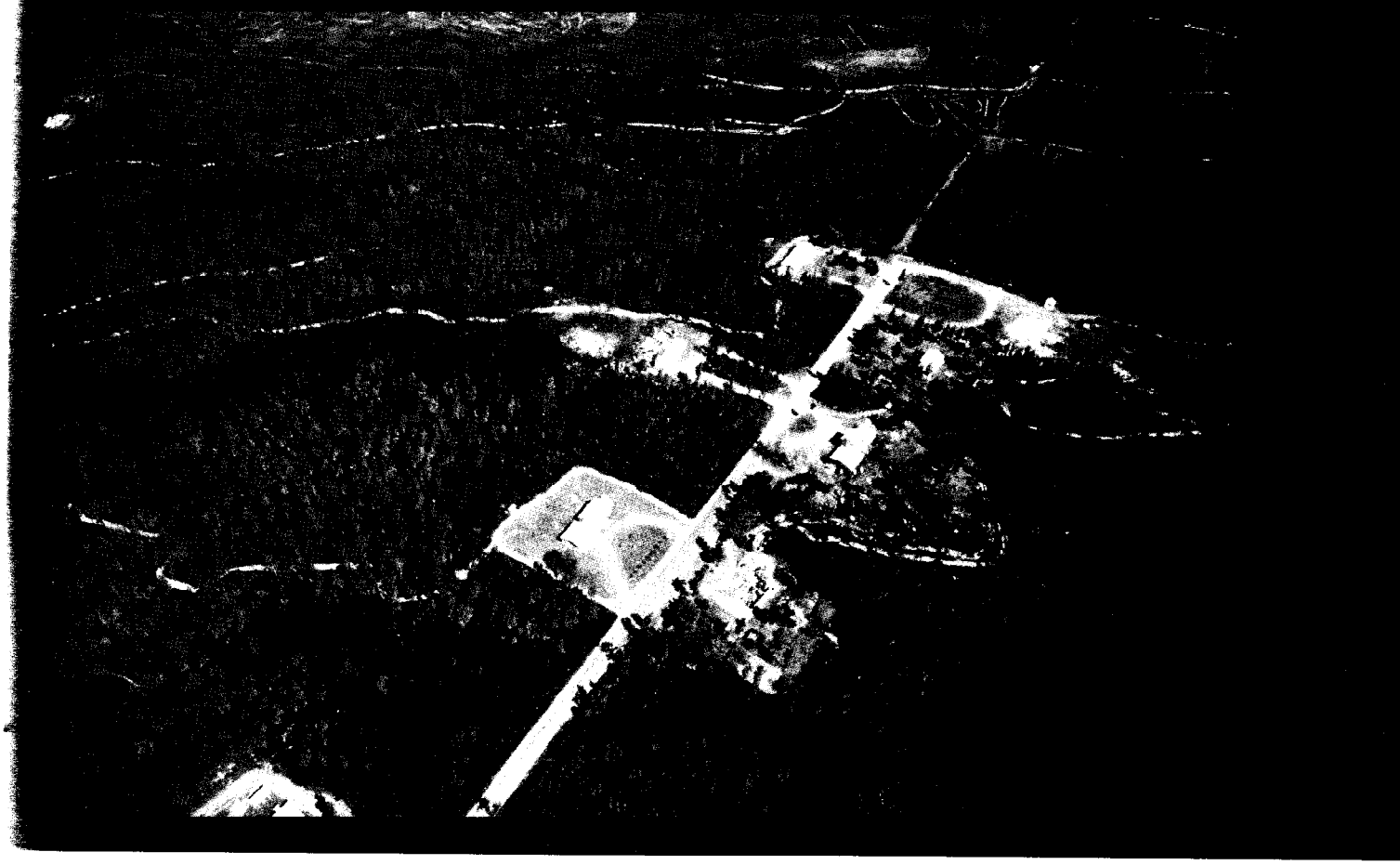
Homeowner preparation and fire crew action affected the fate of many homes. Where residents cleared trees and other fuels from a safety zone *completely around* the home, its chances for survival were greatly increased. After the fire started, plows helped clear a line between burning vegetation and structures.

Enormous power, whether seen from a distance or close up. Above, a massive smoke column indicates a massive fire, and it is moving in terrain offering little to help firefighters or to hamper the fire's spread. At left, firefighters in the rubble that once was a home attempt to uncover the smoldering remains of the fire to complete the extinguishment.



Firefighters came from state, federal and local fire agencies. This National Guard helicopter ferries water from a nearby marsh to help control the fire. Below, despite a massive mobilization of fire crews, this home ignited and burned into the night. Downed power lines made any emergency work more dangerous after dark.

Separate the combustible home from the combustible vegetation. Above, a plowed line helps protect a home, although the trees in the background would remain a major threat if the home had a wood-shingle roof. Below, the home in the lower center survived due to good clearance of surrounding vegetation.



The end and the beginning. Above, plowed lines help pinch the fire against the road, starving denying fuel to the dwindling flames. Additional lines surround spot fires to keep them from starting new fires spreading beyond the tenuous barrier of the road. Below, after the fire is out, a view of the point of origin, looking out to the flat miles ahead where the fire has burned.

STEPHAN BRIDGE ROAD FIRE CASE STUDY

and came from the west. This created a double new danger for firefighters. The wind gusts could create accelerated and erratic fire behavior, and the new wind would push the fire in a new direction unexpected by some of the fire crews. Consequently all units were warned of the wind switch and units on the southeast flank—which is where the fire would now be pushed—were pulled back to safety zones after reinforcing as much line as time and prudence allowed. Aircraft were also advised to seek shelter.

When the winds shifted, the fire made additional major runs to the east. Additional structures were lost during that brief time. Firefighters could do very little for the moment because of the new stream of smoke, blowing embers and intense heat.

This was a critical time. Although the fire had extended more than seven miles, the most intense burning was limited to the northeastern front where winds were still pushing fire into unburned fuels. Some burning extended throughout the day from both north and south sides as the front passed an area and extended to the northeast, but this flank burning was always against the wind and was thus at a much slower rate of spread.

The lower intensity flank burning was a danger and an opportunity. The danger was that this burning was sufficient to ignite a home in its path. The opportunity was that this burning was slow enough to allow fire crews to protect individual homes with engines and hand tools. The difficulty was to assemble available fire plows to conduct operations along both sides of the extended flanks.

Then the shifting winds caused by the passing weather front changed everything. Suddenly the moderate to light flanking fires on the south side of the fire—along the entire seven mile length of the existing burn—were fanned into the flame fronts racing again with the wind. A narrow front became a wide front with an open area of new fuels ahead of it. If not suppressed, it could burn for many additional miles and threaten numerous more homes.

Then the shifting winds caused by the passing weather front changed everything.

The passing front also represented some good news. At 8:40 pm as the front passed, the winds died down, the temperature dropped and a small amount of rain fell. That rain amounted to only a tenth of an inch, but in combination with the other changes it significantly slowed the fire's spread.

Equipped with lights, fire suppression units continued building a containment line around the fire. Other crews moved in again to check structures and rework the new flanks. They made definite progress while trying to avoid a particular safety hazard: downed and falling power lines. Power company crews worked through the night securing lines that had fallen.

The National Guard base four miles southwest of Grayling provided a D-7 dozer during the evening and two helicopters with Bambi buckets during the second day. The water drops were extremely effective in swampy areas where heavy ground equipment was unable to get through.

Fire conditions remained low the next day. Containment lines were completed. Power company crews replaced poles and other lines that were damaged.

At 10:00 pm on the second day the fire was officially declared contained. In the days that followed, the weather helped lower the fire danger in the region with several cool days of rain and snow. Fire crews remained in the local area for final mop-up action. The fire was declared out on May 13 at 1:00 pm.

No lives had been lost. One volunteer firefighter received treatment for smoke inhalation.

EVACUATION ACTIVITIES

Emergency evacuation became an issue as soon as the first fire control and local law enforcement personnel arrived on the scene.

Michigan Department of Natural Resources fire management personnel arrived on scene and took command by 4:39 pm. The team consisted of the fire boss, plans coordinator and resource coordinator. They quickly sized up the rapidly spreading fire as a major operation, but they immediately had to divide their attention between suppression efforts (including organizing the fire base) and the evacuation of residents in broad, scattered areas in front of the fire as well as along the flanks.

