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52. Acknowledgements are made to S. Elberg, dean of the Graduate Division, University of California, Berkeley; the Wenner-Gren Foundation for Anthropological Research; the National Science Foundation (grant GS-2297); Dr. G. H. Stopps, assistant director of the Haskell Laboratory, E. I. du Pont de Nemours & Company; the Archaeological Research Facility; and the department of anthropology, University of California, Berkeley, for financial support during the period 1965–68. We are indebted to many specialists for identification of coprolite components or for radiocarbon dating, and we wish to thank all of them, in particular Dr. Rainer Berger, Institute of Geophysics and Interplanetary Physics, University of California, Los Angeles, and Dr. W. I. Follett, California Academy of Sciences.

NEWS AND COMMENT

Forest Fires: Suppression Policy Has Its Ecological Drawbacks

Careless outdoorsmen and a dry spring in interior Alaska have combined to produce the most severe forest fire season of the decade in the 49th state. The U.S. Bureau of Land Management (BLM), the government agency that supervises most of Alaska's real estate, estimates that this summer's fires have blackened over 4.2 million acres of forest, an area larger than the state of Connecticut. BLM has thrown helicopters, fire-retardant bombers, infrared detection systems, and up to 1700 men into the battle to suppress the fires, but the Bureau has decided to defend only villages and other valuable sites, letting the hinterland forests burn over, as they have for centuries.

For many Alaskans this BLM decision to let some wilderness fires burn unopposed represents a failure that improved technology should eventually remedy. But many ecologists now suggest that forest fires such as these may well be a desirable way to maintain important ecological relationships. In the lower 48 states, some foresters are also having second thoughts about the policy of absolute fire suppression that has dominated the conservation movement since its early days. Federal and state agencies spend large sums ($186 million in fiscal 1968) to suppress forest fires, yet an average of 4.8 million acres still burn each year. The philosophy symbolized by Smokey the Bear—the cartoon emblem of the nation's fire-fighting campaign—has proved successful in many areas, but this very success has generated its own set of problems. Without periodic fires to remove underbrush and decaying leaf matter from the forest floor, many woodlands have experienced marked ecological changes and have become far more vulnerable to wildfire than they were before the white man intervened.

To limit these side effects of fire suppression, foresters in many areas now deliberately set forests afire under controlled conditions. In 1967, government and private land owners removed an estimated 61 million tons of excess fuel in controlled burning operations on 2.9 million acres of land.

This shift in forest-management policy has slowly gained support among foresters over the last 30 years as the forestry profession reexamined its fundamentalist crusade against forest fires in general. The early fire crusaders had focused chiefly on fire's drawbacks:

the loss of timber and wildlife, the erosion of exposed soil, and the air pollution resulting from major wildfires. They pointed to such conflagrations as the 1871 Wisconsin and Michigan fires that killed over 1500 people and burned 3 million acres as proof of forest fires' intrinsic evil. But in recent decades, ecological evidence has caused foresters to modify their blanket condemnation. "The average forester is taught that all fire is bad," said Edwin V. Komarek, head of the privately owned Tall Timbers Research Station in Tallahassee, Florida. "We've always overlooked lightning and lightning fire as a part of the climate." Komarek and other forest ecologists say that the artificial exclusion of fire has produced major changes in many forest plant communities that were dependent on fire as the chief regulator of vegetation types.

In California and the Southwest, tree-ring studies of ponderosa pine forests have indicated that ground fires —small blazes that spread through the turf and underbrush but not the treetops—swept through these areas at least once in a decade during prehistoric times. By preventing even these moderate ground fires from periodically clearing accumulations of litter from the forest floor, the policy of total fire suppression has made some woods easy targets for disastrous fires. In primitive times, periodic fires also prevented an understory of competing shade-resistant trees from developing, and thus gave the ponderosa forests an open, park-like appearance. But, in the absence of fire, understory trees have crowded the forest and weakened the taller pines through competition, Harold H. Biswell, professor of forestry at the University of California, Berkeley, told *Science*. Crown fires—the huge conflagrations that spread through the forest canopy—rarely occurred in primitive California forests, Biswell added, but this understory of trees has formed a new intermediate level of fuel between the canopy and the forest floor that encourages crown fires.

One biologist has advanced the theory that fire-exclusion policies may be a factor in the near-extinction of the California condor. Raymond B. Cowles of the University of California at Santa Barbara has suggested that the condor needs relatively long runways for take-offs, and clearings on ridgetops for feeding. With the prevention of fires, Cowles said, dense plant growth has reclaimed these clearings and thus has narrowed the condor's ecological niche.

