Fire Ecology Review

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IN 1931 Herbert L. Stoddard, the Dean of Game Management in his classic investigation of the Bobwhite Quail stated:

> "While the immediate and direct effect of burning is, of course always apparent, the general effect of long-continued annual or irregular but frequent, burning upon the vegetation of an area, and its indirect effect upon the animal life, present a complex problem, one that would require years of careful research on the part of the personnel of a well-equipped experiment station to work out. Such research is greatly needed, and should be carried on, *for fire may be the most important single factor in determining what animal and vegetable life will thrive in many areas.*" (italics EVK)

This concept expressed so long ago by Stoddard, that fire was an important ecological factor in the natural environment was the basis for the organization of Tall Timbers Research, Inc., on February 7, 1958 as a public, scientific and educational foundation.

The foundation in its charter and in the will of Henry L. Beadel, the founder, is explicitly charged with the conduct of fire research and education along with other ecological research and education. Its charter states in part as follows:

OBJECT

> This corporation is organized exclusively for public scientific and educational purposes and for no other purposes . . . The general nature and object of this corporation shall be to conduct public scientific experiments. . .

> To instruct the public on subjects useful to the individual and beneficial to the community, with particular regard to the effects of fire on quail, wild turkey and other wildlife as well as on the vegetation of value as cover and food for wildlife.
>
> In furtherance of these purposes to acquire, own, operate, lease, and control and cause to be operated and controlled, any and all manner of biological stations, including particularly, without in any manner limiting the generality of the foregoing, the operation and use of a "fire-type" nature preserve, and the conduct thereon of research . . . the conduct of experiments in controlled burning . . . the establishment of such preserves and of facilities for visiting scientists and students . . .
>
> To manage and conduct ecological research . . . [To conduct] demonstrations of educational work in such fields as wildlife management and the proper use of fire as a management tool . . .
>
> To publish and distribute to the public generally any knowledge or information acquired as a result of such research, experiments, and studies . . .

In addition, Mr. Beadel's bequest clearly states that the former Tall Timbers Plantation of 2,800 acres in Leon County, Florida must always be managed and studied as a "fire type" nature preserve. This property is now the Tall Timbers Research Station where its laboratories and offices are located.

FIRE ECOLOGY CONFERENCES

The Tall Timbers Fire Ecology Conferences were organized in 1962 so as to fulfill some of the requirements of the charter; i.e.

> "to instruct the public on subjects useful to the individual and beneficial to the community . . ."

The Proceedings have been published and furnished to the "public generally" to conform with the charge:

> "to publish and distribute to the public generally any knowledge or information acquired . . ."

The conferences, and their printed proceedings now 14 in number, constitute in themselves a broad review of fire ecology on a world-wide basis. They have been held in cooperation with several universities, institutions, and agencies. Today we are indeed honored to hold this conference, the 14th, in Fire and Land Management, jointly with the Intermountain Fire Research Council. Its conference committee is largely responsible for the excellent array of speakers and breadth of subject matter as it relates to the Intermountain Region.

The proceedings of these conferences, at which over 225 speakers have presented their views and scientific data, along with the publications resulting from several other fire symposia over the past decade constitutes a scientific library on fire ecology of considerable expertise and breadth of interest unequalled anywhere.

It is perhaps fitting to point out here that the first symposium on the beneficial aspects and possible use of fire in silviculture and wildlife management was held at Washington, D. C. during the 1935 annual meeting of the American Society of Foresters. The symposium was held under the chairmanship of Dr. H. H. Chapman, president of the society, a "father" of southeastern pine forestry. He was a pioneer fire ecologist and one of the southeastern group to whom we dedicated our first Tall Timbers Fire Ecology Conference in 1962.

Many articles and papers on fire ecology have appeared in the last decade or two in such scientific journals as the *Journal of Forestry, Journal of Range Management, Journal of Wildlife Management,* and others such as *Ecology, American Midland Naturalist, Botanical Gazette,* as well as in the *Journal of Ecology* (British) and several other foreign publications.