Access would quickly become a problem. Although many road and trails followed section lines in the area, homesites were often at dead-end trails or driveways. DNR conservation officers converged on the scene and were assigned evacuation duties. On several occasions they found themselves nearly trapped by the fast-moving fire as they checked homes on these divergent and dead-end trails. The early evacuation efforts proceeded more from dramatic urgency than from any plan.

The fire boss requested additional assistance from the DNR district office at Mio. Sheriff's deputies soon arrived from adjacent counties to help with evacuation. Personnel from more distant adjacent areas had less detailed knowledge of the layout of homes in the fire area, but the extra personnel were essential to spread out over the affected area. Incoming law enforcement agency personnel were assigned priority areas, such as Pappy's Trail, Evergreen Road, Tubbs Road, Shaw Park Road, Stephan Bridge Road, Pine Road, North Down River Road and other connecting trails (see Figures 17–19).

Evacuation supervisors set up in the DNR communications van and moved evacuation communications to channel one from the suppression operations on channel two. This reduced the radio traffic on both channels.

Shortly after 5:00 pm the evacuation effort focused on North Down River Road from Stephan Bridge Road all the way to Wakeley Bridge Road, a distance of 2.5 miles. This portion of the evacuation was probably the most hazardous for law enforcement personnel due to the road system and the speed of the fire at that time and in that particular location. Numerous homes were located on dead-end trails off North Down River.

On several occasions they found themselves nearly trapped by the fast-moving fire as they checked homes on these divergent and dead-end trails.

A second major fire near Roscommon to the south (the Billman fire) also required attention at this time, drawing off personnel and equipment. Everyone involved in the evacuation had to do the best they could despite high demands on the available resources.

The DNR airplane that had discovered this fire remained in the air and assisted the evacuation by using its PA system to direct fleeing residents away from the fire. This assistance was lost when the pilot reported his own emergency and had to set down back at the Grayling Airport. The fire base command post requested a replacement airplane from the Gaylord District. This unit eventually arrived over the fire after breaking away from other fires in its original district.

Roads were closed to sightseers, but traffic control became a major problem due to congestion of residents trying to reach their homes or flee from them, as well as from the influx of sightseers. An incident occurred around 7:45 pm. in which a man with a gun in his truck was becoming unruly. Two conservation officers apprehended the man, but the incident resulted in additional danger to officers and a temporary loss to the evacuation effort.

When forecasters determined that the approaching cold front would be arriving in the fire area by 8:30 pm, instead of the original later forecast of a 6:00 am arrival, fire management personnel expanded the evacuation area to the east and southeast in anticipation of the new wind direction.

During a night meeting personnel planned a systematic search of all lost structures in the morning for safety concerns and to determine that all residents had successfully evacuated. Roads remained closed until the next day after these checks were made.

The National Guard, American Red Cross, local churches and schools opened facilities to help the more than 300 people who were evacuated, many not certain if their homes had survived

WITNESS:

They said to just get the hell out of there.
—Joani Massara, resident
(from news reports)

or been destroyed. Local merchants provided food and clothes. Civic organizations helped with damage assessment and care of displaced people.

Residents were allowed to return to their property at 4:00 pm the second day. The governor and other state officials toured the area and declared a state emergency so that residents could qualify for state aid. Later in the week the designation was upgraded to a national disaster area, making federal funds available for recovery efforts.

STEPHAN BRIDGE ROAD FIRE CASE STUDY

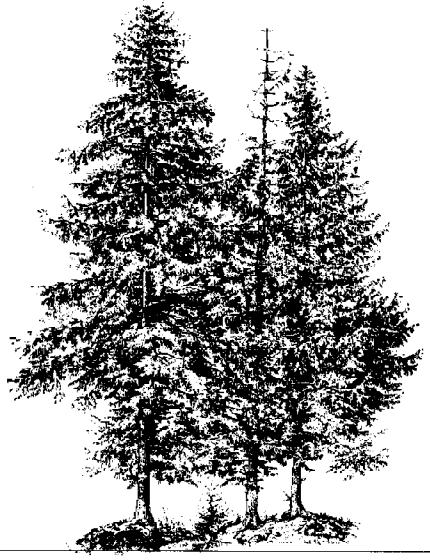
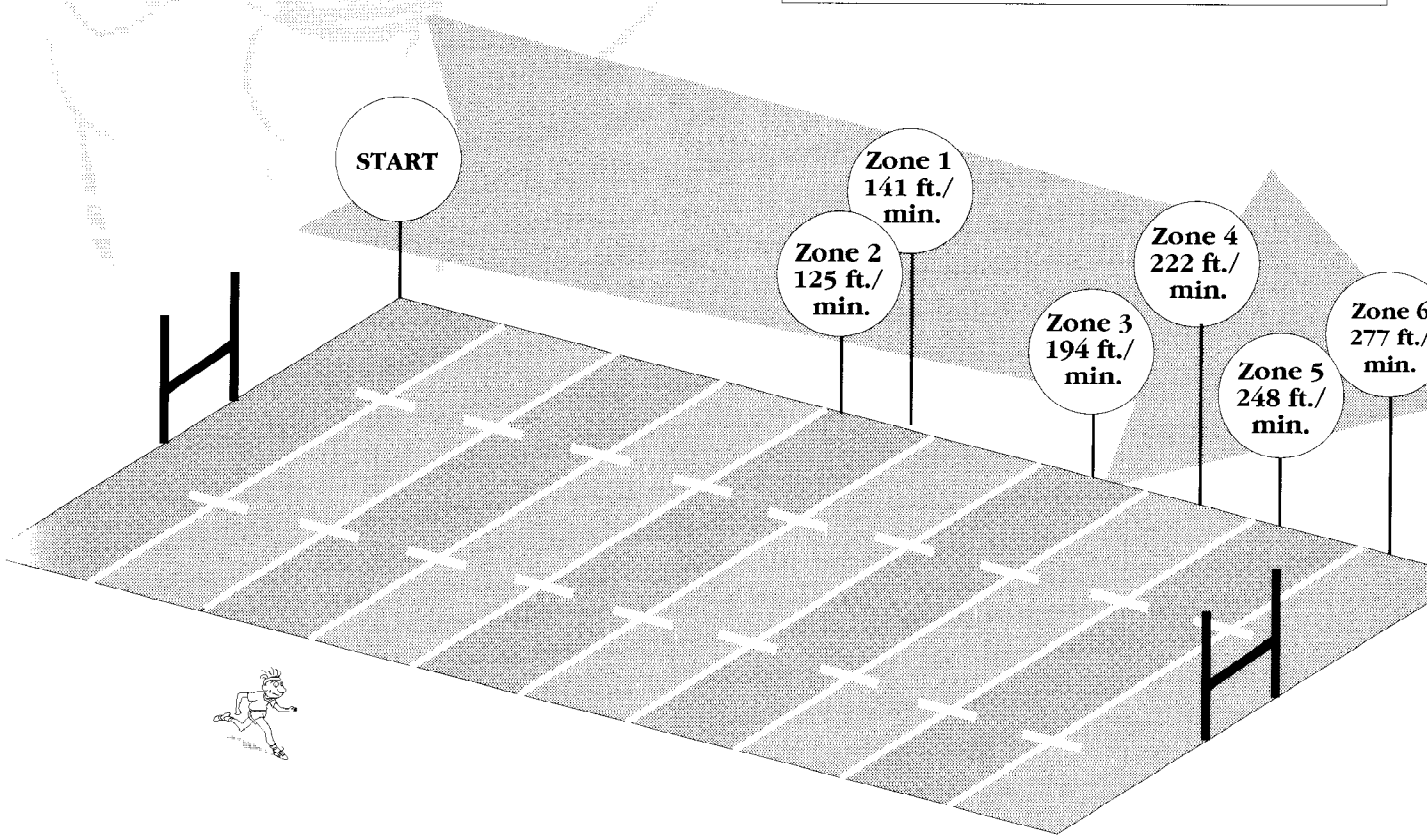


Figure 16

Visualizing the Fire's Rate of Spread EVERY 60 SECONDS!

Every minute, the fire advanced an average of the indicated distance, shown here against a football field to help visualize the distance. This placed tremendous strain on evacuation efforts, positioning of equipment and overall suppression activities.

Figures 10–15 describe the fire zones experiencing the rate of spread information given below.



STEPHAN BRIDGE ROAD FIRE CASE STUDY

ANALYSIS

Spring fire season in Michigan often presents a dangerous combination of weather conditions conducive to a major fire. The moisture content of jack pine foliage is at a minimum during the onset of new growth in the spring. This increases crowning potential up to 100 percent over foliage in the fall. These changes are incorporated into fire management planning in Michigan and should be elsewhere.