In Alaska, the permafrost layer complicates the relationship of fire to wildlife populations. "Fire has been an important part of the ecology of interior Alaska," said David R. Klein, leader of the Cooperative Wildlife Research Unit at the University of Alaska. When fire is excluded from many lowland sites, an insulating carpet of moss tends to accumulate and raise the permafrost level, he said, and permafrost close to the surface encourages the growth of black spruce, a low-growing species with little timber or food value. "These areas are veritable deserts," Klein said. Bear, deer, moose, and other animals depend on lightning fires to maintain a constant cycle of vegetation types for food and cover.

Other biologists at the University of

Anti-Smoking Forces Gain Ground

Anti-smoking forces have put the tobacco industry increasingly on the defensive in recent weeks through a strong health report and congressional pressure that has forced the industry to announce plans to give up cigarette advertising on radio and television.

Last week HEW Secretary Robert Finch released a Public Health Service report that provides new evidence linking cigarette smoking with coronary heart disease, chronic bronchitis, pulmonary emphysema, throat and respiratory cancer, and—for the first time—with noncancerous diseases of the mouth. In addition, the 135-page report cites data suggesting that women who smoke during pregnancy may increase the risk of spontaneous abortion, endanger the lives of their unborn babies, and stimulate premature births. The report, entitled "Health Consequences of Smoking—1969 Supplement," may be obtained from the National Clearinghouse for Smoking and Health, PHS, 4040 Fairfax Drive, Arlington, Virginia.

Meanwhile, the tobacco industry, acting under pressure from Congress, has offered to drop all television and radio commercials by September 1970 or earlier. Tobacco industry spokesman Joseph F. Cullman III made the offer before a Senate Commerce subcommittee hearing, chaired by anti-smoking advocate Senator Frank E. Moss (D–Utah). Government officials say the industry's move is an attempt to avert strong federal regulation of cigarette advertising in all media by two government regulatory agencies, the Federal Communications Commission and the Federal Trade Commission, or by congressional legislation. In response to the tobacco industry's offer to halt advertising, Vincent T. Wasilewski, president of the National Association of Broadcasters, said the move would be "no great sacrifice" to the tobacco industry because it would save $200 million in annual TV and radio advertising costs while it continued to advertise in the print media with "full knowledge" that the consumption of cigarettes "will not decrease."

Whether the ban on cigarette advertising will achieve the desired goal of reducing U.S. consumption of cigarettes certainly is not clear. An Associated Press survey released last week shows that, in Britain, Holland, Italy, Switzerland, and Poland, cigarette consumption has risen despite bans on radio and television ads for cigarettes in these countries.

Congress is continuing to wrestle with the question of whether or not the federal government should clamp down on cigarette advertising in all media. At the present, the federal government requires that the manufacturer place a mild health warning on the cigarette package. The House in June passed a bill sponsored by tobacco state congressmen that would place a harsher health label on the cigarette package but would bar the government for 6 years from requiring that cigarette advertising contain a harsh mandatory health warning. Moss, whose subcommittee is handling the bill, threatened to use a filibuster, if necessary, to keep such a bill from passing the Senate.—MARTI MUELLER

NEWS IN BRIEF

• **REPORT URGES UNMANNED SPACE PROBES**: A National Academy of Sciences (NAS) panel, consisting of 23 leading space scientists, urged this week that a series of unmanned planetary and outer space explorations be planned for the 1970's. In a report that was approved by the NAS Space Science Board, the panel estimated that such unmanned flights would be far less costly than NASA's present manned program and would reap valuable scientific information on the origin of the universe and the nature of the earth's own atmosphere. Specifically, the report recommends, in order of their scientific importance, the following series of missions: Jupiter deep-entry probe and flyby (1974); Jupiter orbiter mission (1976); Jupiter-Saturn-Pluto grand tour (1977); Jupiter-Uranus-Neptune grand tour (1979); Jupiter-Uranus entry probe missions (early 1980's). The NAS committee, chaired by James Van Allen of the University of Iowa and Gordon MacDonald of the University of California, stressed that the 1970 decade will present a rare opportunity for solar scientists to observe the planets in a line-up formation that occurs about once every 200 years. The report specifically recommends that NASA submit to Congress in 1971 a budgetary plan for a long-term solar system exploration. *The Outer Solar System: A Program for Exploration* may be obtained at no cost from the Space Science Board, 2101 Constitution Ave., NW, Washington, D.C.

• **U.S.–FRENCH SCIENTIFIC COOPERATION**: Presidential Science Adviser Lee A. DuBridge and French Minister of Scientific Research F. X. Ortoli will exchange visits this fall to discuss development of new fields of scientific cooperation. The U.S.–French exchange was proposed in discussions during President Nixon's visit with General de Gaulle in Paris earlier this year. The exchange marks the first time in 5 years that bilateral scientific talks between France and the United States will occur on a ministerial level. The two science representatives are expected to discuss possible new fields of cooperation in such areas as environmental and urban research, and to review ongoing cooperation in space, oceanography, medical and biological research, and education.