A large series of publications on fire, essentially a library in itself, primarily devoted to U. S. forestry, has been published by the U. S. Forest Service largely by its eminent Forest Experiment Stations and Fire Laboratories. The Indian Forest Service at Dehra Dun, India has a remarkable series of articles on fire and fire relationships to the major forest types of India covering more than 50 years. The Australian Forest Services, federal and state, have also published a most valuable series that deal with fire and its relation to the Australian forests. There is also considerable material in Finnish and Swedish publications relating to fire and the northern forests of that region. A large body of fire literature relating to Africa can be found in the *Journal of Ecology* and in several publications of the African countries. An excellent and sophisticated series of papers on fire and Japanese grasslands has been published in Japanese journals.

To review all of this literature at this time is impossible but I do want to leave with you in a capsule form my general impressions of the interesting and useful aspects of fire, ranging from those natural "pre-adaptations" and fire ecology, to that of its use and management which is applied fire ecology. They are based on a world review of the fire literature as well as on personal experience which has been broadened by travel for the study of fire ecology on the major continents. There is no dividing line between the scientific basis of fire ecology and fire management or fire use. I have been concerned with the practical, scientific and theoretical aspects of fire and the environment for more than 40 years, and my comments, even though generalized and in capsule form may be of interest, if not of value.

ANCIENT FIRES

The earth, born in fire, baptized by lightning, since before life's beginning has been and is, a fire planet. As soon as there was flammable fuel left from formerly living organisms fire by lightning, vulcanism, and perhaps by spontaneous combustion and friction produced stress on living things. The process of natural selection by fire began and continues to this day. Fossil charcoal, known as fusain, is found in coal beds from some of the earliest geologic periods and it is generally agreed among petrologists (coal scientists) that this is the result of ancient forest fires caused by lightning. Fusain from British coal beds has been compared with recent charcoal from fires in British pine forests and found to be similar. Charcoal particulates have recently been studied by electron scanning microscopes from charcoal layers retrieved from deep sea cores in the Pacific and Atlantic Oceans, dated at over 10 million years of age, and have also been found to be similar to particulates from California fires. Physicists and meteorologists have pointed out that lightning was not only a part of the earth's beginning but may have been the "trigger" of life itself. They estimate that lightning strikes the earth at the rate of about 100 times a second and that this discharge is a mechanism of the earth's electrical field and at least assists in keeping the electrical potential of the earth's atmosphere relatively stable. With such an "electrostatic match" fire has had to be a part of the earth's environment, of its ecology, from the beginning.

EARLY FIRE VEGETATION

The ancientness of these earthly fires can to some extent be deduced indirectly from a study of the modern descendants of many of our plants. Cycads, ferns and club mosses that at one time literally covered the land areas of the earth but now reduced in number, are still represented by a variety of genera and species that may be said to be fire-selected. Today these descendants have many so-called fire adaptations and occur in many different kinds of fire environments. They are plants of the sunshine and cannot thrive in dense shade. All three of the above mentioned groups are found in the more or less natural southeastern coastal plain pine forests that are frequently and even annually burned over. Most will not exist in unburned forests.

Forests

Most of the conifer species that cover such wide expanses of the forested sections of the earth have many, varied fire-related qualities that range from the need for mineral seed beds to necessary high temperatures for the opening of serotinous cones for regenerative purposes. They have such requirements necessary to thrive in fire environments as thick bark, adventitious buds, the ability to sprout or coppice, etc. They are mainly forest trees of sunshine, open space, and not plants of dense shade. Some require fire treatments at rather regular intervals, and others only once in the lifetime of the forest for regenerative purposes.

Members of the myrtle family range from the fire tolerant myrtle bushes of the southeastern United States to the vast fiery eucalyptus forests of Australia which also have similar fire environment requirements. In fact, some of the major eucalyptus forest trees require deep ash beds for proper germination, growth and survival. The major forest trees of India, chir pine (*Pinus roxburgii*), Teak (*Tectonis grandis*), and Sal (*Shorea robusta*) likewise have many fire adaptations as have the Bracheystegia, Terminalia, and Combretum woodlands of Africa. Many of the circumpolar forests, largely conifers, are also fire-related. These include many of the spruces (*Abies*) larches (*Larix*) and some pine species. The Douglas-fir (*Pseudotsuga douglasi*) of our Northwest and western Canada as well as the California sequoia (*Sequoiadendron giganteum*) and redwood (*Sequoia sempiverens*) are also quite fire dependent forests. In fact, the major timber trees of the world, excluding only some of those of the tropical forests, and of the moist deciduous forests are so fire-related that fire has been used as a silvicultural tool and has been of long standing practice, in some cases for well over 100 years. However, it must be stressed that no matter how fire-dependent most of these species of forest trees are, they can be destroyed leaving only devastated forests where wildfires occur at the wrong time and under the wrong climatic conditions. It can be said then of the major forest trees of the world that they are both fire-dependent and fire-prone.