By the end of the first week in May, officials from state, federal and local fire agencies knew that dangerous wildfire conditions were present. History suggested that the month of May was annually the time of highest fire danger. Indeed, a worst-case scenario had developed on May 6, 7 and 8, combining the known hazards of extreme low precipitation and humidity, high winds, rising temperatures, and abundant fuels, mainly in the form of jack pine. All that was missing for disaster to strike was an ignition source. Lightning-caused fires in this region are not common; if an ignition occurred in the ready fuels, it would be more likely from human activity.

The region featured flat terrain that offered few obstacles to a wind-driven wildfire. The Au Sable River could serve as an obstacle, but only if the approaching fire burned along the surface. In this case a high intensity crown fire approached and extended beyond the river as if it were not present.

When all of these conditions are present, a fire quickly exceeds the suppression capability of any available force. Fire crews in this wildland area had no large system of water mains to help quench a broad flame front. Once started, a fire in the region could be expected to spread fast and far, destroying the forest, animals, homes and people in its path.

Despite the serious annual threat of fires in the region, residents built numerous homes among the trees and failed to take recommended precautions. Repeated fire prevention messages to these residents over recent years urged them, among other things, to provide a cleared or thinned safety zone around their structures. In too many cases this was never done.

By May 8 it was too late to begin the process of clearing combustible vegetation from homesites; serious fire danger was already present and DNR personnel knew it. Fire personnel and equipment continued on alert status. Public messages on television, radio and in print from the Michigan Interagency Fire Prevention Group attempted to warn of the current critical danger. Nevertheless, ignitions occurred and fire crews saw action with increasing frequency in the days leading up to May 8.

The affected area was too large to patrol on the ground, but Michigan DNR airplanes were in the air to provide the fastest-possible detection and alarm of any new fire. Given the widespread danger, everything possible was being done to allow rapid response in attacking the next fire to be ignited.

Despite the serious annual threat of fires in the region, residents built numerous homes among the trees and failed to take recommended precautions.

■ Fire Origin

The manner of fire origin at this incident was seemingly against all odds but demonstrates the insulating ability of earth on smoldering combustibles. Prolonged burning can result and illustrates that proper care and precautions must be taken.

The bulldozing and subsequent burning of the cleared timber resulted in a certain arrangement of the dirt, fuels and available oxygen that allowed an extended period of smoldering without visible exterior signs.

The sandy soils functioned as an insulator to hold in the available heat within the pile. With any less dirt, the heat would have escaped to the air faster, and the fire would have died.

The peculiar arrangement of the pile also allowed a sufficient supply of oxygen to be trapped among the smoldering wood. If a more abundant supply of oxygen had been available, the fire would have produced additional—and probably noticeable—heat or smoke; if any less oxygen reached the fire, it would have died.

That the actual amount of insulating dirt and the supply of oxygen remained within these narrow limits for so long is extremely unusual but not without precedent and illustrated precautions for such a burning operation. A wildfire the weekend before this fire, in Kalkaska County west of Crawford, was the result of slash piles

Witness:

Jonathan Weymers, 21, had gone downstate to pick up a bed. He returned with his wife and daughter to find that everything except the bed had been destroyed by the fire. They did not have any insurance.

(from news reports)

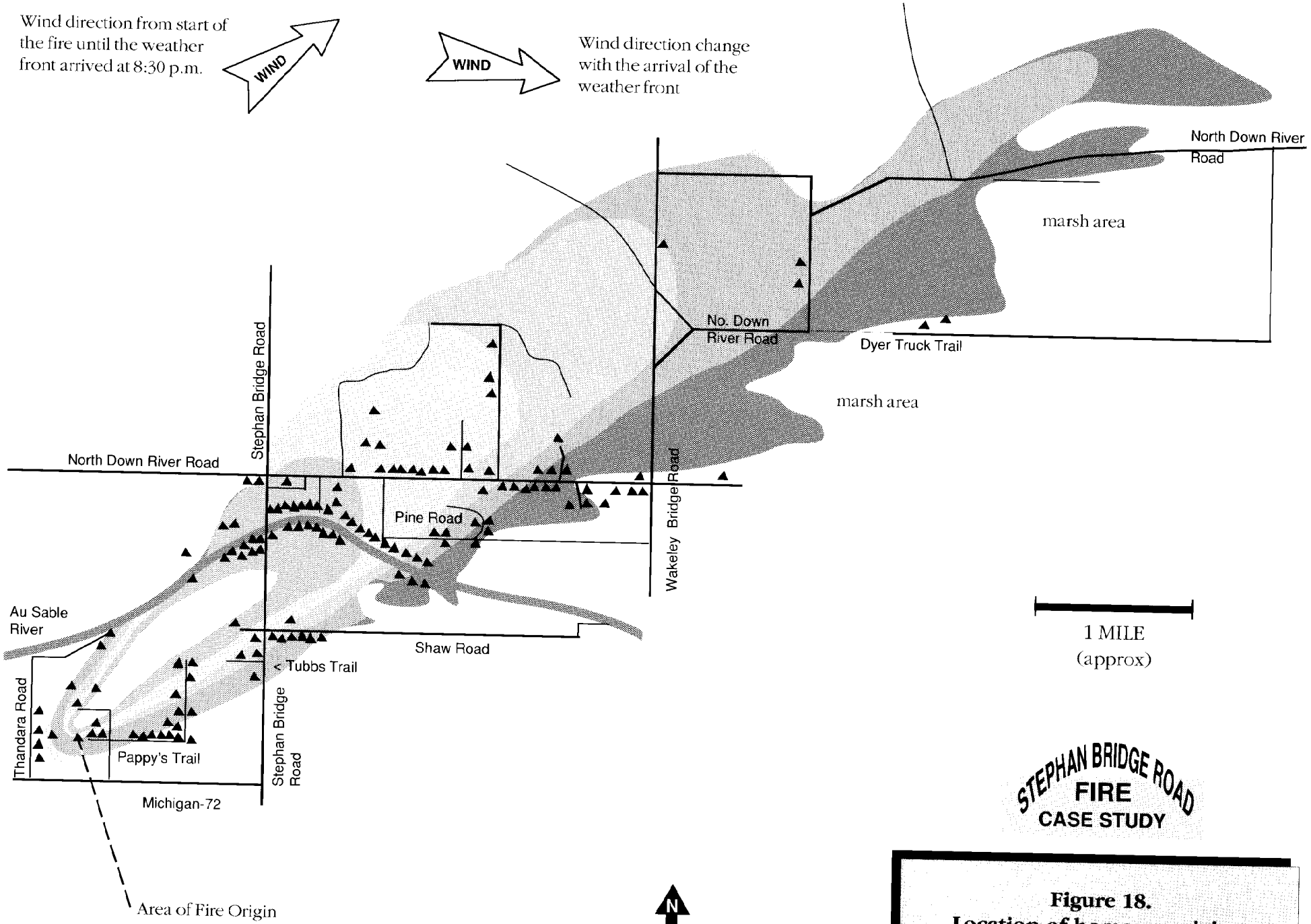


Figure 18.
Location of homes surviving.

that had been burned the previous November. When the rare situations occur there are usually three common denominators:

- The brush has been piled up with machinery, causing dirt to be mixed with the slash. These piles are often quite large.
- The area is experiencing dry conditions if not outright drought. This makes the larger fuels dry enough to continue smoldering.
- The situation usually misleads the individual doing the burning into thinking that the fire is out. Then when the next strong wind comes up, the fire escapes.

Meanwhile at the hidden, smoldering brush pile, the increasing winds of early May served to blow away the insulating dirt and outer debris from the pile layer by layer—while adding more and more oxygen to the smoldering core—until finally creating an open burning condition. At this point the effects of the wind and the fuel type became significant.

■ Fire Spread

The combustible conditions of adjacent ground fuels led to a severe ground fire that grew in area and in fire intensity. The significant ground fire was soon able to involve the ladder fuels and reach the crowns of the jack pine soon after detection. The low moisture content and density of the jack pine resulted in the intense and rapidly spreading fire that threatened homes almost immediately.

Fuel type and arrangement were important factors in that fire spread, but wind speed was the greatest single determinant of rate of spread at the Stephan Bridge Road fire:

- While the winds remained between 20 and 30 m.p.h., rate of spread varied between 108 and 158 feet per minute.
- As the winds increased to the 30 to 40 m.p.h. range, the rates of spread increased to between 158 and 203 feet per minute.
- When the winds peaked at 50+ m.p.h. as the cold front passed, the rate of spread hit 277 feet per minute.