• **SPACE CONSORTIUM CREATED**: The Universities Space Research Association (USRA), a national consortium of 48 universities, was organized on 16 July by the National Academy of Sciences to foster cooperation in space research among universities, research organizations, and the government. The USRA is slated this fall to take over the management of NASA's Lunar Science Institute in Houston, which is temporarily under the direction of the National Academy of Sciences. The Lunar Science Institute provides a base for outside scientists who wish to conduct space science research in Houston, particularly at the Lunar Receiving Laboratory at NASA's Manned Spacecraft Center. The USRA has plans to operate other laboratories and research and educational centers in the future.

• **POISON GAS**: The U.S. government has acknowledged that a limited amount of poison gas is being stored in West Germany. The Pentagon had earlier admitted storing chemical weapons on the island of Okinawa; this was its first acknowledgment that poison gases were being stored abroad.

• **APPALACHIAN HEALTH CENTER CREATED**: A new regional center for environmental health studies has been established in Appalachia to conduct broad health studies on regional problems such as coal worker's pneumoconiosis or "black lung" disease, occupational injuries, noise, solid waste disposal, hygiene, and radiological health. The $5 million Appalachian center, which will be located in Morgantown on the campus of the University of West Virginia, is being established by the Environmental Control Administration of the Public Health Service (PHS). The center, which will work closely with the university to coordinate research activities, is expected to send teams of scientific persons to do field work and conduct training and demonstration programs throughout the Appalachian region. The Appalachian center, to be completed in 1971, is the second regional PHS environmental center to be established; an Arctic Health Research Center was set up in 1948 in Fairbanks, Alaska, to coordinate health programs for Indians in the region.

Alaska have suggested that the sheer momentum of the fire-fighting crusade has not only obscured the role of fire in forest ecology but has extended a policy of total fire exclusion to situations where the classical reasons for fighting fires do not exist. This argument has been applied particularly to sections of interior Alaska where the permafrost and short growing season produce timber of minimal market value, far from any road or settlement. Lightning-caused fires smolder in the thick carpet of moss above the permafrost and quite often do not burn thoroughly enough to expose the mineral soil to erosion. Little research has been done on the subject, but several Alaskan researchers have suggested that the bulldozers used in carving fire lines around interior fires may cause more erosion than the fires themselves.

Fire exclusion has also raised problems in Southern pine forests. As in the West, fire-suppression policies allowed dangerous amounts of combustible materials to accumulate on the forest floor. A type of pine fungus disease that thrives in forest litter also became an increasingly serious problem to forest managers. Foresters in the South are chiefly interested in producing softwood pine trees, but, under the policy of total fire suppression, the deciduous hardwood trees that are normally controlled by fires began to wrest control from the softwoods.

As foresters recognized these adverse side effects, a more balanced attitude toward fire emerged. A technique known as "prescribed burning" was developed in the South to manage plant communities for silvicultural or wildlife-management purposes and to complement fire-suppression activities by eliminating fire hazards. As the name indicates, prescribed burning involves setting a controlled fire under specific conditions of wind velocity, humidity, local topography, and time of year. Among the practices currently lumped together under the heading of prescribed burning are the burning of slash (waste wood) after logging operations, the clearing of fuel breaks to prevent wildfires from spreading from one stand of timber to another, and the burning of undergrowth and litter on the forest floor to reduce fire hazards. Prescribed burning is usually done before or after the local fire season when fires are easily controlled and generally not intense enough to cause extensive soil damage.

Prescribed burning has recently become a standard practice in the South-

ern states, which in 1967 accounted for most of the 2.66 million acres treated with prescribed burns east of the Mississippi. But in the West, where only 259,000 acres received burning treatments, the use of fire has triggered a sharp controversy.

One school of thought, now led by Harold Biswell of the University of California, Berkeley, argues that underbrush and leaf litter in ponderosa pine and some mixed conifer forests should be removed much as they were before the white man came—by means of small ground fires every few years. When Biswell advanced this forest-management proposal, in the early 1950's, the idea received so much flak from government foresters that he claims he was forced to do his research on private land. His burning technique involves setting a fire on a hilltop at a time of year when only the upper layer of pine needles is dry enough to burn, and letting the fire creep down the slope under close supervision. The technique involves extensive initial cutting of underbrush in forests with thick undergrowth, and heavy investments of manpower to control the low-intensity blaze, but Biswell claims that the investment pays off in fire hazard reduction.