Grasslands and Savannas

The grasslands of all the continents show a like dependence on fire (or man-made substitutes) much like that of the previously mentioned forests. Without burning the grasses become decadent or heavily invaded by woody growths. The species that inhabit such grasslands are plants of the open or filtered sunshine. The largest and most widespread grass genera consist largely of fire-dependent species that have many fire-related "pre-adaptations" that range from diverse underground root and stem systems, to the need to regenerate on mineral soil and only a few can tolerate much shade. Perhaps most interesting is that the growth that regenerates after burning is always higher in protein and such essential mineral elements as phosphorus and potash. Also most such species will seed more prolifically if burned regularly at the right time and under the right conditions. Fire induces increased seed yields which have been reported as high as 20 percent or more.

The genera of such fire-selected species are the most widespread and cover the greatest amount of land areas. These are such genera as *Agrostis, Agropyron, Aristida, Avena, Bouteloua, Bromus, Chloris, Cynodon, Digitaria, Eragrostis, Festuca, Glyceria, Heterapogon, Hilaria, Hordeum, Imperata, Oryza, Panicum, Paspalum, Pennestum, Poa, Sorghum, Spartina, Sporobolus, Themeda,* and so on. However, I wish to stress again as with the forests, that the fire must be of the right kind, at the right time, and under the right conditions. Also heavy grazing by both wild animals and domestic livestock can maintain many of these grasses, but not all.

The use of fire by man to maintain rangelands, that extend from the tropical lowlands to the high alpine meadows of the Himalayas is most ancient and its beginning disappears into the mists of man's pre-history. The early ancestors or close relatives of mankind's cereal foods, such as wheat, rye, oats, barley, rice, sorghum, millet and maize live today in fire-dependent grasslands and savannas.

In many regions grasslands merge into savannas. These are grasslands in which scattered or more or less widely spaced trees occur, or forests in which the canopy is so open as to allow a large measure of sunlight to filter through. The necessary ingredient for the grasses is sufficient sunlight and the number of the trees and their spacing appear to be directly related to the frequency of fire. All of such trees or woody shrubs have such fire-related characteristics as coppicing (suckering), adventitious buds, the need for mineral soil for regeneration, thick bark or bark very resistant to burning, etc. Like many of the fire-related forest trees they must have freedom from fire after regeneration for varying periods of time where tree form with fire resistant stem characteristics may develop.

Another great group of plants, the legumes, considered by some to be the third largest family of plants, are of primary importance in most regions in the composition of the grassland or savanna. Many such genera have been reported in the past Tall Timbers Fire Ecology Conferences as fire-selected, fire-related and adapted to reoccurring fires. The species range from annual legumes, whose seeds must have heat to properly germinate, to perennial forbs and to many species of leguminous trees such as those so characteristic of the African savannas.

The grasslands and the savannas, both fire dependent, contain the most number of species of two of the largest and most important families, grasses and legumes, which produce the bulk of the food of mankind, directly, and indirectly. The grasslands and savannas in addition contain a great many flowering plants that give much beauty to these lands. Most of these species, represented in such groups as orchids, lillies, composites, etc., flower profusely after burning and must be regarded as fire selected. On many nature reserves of the prairie type, fire is used regularly for this purpose.

The palm savannas merit special attention because of their value as well as beauty to mankind. These savannas consisting of a wide variety of fire-dependent grasses and various fire pre-adapted palm species such as the *Doum, Borassus, Phoenix*, etc.; palms of Africa and Asia. These palm species are so tolerant of fire that they can be literally termed fire-proofed for the trunk must either be burned through entirely or the well insulated bud must be killed by intense heat. However, these palms germinate and grow readily in frequently burned grasslands, but for regeneration they require a period of light, little or no burning to attain tree size as is true with most savanna woody species.