By comparison, the Black Tiger fire featured upslope winds and a rate of spread ranging between 25 and 78 feet per minute. Homes were lost at Black Tiger to fires spreading at its lower range of 25 feet per minute, yet the Stephan Bridge Road fire at its slowest rate of spread was nevertheless faster than the Black Tiger fire at its top rate.

The tremendous amount of heat generated by a typical major fire in jack pine can form a towering convection column of smoke and embers reaching 8,000 to 10,00 feet high. In the absence of winds, more of the embers soaring up such a convection column burn out before dropping back to the ground. Because of the high winds accompanying this fire, however, the convection column did not rise so high but was pushed forward, preheating the combustibles (homes and jack pine) ahead of the fire front and carrying burning embers even greater distances as well. Many of the embers created spot fires that grew in intensity and created fire conditions that fire managers described as "burning in waves."

Further accounts from firefighters tell of houses with roofs glowing with embers, and of burning embers "raining" around them. This activity caused continuous spotting over control lines, making suppression work extremely hazardous. Some spotting is believed to have occurred over a distance of 1/2 mile.

■ Fire Suppression

DNR and local fire department personnel deployed along the flanks of this wind-driven fire, attempting to pinch the front to a narrowing size. Tractors attempted to cut fire lines to curtail the affects of the subsequent ground fires; actual suppression was impossible for the crown fire ahead of them.

In areas where the fire had moved through, additional fire crews responded to protect those homes that had survived the fire front. If access to a particular home allowed a rapid exit if necessary, the crews extinguished burning vegetation and grass adjacent to the home. Then the crew relocated to another home. These actions were responsible for saving many homes.

These suppression efforts continued for the next several hours while the fire made several runs and threatened more and more area and homes.

Fire commanders were hoping that, as winds died down during the evening hours, their suppression efforts would allow them to get ahead of the fire and stop its tremendous leaping progress. Weather reports seemed favorable to these tactics, but fire command officers looking into the sky observed that the front had moved into the area sooner than expected. Fire commanders knew what this would mean: shifting wind direction with increasing wind speed.

This would also threaten fire crews working on the south flank of the fire. Fire commanders realized the potential devastating results:

- Firefighter lives could be lost.
- The front of the fire would extend the entire south flank of the fire, creating an 8-mile front instead of the much smaller existing front.
- An abundant amount of fuels to the south—and numerous people and homes—would soon be exposed.

Fortunately, in this fire, the front also contained a small but important amount of precipitation that prevented a worst-case-scenario of devastating results. Reduced winds followed. The main head

STEPHAN BRIDGE ROAD FIRE CASE STUDY

The moisture content of old jack pine foliage is at a minimum during the onset of new growth in the spring.

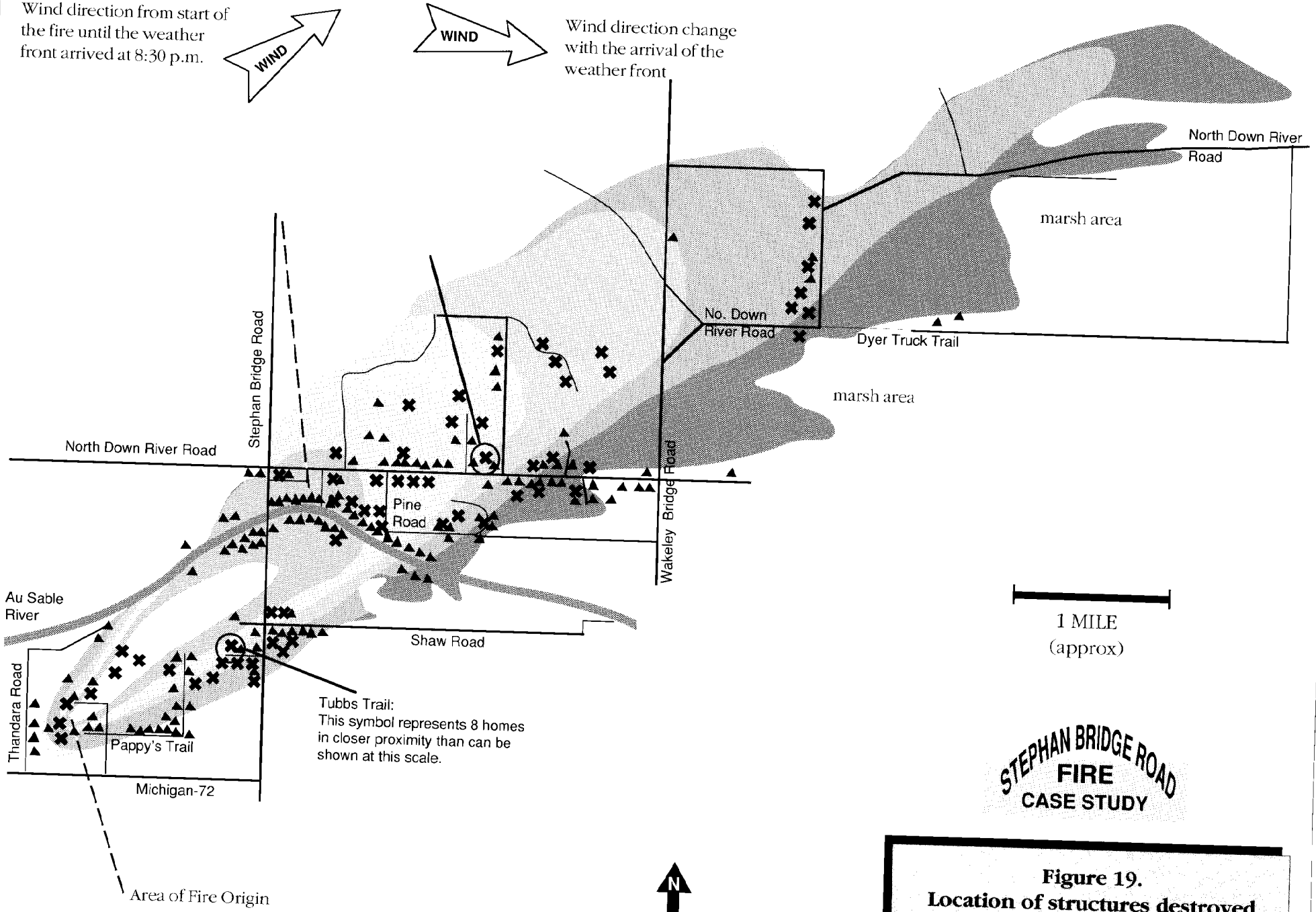


Figure 19.
Location of structures destroyed and homes surviving.

of the fire was stopped and fire crew would take advantage of the reduced intensity and work over the next several days on extinguishing the remaining pockets of fire.

■ Loss of Structures

Many homes in the direct path of the main fire front could not have been saved by any available fire fighting force. Several conditions made this a reality:

- Piped water supplies were not available.
- Fire spotting over the heads of fire crews could have trapped them if they tried to attack at the head of the fire.
- Inadequate clearance of combustible vegetation allowed the fire to burn right up to the structure—and into it.
- High winds held more heat lower to the ground in front of the fire and increasingly preheated a structure before the fire front arrived. This massive radiant heat could even overcome the benefits of greater vegetation clearance. Such a preheated structure tended to burst into flames all across the structure, making control impossible with the available water supplies.

Even so, in many cases homes were spared. Investigators felt that the lack of combustible roofs played an important role in their survival. Further, they observed that fire suppression crews worked hard to extinguish the ground fires near the homes that survived the crown fire. Finally, they observed that survival was more likely if clearance from combustible vegetation was present.