In 1962, a crown fire whipped through a forest adjacent to his prescribed burning plot at Hobergs, California, but as soon as the fire reached his land it dropped out of the tree-tops and crept through the forest floor, where it was easily controlled. His prescribed burning causes minimal soil erosion and has no adverse effects on long-term soil fertility or water-holding ability, Biswell says. He estimates that his technique may be applicable to 4 million acres in California alone.

Park Service Treats Sequoias

Curiously enough, some of the smaller land-management agencies in the West have been the first to adopt broadcast burning of this sort. Last year, the National Park Service began using controlled burning in some of its valuable sequoia forests to reduce fire hazards and expose the mineral soil for seed germination. The Bureau of Indian Affairs (BIA) has treated nearly 200,000 acres of ponderosa pine forests with prescribed burning treatments. Under special conditions, BIA foresters have even allowed moderate wildfires to burn without interference. "It's doing the job we would do in 4 months anyway," said Richard Ely, BIA forester in charge of forest fire policy, "so why put it out?"

But in California, Biswell has attracted little support. The U.S. Forest Service, the country's chief forest research agency and landlord of 187 million acres of national forests, has viewed prescribed burning very cautiously. Referring to Biswell's approach as "promiscuous or wholesale burning," one Forest Service official pointed out that the Forest Service had enough trouble financing its less ambitious fuel break program. The Service has been removing trees and burning undergrowth, in strips 100 meters wide, on ridge tops and in other strategic locations in some Western national forests to prevent fires from spreading. Congress has provided the Service with only $300,000 a year for this program. "At the present rate, it will take over 100 years" to complete the program, Marion M. Nelson, deputy chief of the Forest Service, told a congressional subcommittee. The Forest Service considers its fuel break program safer and less costly than broadcast burning. Service foresters acknowledge that a broadcast-burning technique worked well in the South, but in the West, they say, the terrain is rougher and the trees are less fire-resistant.

Some observers also say that, whatever the intrinsic merits of Biswell's case, the Forest Service cannot wholly endorse broadcast burning at the moment, both for lack of detailed prescriptions and cost estimates for a wide variety of forest situations and for fear that an outright endorsement would encourage private landowners to use broadcast burning without expert supervision. Some foresters also fear that the success of the Keep America Green and Smokey Bear programs in curbing careless recreationists would be jeopardized if the Forest Service embraced Biswell's policy. "The public," said one administrator, "can't see why we allow a fire we set in November to burn when we'll jump in with a thousand men to put out a wildfire that starts in June."

Carl Wilson, director of the Forest Service's Fire Laboratory at Riverside, California, said that "the public's concern for the quality of the environment," including air quality, imposed a major limitation on any prescribed burn. Apple- and pear-growers in Washington State complain that smoke from prescribed burning prevents fruit from ripening, and hunters complain that these fires chase away game.

Forest Service officials also fear that a prescribed burn will escape and do extensive damage to private as well as government property. One prescribed-burn escape in California's Eldorado National Forest destroyed 18,000 acres of forest and caused damage estimated at $5 million.

Proponents of prescribed burning agree that the use of fire certainly involves the risk of a costly escape, but this danger indicates, not that the techniques should be avoided, but that better prescriptions for various burning conditions should be developed. Advocates of burning also counter the air-pollution argument by pointing out that forest-fire smoke is only a temporary irritant and not a toxic pollutant. Except in the interior of Alaska, the air over the forests is now considerably clearer than it was while the country was being settled, they say, and when the smoke-annoyance of prescribed burns is balanced against the damage and smoke from wildfire, controlled burning comes out on top.

Prescribed Burning in Perspective

Many foresters consider their current alliance with fire to be temporary. Forest Service researchers hope eventually to develop chemicals to hasten the decomposition of leaf litter; inexpensive mechanical wood chippers to remove understory shrubs; or safe, cheap herbicides to remove undergrowth. But prescribed burning will probably remain a standard silvicultural tool until these safer techniques become more economical.

Meanwhile, the need for any sort of fire-hazard removal may eventually decrease as more intensive use of "weed" trees and "overmature" timber stands reduces the amount of excess fuel in commercial forests. Many European forests are already managed so intensively that fires are rare, even in dry regions. In Europe, large quantities of what Americans would consider waste wood have traditionally been utilized for home fires if not for commercial purposes. But until population growth forces American forestry to become as intensive as its European counterpart, foresters may well have to modify Smokey Bear's public image and use fire to fight fire.—MARK OBERLE

An intern in the news department for the summer, Mark Oberle served as an emergency fire fighter last August in the Kuskokwim River watershed of interior Alaska.