■ Structure Survival In or Near the Fire Zone

More structures survived the fire than were destroyed by the fire. The map in Figure 18 shows the location of the surviving structures within the fire area. The indicated structures generally fall into three groupings:

- ***Those facing slower-moving flanking fires.*** From the area of fire origin (lower left), the fire raced with the wind to the northeast. After the main fire front extended past each center area, fire continued to spread out to the flanks, but at a slower rate because this was at right angles to the wind. Homes in the flank areas generally faced flames that were less intense, and the slower spread rate allowed more options for fire crews to move in and defend single homes and groups of structures that were relatively close together.
- ***Those located along the Au Sable River.*** The river contributed to a microclimate that helped reduce fire intensity in that area. Tree species along the river were less conducive than jack pine to rapid burning and crowning. Increased humidity was another factor. Vegetation of all types grew more densely along the river because of the additional moisture; that density further helped hold to humidity even during windy conditions. Unfortunately, the wind was strong enough to help the fire spot over the river and continue burning into new stands of jack pine.
- ***Those in the path of the main fire front.*** These structures were often facing the head of the fire, with its higher burning intensities. Determination of why individual structures survived in the face of such high intensity burning requires a case-by-case analysis based on conditions existing before the fire. Structures survived the main fire front north of North Down River Road and also south of that road after the wind changed direction around 8:30 pm.

Investigators observed many instances where homes had narrowly survived. They observed ground fires that burned to the foundation and ignited combustible construction, but the fire did not continue to propagate. Further, they observed ignition of combustible porches and steps that again did not continue to propagate. Some of these were attributed to fire crews' intervention, but some lacked a technical explanation.

STEPHAN BRIDGE ROAD FIRE CASE STUDY

NFPA 299, *Standard for Protection of Life and Property From Wildfire,* presents minimum planning criteria for the protection of life and property from wildfire.

■ NFPA 299

NFPA 299, *Standard for Protection of Life and Property From Wildfire,* presents minimum planning criteria for the protection of life and property from wildfire. It includes information on safe procedures and practices at the wildland urban interface. The purpose of this standard is to provide this criteria for fire agencies, land use planners, architects, developers and local government for fire safe development in areas that may be threatened by wildfire.

This standard will be voted upon at the May 1991 NFPA Annual Meeting in Boston. The content details are subject to change at that meeting, but the final document is expected to present useful information that would allow homeowners to better evaluate their current homes and homesites—or homes being considered for purchase—with regards to wildfire survival.

Information in the latest draft version of the standard provide assistance in determining the hazard rating for surrounding fuels, slopes, structures and the broader wildland/urban interface area itself. Guidance is given for fuel modification planning and creation of defensible space, design requirements for roads and driveways, and other factors. An appendix addresses public firesafety and fire prevention education.

Contact NFPA for ordering information when the final standard is issued.

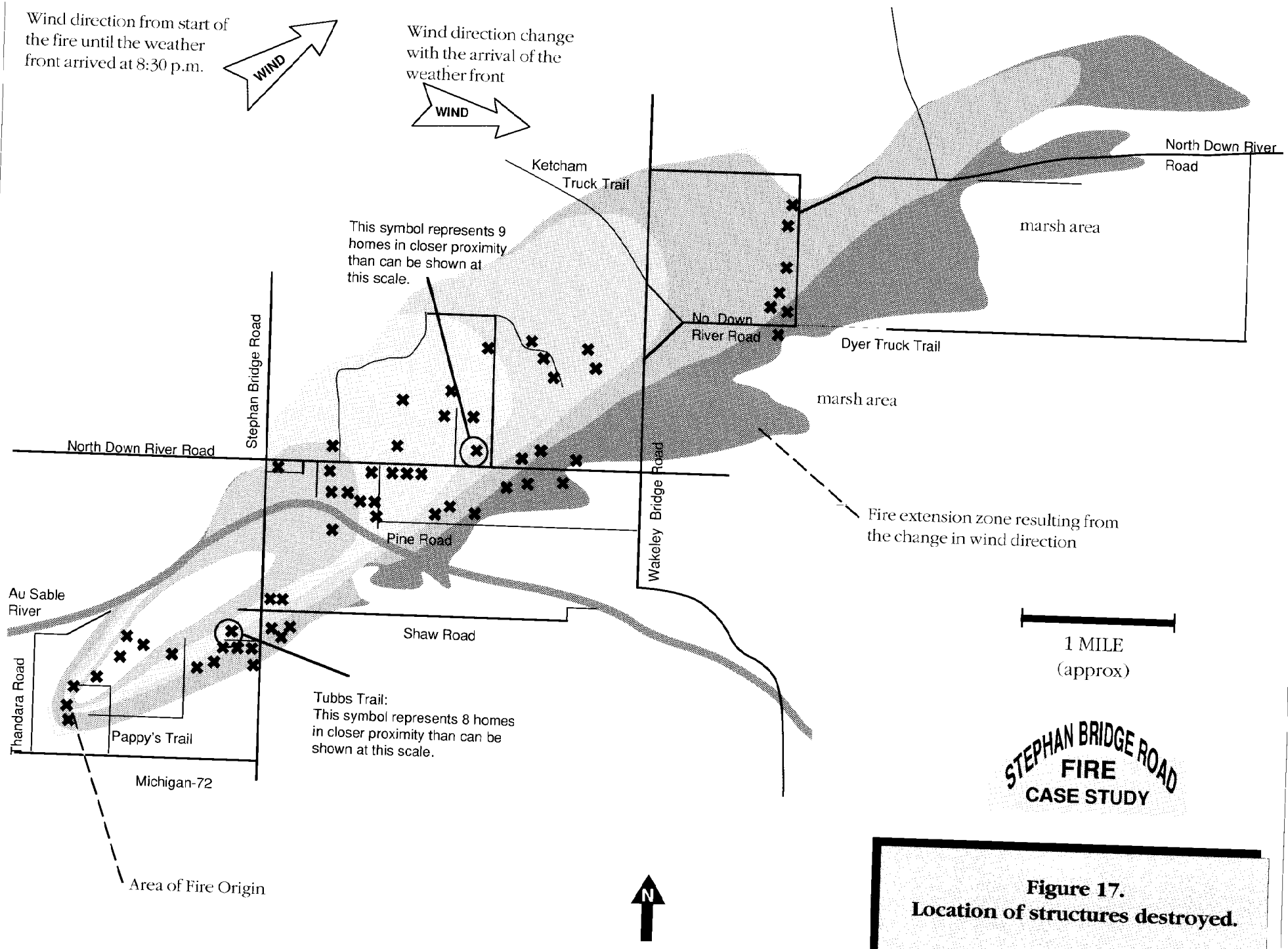


Figure 17.
Location of structures destroyed.

CONCLUSIONS and RECOMMENDATIONS

The Stephan Bridge Road fire resulted in the loss of almost 6,000 acres of natural resources, numerous structures and personal property, and threatened many lives. This fire demonstrates not so much the effect of a single particularly dangerous factor, but instead shows the cumulative effects of a number of multiple factors. The analysis indicates that these factors are very predictable and can occur at least annually. To reduce the likelihood of severe losses combined efforts of community organizations: fire services; federal, state and local governments; and individual homeowners are necessary. The Stephan Bridge Road Fire has resulted in a greater local and statewide awareness of the problems associated with the wildland/urban interface. Nevertheless, a continuing and expanded effort must be undertaken to inform the public nationwide of the potential hazards involved in interface areas, to inform them of how they can assess the hazards in their area, and to assist them in alleviating the hazards. Clearly, this effort cannot be accomplished by just the *individual* efforts of one of the above listed groups.

The Stephan Bridge Road Fire dispels the perception that major wildland fires occur only in the western portion of the United States. The Stephan Bridge Road Fire demonstrates the susceptibility of an additional region of the country equally as large as the western state region. Combining these geographical areas with recent wildland fires in the North Carolina and Florida regions elicits a sobering conclusion: each of us need to be more aware of the factors involved in devastating wildland fires in order to better assess our risks and to implement fire prevention measures.

Based on NFPA's analysis of this incident, the following are significant factors affecting the outcome of this fire; each is followed by specific recommendation(s) on how they might be mitigated.

■ **The nature of the fire ignition.** Careless burning of trash or debris is the source of too many wildfires, but the scenario of this fire would not qualify as a typical careless burning. Two burning permits were requested and received. The burning was allowed and was done when authorities determined that conditions seemed to ensure that the fire would not spread. However, a smoldering fire continued into the spring when winds removed portions of the insulating dirt, accelerated the burning and transported dangerous embers to adjacent fuels.

❑ *RECOMMENDATION: Persons involved in land clearing activities need to be aware of the prolonged burning potential that occurs when dirt is integrated into controlled burning sites. Land clearing equipment such as "rakes" could substantially reduce the build up of dirt on burning piles compared to that accumulated by the more typical "blade" operation.*

Agencies issuing burning permits might want to consider highlighting this issue on the burning permit application. If on-site inspections are made by the issuing agency, verification of compliance and communication of the phenomenon can be also reduce unwanted extensions of the fire. Computer files of the burning permits could be searched upon approach of fire season to determine if further inspections are necessary.

The public needs to be made more keenly aware of the times when wildland areas are highly susceptible to destructive fires. They must realize that human-caused fires top the list of the causes of wildland fires in this region and that they have the power to reduce such ignitions. For the most part ignition sources provided by humans occur year round in wildland areas. Yet because of the nature of fuels or weather, sustained ignitions do not occur frequently at these times. However, during the spring of the year when the nature of the fuels and weather change, the number of potential ignition sources increases dramatically. Specifically, land clearing or brush burning and other like activities that typically parallel the ritual of spring significantly increase the likelihood for sustained burning and disaster. Public awareness campaigns, such as those undertaken by DNR in Michigan, need media

This fire demonstrates not the effect of a single particularly dangerous factor, but instead shows the cumulative effects of a number of factors.

and public support in order to be successful at ignition prevention. The community, government and the public equally share the responsibility of informing others, ignorant of the potential results of their dangerous actions and of the devastating results that can occur. Neither the government nor fire service could ever be successful at this task alone.

■ **The windy and drying weather conditions.** Drought conditions over an extended period of time reduced the moisture available for the roots of growing vegetation. Increasing winds and temperatures from May 6 through May 8 further depleted fuel moisture from both living and dead vegetation. The result was that combustibles in the area were more susceptible to ignition sources and more rapid fire spread after ignition. Human intervention cannot change these weather-related factors, but their seasonal nature and predictability do provide a motivation to address other factors that also contribute to fire spread and loss of life and structures.

☐ *RECOMMENDATION: Acute public awareness and specific precautions regarding care with ignition sources needs to occur. Further, increased planning and coordination of public agencies will result in more rapid detection, response, deployment and suppression of wildland fires. These efforts usually result in more awareness and attention being given to wildland fire potential. Prevention is an achievable goal that saves valuable resources and lives.*

■ **The type and arrangement of the fuels on flat terrain.** Dense jack pine forests provide significant amounts of fuels that result in devastating wildland fires. Their susceptibility to even more rapid spread occurs in the spring of each year. Also contributing to this rapid fire spread is flat terrain, which allows unrestricted spread of a wind-driven fire. The one major break in the fuels, the Au Sable River, was not sufficient to stop the crown fire approaching it.

Jack pine is especially subject to crown fires and resulting fire spotting ahead of the main fire front (in this case as much as a half-mile) adds to this known hazard. Large crown fires will continue to be an intermittent fact of life in jack pine forests.

☐ *RECOMMENDATION: Michigan DNR officials are keenly aware of the fire potential in the region. There does not appear to be a similar awareness on the homeowners part of this hazard and its seasonal variations. Further, the public seems unaware of the prevention measures currently available to them on what actions they might take to protect their homes. Considering the combustible nature of the wildlands in this area, if homeowner precautions are not taken, predictable results can be foreseen. Community, fire service, government and private sector involvement on a focused goal of awareness and prevention will reduce risks. Funding and support of such programs by government and private sector initiatives should occur to counterbalance the wildland fire hazards in this area.*

Guidance is available from local and national sources to help homeowners determine the size of an adequate clearing.

■ **The type and arrangement of structures in the forested setting.** A wood-frame structure in a wildland setting represents a lack of consideration of the natural occurrence of fire in such areas. Although much can be done to prevent ignitions, natural fire has long been part of nature's "cleansing process" of the forest. Man must learn to live with this natural process. He must be aware that combustible building materials used to construct his home allows the fire to jump from the burning natural vegetation to the home itself. Analysis of this fire indicates that this resulted in the destruction of many homes. Although wood roofs were not common in this fire area, a wood-shingle roof is even more of a danger to a home. However, wood construction of siding, decks, porches and connecting fences were very common in the Stephan Bridge Road Fire area.

☐ *RECOMMENDATION: New structures should be built with materials that do not facilitate the spread of wildfire to the structure, and although not involved in this fire, non-treated wood shingles should be prohibited from use (conclusion from prior fires investigated). Further, combustible materials (such as from wood piles) and vegetation need to be placed far away from homes. Even brick homes have numerous points of fire entry from an adjacent fire. Again, numerous publications exist to offer guidance in constructing homes with fire-safe materials. Public awareness campaigns are essential, however to be successful, the homeowner must be convinced that a potential problem exists or that his or her family is at risk if nothing is done.*

■ **Failure to clear combustible vegetation from homesites.** In addition to the rate of spread and intensity of the fire, assisted by the weather and the physical arrangement of the fuels, a major factor determined in the loss of structures and vehicles to this fire was the lack of adequate clearing between them and the highly combustible vegetation. Guidance is available from local

and national sources to help homeowners determine the size of an adequate clearing. The public has the power to take reasonable steps to improve the chances of their homes to surviving a major wildfire. However, the public must accept the possibility of wildfire threatening them personally. History proves the predictable nature of wildfires in this region of the country.

☐ *RECOMMENDATION: Public awareness campaigns are essential and perhaps community groups and organizations need to become more involved with the fire service on sponsoring "clean-up campaigns." Homeowners from the community organizations can, for example, offer to have predisposed factors that can destroy homes remedied. Broadcasting of such improvements could then be used for public service announcements and news stories during peak hazard times.*

■ **Public apathy to fire prevention and fire protection messages.** Many of the residents of this wildland/urban interface area displayed a dangerous indifference to known hazards. The area has a clear history of crown fires in jack pine, and May is the most common month for a disastrous fire, yet homeowner throughout the area remained unprepared. Remarkably, homeowners fail to properly perceive and act on these obvious threats. Public fire education is a natural response to public apathy, and more can be done in this regard. Of course, this implies more support and funding, as well as more-focused efforts.

Area fire agencies were active in trying to make homeowners more aware of the wildfire danger. However, the success of fire prevention efforts is not measured in the number of brochures distributed nor the number of television announcements broadcast. Effective public fire education results in changed behavior.

☐ *RECOMMENDATION: Government officials need to be more aware of how the modest funding levels for such fire prevention programs can ultimately save millions of dollars spent after a devastating loss such as the Stephan Bridge Road Fire. Further, utilization of the media for public service announcements can reach large numbers of people and have positive effects. The media must be willing to avail key broadcast times to fire service organizations in order to maximize awareness and reduce apathy.*

■ **Interagency cooperation.** Major wildland fires by definition affect large areas and may threaten large numbers of people. Typically, no single agency has the resources to deal effectively with so large an incident. The simultaneous demands for suppression, evacuation, public information and the coordination of diverse efforts in the air and on the ground are daunting. Repeated incidents have demonstrated that investing time before a major fire to plan and train for coordinating interagency operations is well worth the effort.

☐ *RECOMMENDATION: It is hoped that other agencies, if they have not already done so, will also prepare for the overwhelming attention to detail necessary in: (a) planning for rapid detection of a wildfire during time of a high risk, (b) massive response of personnel and equipment applied to a wide area, (c) large-scale evacuations in the face of a rapidly spreading fire, and (d) coordination of forces leading to eventual control and extinguishment. Awareness of changing weather patterns is one of a hundred other details that can affect a successful conclusion of a disastrous wildfire. This information was essential to fire service managers of the Stephan Bridge Road Fire. Although the changing weather patterns threatened additional homes and firefighters, the front also brought rain which greatly helped the suppression effort. The outcome of this fire indeed benefited from well-planned interaction between state and numerous local fire agencies.*

This report has discussed numerous variables that were factors in this devastating fire. Issues such as ease of ignition and spread of this wildland fire were addressed. Further, the impossible task that firefighters face in suppressing a fire that reaches the magnitude of the Stephan Bridge Road Fire was illustrated. Firefighters know that in such a fire, nature must assist them if they are to be successful. People and property are in jeopardy when they are in the path of such a wind-driven fire, and survival of people depends on their prompt action to evacuate.

Survival of property, including homes, depends on a number of predisposed factors that are likely to cause their ignition. If a home fortunately survives the initial assault of the fire front, survival is still not guaranteed. Slower moving "flank fires" can result in a loss if fire suppression personnel cannot intervene. However, firefighters will not jeopardize their lives if they determine that access is poor to homes, i.e., they cannot hastily retreat in case of significant changes in the direction of the fire. Many of these issues are addressed in proposed NFPA 229, *Standard for Protection of Life and Property from Wildfire* (See pg. 28 for further details). Community planners, fire service managers and the public can use this standard to make baseline determinations of their risk potential.

APPENDIX I

METHODOLOGY OF THE STUDY OF THE STEPHAN BRIDGE ROAD FIRE

Soon after the Stephan Bridge Road Fire, representatives from the National Fire Protection Association, USDA Forest Service and Michigan Department of Natural Resources met to discuss a study of the fire to be conducted by the NFPA's Fire Investigations Division. A one-day meeting of the participants was held, resulting in the discussion of various approaches to the analysis. Participants identified the available data and how it might be collected and discussed. In general terms, the wildland/urban interface fire problem was also discussed and how those factors may or may not be applicable to the Stephan Bridge Road Fire.

In addition to the meeting, an on-site survey of the fire area was arranged through the DNR office so that participants might begin to determine factors that might have led to the destruction of homes and how to mitigate other severe fires from causing such extensive damage. A thorough one-day survey of the burn site including examination of some of the homes that were destroyed/survived was then undertaken.

A comprehensive drive/walk through the fire area was conducted by the representatives. During the tour, the representatives spoke to several residents to supplement previous observation and determinations. Participants discussed their observations/determinations among the group. Details of the rapid development and spread of the fire were provided and physical evidence shown to corroborate determinations. Further, the effects that such rapid growth and spread might have had on the ignition/survival of the homes was discussed. Again, these technical observations were corroborated with physical evidence.

The meeting also included participants viewing available videotapes and slides of the fire, interviews conducted with local fire authorities and other eyewitnesses, and upon examination of the physical evidence, the group began to piece together a scenario of how the fire developed and spread. These determinations were then coupled with the fire spread scenario that was documented during the fire suppression effort by the incident commanders. These fire spread observations plotted the "head" of the fire as it varied over time.

Within a month of the planning meeting, the investigating team comprised of representatives of DNR and NFPA returned to the burn site to conduct a more in-depth survey and analysis. The objective of this phase of the study was to try to correlate the growth development and spread of the fire to those factors that might have led to the destruction of the homes. Further an attempt was made to research public records of the homes damaged or destroyed in an attempt to better establish pre-fire conditions of the home, i.e. combustible roofs, proximity to combustible vegetation etc. It was planned that this information would then be integrated with the results of an on-site survey of damaged/destroyed homes in an attempt to determine reasons for the loss.

Twenty-three destroyed homes were chosen for detailed analysis. Upon review of the public records; however, documentation of the home sites was found not to be current for use in the analysis. As a result determinations of the reason(s) for destruction of properties within this report was based on the expert judgement and experience of the on-site survey team. Their determinations and conclusions were based on the actual survey of damaged/destroyed homes and their finding parallel determinations of like surveys conducted of other wildfire losses. They found that many of the homes were in the direct path of the fire and only a few with abundant clearance survived. In addition, pre-existing home construction features, such as combustibility of siding coupled with owners practices, such as wood plus storage, build-up of combustible pine needles on roofs and proximity of combustible vegetation to the home were significant factors in ignition of homes both in the direct path of the fire and in "ground fires" that also led to many ignitions. Further, positioning to the home along roadways affected fire suppression crews attempts to intervene with the spread of fire. Finally the team observed many incidents of aborted ignition scenarios of evacuated homes that also could not be protected by suppression crews. In those cases the team observed, for example, deep charring of wood porches and steps but no continued propagation. Further, they observed ground fires bringing flames to combustible home construction and although there was charring, there was no ignition. The team concluded that these "near misses" were likely scenarios for

many of destroyed/damaged homes as well.

This thorough survey of homes led to a number of additional variables, if representative of the homes in the Stephan Bridge Road area, that would have contributed to the ignition of the homes. They were:

- Inaccessibility for fire fighting during a severe wildland fire
- Lack of water supply
- Close proximity of combustible vegetation to the home
- Combustibility of roof and structure
- Storage of combustible materials beneath wooden porches.

STEPHAN BRIDGE ROAD FIRE CASE STUDY

APPENDIX II

Lessons learned from the Michigan Department of Natural Resources critique of the fire

A DNR fire analysis summary listed several important lessons to come out of this fire:

- Major fires require many different agencies to work together. The coordination needed cannot be sorted out during the fire. Interagency cooperation was high at the Stephan Bridge Road fire, and all DNR stations were strongly encouraged to cement these types of relationships.
- On this fire key management personnel had extensive knowledge of the area involved, which proved to be invaluable in planning strategy as well as evacuation. If the DNR fire boss does not have this knowledge on any future major fire, it is imperative that someone with the knowledge act as an advisor.
- As with most other large fires, radio communications were a problem. Three zone fires in the same county, other fires in surrounding counties, and a major evacuation overloaded the available low band frequencies. Additional high band radios, as well as a good quality portable repeater, are badly needed. A better communications plan is also needed.
- The safety consciousness of all personnel contributed to the lack of fatalities and injuries of residents and firefighters. At least one safety officer is a must on any large fire.
- Any large fire involving structures will cause great concerns with local residents. To keep anxiety to a minimum, it is important to make accurate information available to the public. In order to eliminate the chance of conflicting information, it is important that only trained information officers be the contact person on a fire. This should be done at base camp and include maps of the fire. The fire boss needs to keep the information officer appraised of the current situation.
- Critical incident stress (CIS) occurs when emergency services personnel become psychologically distressed because of the overwhelming loss and suffering around them at a major disaster. This is more likely when the emergency personnel know those who are suffering the losses, or the sufferers are children. A key to successful CIS debriefing is to have a professional do it as soon after an incident as possible.

APPENDIX III

Black Tiger Fire

An escaped trash fire at the base of a scenic slope in the Rocky Mountains near Boulder, Colorado swept through residential areas nestled among the trees above the slope beginning on July 9, 1989. Within the first five to six hours after ignition, 44 homes and other structures were destroyed and many others were damaged. This fire was not completely extinguished until four days later after burning 2,100 acres. Loss estimates of homes and natural resources amounted to $10 million, and the cost to control the fire was another $1 million.

Known as the Black Tiger fire, from an old silver mining claim where the fire began, this conflagration shared similar circumstances with the Stephan Bridge Road fire as well as conditions that were markedly different. The Black Tiger fire was the subject of a previous case study report because of its significance as a wildland/urban interface fire. The Stephan Bridge Road fire is the second in a series of such case studies.

Comparing and contrasting the circumstances of the Black Tiger fire and Stephan Bridge Road fire further indicates the widespread potential for fire danger in a variety of wildland/urban interface areas and situations. One of the most significant factors affecting home loss in the Black Tiger fire was the lack of clearance between forest fuels and combustible homes.

Weather conditions The Black Tiger fire area suffered from hot, dry, windy weather immediately before and during the blaze. These conditions occur seasonally in Colorado and elsewhere. The result is that vegetation becomes dried out for easier ignition and spread.

Topography The steep sloping topography of the Black Tiger area created a chimney effect that funneled the fire toward homes at the top of the canyon. The normal rise of heated air up the slope helped to preheat vegetation above the fire.

Fuel types and arrangement Ponderosa pine and mixed conifer trees were interspersed with dried out grasses that also sustained rapid fire spread. The area featured heavy forest litter build-up. These dead fuels were especially susceptible to drying out and serving as ladder fuels contributing to crown fires.

Fire spotting Crown fires in dried fuels under windy conditions caused fire spotting ahead of the main fire front and further accelerated fire spread, as well as expanded the affected area. This greatly increases the danger to firefighters and greatly increases the number of firefighters needed to control the larger area.

Construction features Certain home construction features contributed to the survival or loss of many homes. For example, a high occurrence of wood exterior homes and open wood decks or porches was related to home loss. Noncombustible roofs, however, were one factor contributing to a home's survival.

Command and control The rapid growth of the Black Tiger fire required a multi-jurisdictional fire attack that complicated the command structure and strained communications capabilities.

Emergency access Restricted and remote roads and driveways to homes limited response and operational choices of firefighters. Black Tiger featured twisting roads and mountainous terrain.

Lessons learned from two previous major wildland fires

Mack Lake Fire

The Mack Lake fire is worthy of note because it occurred in similar terrain and jack pine fuels in the next county east of Crawford County. It destroyed some 44 homes and buildings, burned 25,000 acres starting on May 5, 1980. One firefighter died in the fire. The incident began as a prescribed fire, but it spotted across a highway and became a wildfire. In the first 3 hours the fire advanced 7 miles. No amount of fire line or road width held or slowed the fire. Changing fuels and weather conditions later slowed the fire and allowed the fire crews to build 35 miles of fire line to contain the fire 30 hours after it started.

In consuming 270,000 tons of fuel the fire released 3,000,000,000 Btu of energy, or nine times the energy released by the Hiroshima atomic bomb. Investigator/researchers determined that within the area burned by the Mack Lake fire, there have probably been five other fires in

excess of 10,000 acres since 1820, for an average of one major fire every 28 years.

A report on the fire by the USDA Forest Service contained this discussion about local weather conditions:

"The most severe fire weather in Michigan normally occurs when the Lake States are on the northwest or back edge of a ... high pressure area. Generally, air masses and associated frontal systems move through the region in a southeasterly direction every 3 to 5 days. When a high pressure system persists longer than normal, however, fuels have more time to dry out. The approach of a cold front aggravates the situation by increasing the flow of dry, warm air from the southwest. Consequently, peak fire danger is expected when the Lake States have been under extended high pressure influence just before the passage of a cold front, as happened, for example, prior to the Peshtigo and Great Chicago fires of 1871 (Haines and Kuehnast 1970). Precipitation associated with frontal passage normally ends the period of high fire danger."

Almost all of the conditions of the Mack Lake fire were present at the Stephan Bridge Road fire, reminding us of the powerful effect of fire weather and certain fuels.

Weather conditions The Mack Lake fire area suffered from hot (the high was 17 degrees higher than the average maximum for May) and dry (21 percent at the lowest point, compared to a May average of 51 percent) weather immediately before the blaze. A cold front moved through and at 2:00 pm produced a wind speed of 15 to 18 m.p.h. with gusts of 25 to 30 m.p.h.

STEPHAN BRIDGE ROAD FIRE CASE STUDY

Peak fire danger is expected when the Lake States have been under extended high pressure influence just before the passage of a cold front.

Topography The fire was on a plateau with very little variation of elevation. The area is very similar to the topography of Crawford County.

Fuel types and arrangement The predominate fuel was jack pine growing on sandy soil which dries rapidly after a rain. Other timber types and understory vegetation were similar to that in the Stephan Bridge Road fire. On average, 19 tons of jack pine fuel per acre were present before the fire. About 6,000 of the acres burned had predominantly hardwood stands on better soils. Fuel loading in a typical sedge area was 3.5 tons per acre, also similar to the Stephan Bridge Road fire.

Fire spread and intensity During its major run the fire spread at an average rate of 2.1 m.p.h., similar to the Stephan Bridge Road fire. At that time the average fireline intensity was calculated at 8,800 Btu/ft/sec. The limit of manual control is established as 100 Btu/ft/sec; the limit where spotting would be expected to present serious control problems for mechanical equipment. The fire continued to spread until the relative humidity increased to 55 percent and the fire burned into hardwood stands that burned slower than the jack pine.

Fire spotting The prescribed fire escaped control because of spotting. It was later observed spotting at least 1/4 mile ahead of the front. A research model by Albini predicts spot fire distances from burning trees. A 5-inch thick, 25-foot-high jack pine in a 15-mph wind indicates a 1/3-mile maximum spotting distance during a major run. Higher winds extend the spotting distance.

Another brochure is titled, *Wildfire: Are You Prepared for its Deadly Force?* Also distributed by the Michigan Interagency Wildfire Prevention Group, this publication shows a burned home on the front. Inside is a checklist for residents to use to answer the all-important cover question. Residents indicate Yes (safe) or No (Needs improvement) to 20 questions:

- Is your residence and surrounding property safe from the threat of wildfire?
- Have the pine trees been cleared within 25 feet of the house?
- For the next 75 feet are the pines thinned approximately 25 feet apart, and are branched pruned to a height of 6 to 10 feet?
- If you burn firewood, is your wood piled at least 25 feet from buildings?
- Is the roof clean of combustible material?
- Are combustible materials removed from under and around the building?
- Do the buildings have skirtings where needed?
- Are there fire tools such as a preconnected 100 feet of hose, shovel, rake, ladder and pail available?
- Is the grass mowed to 100 feet from the house?
- Is the chimney clean with a spark arrestor on top?
- Is the roofing made of noncombustible material?
- Is your road or driveway accessible for a fire truck? (Consider locked gates or chains, driveway width and steep grades before answering.)
- Are all bridge crossings strong enough to hold a fire truck?
- Is there an area for a fire truck to turn around?
- Have you and your family planned a safe evacuation route in case of a forest fire?
- Do you have emergency fire phone numbers posted?
- Do you know proper burning techniques and the safest time of the day or year to burn?
- When doing any open burning, do you know how to obtain a burn permit from your local agency?
- Is your burn barrel in good condition with a safe screen covering, and does it have a 10-foot clearing around it?
- Can you honestly say that you cannot do anything to your dwelling or property to make them more safe from forest fire?

STEPHAN BRIDGE ROAD FIRE CASE STUDY

See page 7. This area had a known danger of wildfire, especially in the month of May.

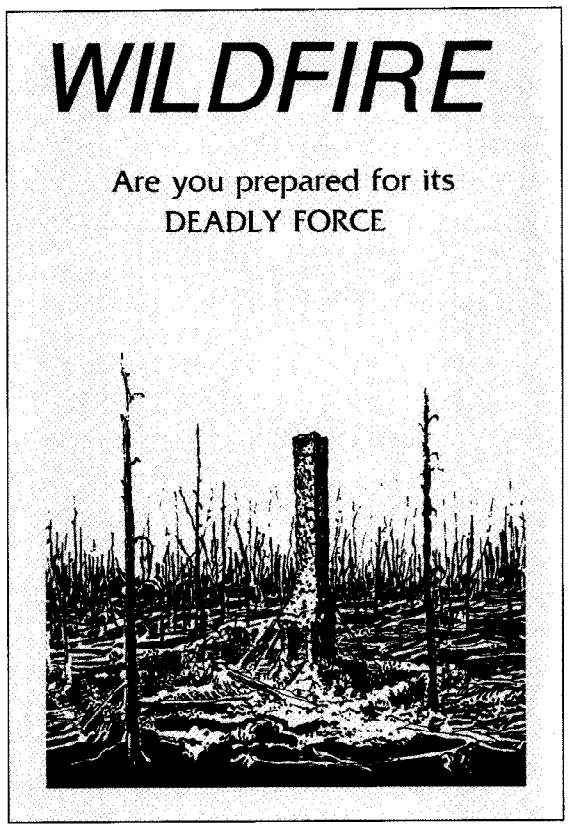
See page 10. Lack of clearance was the chief cause for the loss of most structures.

See page 10. Wood piles too close to structures provided additional fuel for wind-blown embers to settle in and ignite even when adequate clearance from trees was maintained.

See page 31. Grass fires spread out from the fire flanks after the crown fire passed. Many homes succumbed to this relatively slow fire.

See page 22. Some homes could not be approached without placing fire engines in danger of becoming trapped.

See page 16. Permits help to prevent burning during dangerous fire weather conditions.



Witness:

Now to tell Dave... There has been a horrible forest fire. I saw the garage burning. Moments later I saw the house burning. I do not have the animals with me.

His response is a wail: I can live without the house, but I can't live without the animals.

I don't think the animals are alive, I tell him. I saw the house and I saw the garage, but I did not see them. Although I tried, I tell him. I heard the reports of fire as I drove toward Grayling, and I defied a roadblock to get home, and I tried hard to save them, but I don't think...

I wait for an hour or more as he drives from Traverse City to Grayling alone. He tells me later that in the car he called out the names of the pets. Jody. Missy. Murphy. Ally. If his calling their names again and again could have saved them, they would be here with us today. (...)

[Later] *Maybe, maybe, the dogs escaped under the fence. We see a fresh hole and for a few moments we feel hope for the first time since the evening before.*

It is short-lived. Our friends find the remains of Murphy, then Missy. Dave is stoic, but now I wail. They look further for Jody, but I cannot find her. I am distressed because I want her buried with her kennel mates.

Dave and I are like parents who, though sickened by the messes of others, can easily and lovingly clean the vomit and the offal of our own children. We pick up the charred remains of our dogs and take them to be buried next to Buddy. (...)

And yes, we lost our home and all of our belongings. I will deal with that loss later, but today it seems only a footnote to the four little lives that went with the fire.

—Nancy Lemmen, resident
(from news reports)

SOURCE LIST OF ORGANIZATIONS

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National Fire Protection Association
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United States Fire Administration
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