Brush or Shrub Lands

The brush or shrub lands occur wherever there are grasslands and woody growths to invade. In the former, however, the grasslands have been invaded by woody shrubs; in many instances by shrub forms of *Quercus* and *Cistus.* This has been caused largely by overgrazing by cattle, sheep and goats which has for all practicable purposes eliminated the grassland. The resulting shrub growth, however, is highly flammable in dry climates and the species are well adapted to reoccurring fires. In the absence of grazing these might in time allow grasses and an entirely different fire regime to occur. Such are the brushlands of the Mediterranean called the "garrigue", and in Africa the "machia."

In addition, however, there are certain communities such as the chaparral of California that are totally fire dependent vegetations. The chaparral of western United States has little grass except in its very earliest stages after being burnt. The shrub species that make up these brush lands are highly flammable as the leaves are filled with volatile oils that disperse generally under hot and dry conditions. They have a very diverse collection of fire characteristics, much too long to even list here. This type is well discussed in the Fire Ecology Proceedings.

WETLANDS–MARSHES AND SWAMPS

The wetland areas of the upland are the regions where plants (and animals) have become adapted to both fire and water. They range from the Everglades and Okefenokee Swamp of America, the Okavanagan Swamp of Africa, the Arnhiem land of Australia, the wet meadows and tundra of northern climates, and to the marshes and swamps that border the coasts, rivers and lakes everywhere. These regions are made up, in many areas, of grasses, grass-like plants and some trees and shrubs that are fire dependent. Perhaps the Everglades sawgrass and marshes are the best known from the fire ecology standpoint and are now regularly burned by both prescribed and lightning fires.

However, the intricate relationships of fire and water of plants, along with their wide variety and with many special characteristics, are sorely in need of scientific study. This is particularly true of coastal marshes, inland marshlands and wet meadows ranging to bog or bog-like habitats. Certainly this is an area for pioneering fire ecology.

ANIMAL LIFE

Vegetations are the necessary foundation, directly and indirectly, for all animal habitats and as much of the upland vegetations of the earth are fire related so must the animal life have the necessary characteristics and qualities that allow them to live in fire environments. They also must have been fire-selected.

The scientific study of fire and animal life received its biggest impetus when Stoddard conducted his investigation of the bobwhite quail and its relation to its environment. However, the knowledge of fire ecology and animals that have served as food for mankind has been an essential part of man's own evolution. Man, is after all, a grassland creature not an original inhabitant of dense forests and even today his food consists largely of those plants and animals that inhabit open space and sunshine. However, Stoddard's study focused attention on "why" plants and animals could live in fire environments, and demonstrated that quail, and its associated birds, mammals, etc., as well as their necessary plant food items were indeed "fire-adapted" or fire selected. He showed that there were many requirements in the open pinelands of the Deep South for the welfare of the quail and its associated plant and animal communities and that only fire could in these lands produce the required habitat. He also showed that such a habitat had to be re-cycled or "managed" and that the use of control burning was the most efficient, practical, and in many instances the only tool that would recreate the necessary conditions. Today we know that throughout the world there are like species such as grouse, prairie chicken, francolin, the jungle fowl (the ancestor of our modern chicken), the peacock, which live in the wild in regularly burned habitats and it appears that fire is just as much a factor with them as it is with the bobwhite quail. Outside of the studies on bobwhite and of the red grouse of Scotland our information concerning birdlife is largely by analogy and lacks the necessary data to thoroughly understand its fire ecology. However, there is enough empirical knowledge and experience that has already been used for management purposes to show that these birds, like the bobwhite and red grouse, are indeed birds of fire environments, at least under more or less natural conditions.

Although we have little knowledge, and no experimental data, on the fire relationships of our vast herds of buffalo and antelope in the grasslands of North America we can by analogy compare the studies on the vast grasslands and savannas of Africa. The Proceedings of the Fire Ecology Conferences have listed a great many species of herbivores and other mammals and their relationships to the fire environments of Africa and some elsewhere. Knowledge in the

United States is beginning to accumulate on the relationships of fire to many of our larger mammals such as the moose, elk, mule deer, Virginia deer, mountain sheep and mountain goat. The fact that the herbivores of the world have been reported attracted to the new green forage of grass, forb, and browse on burned land in all parts of the world should have alerted scientists to the fire ecology of our mammals and birds. Certainly the fire ecology and other fire relationships of vertebrate animals is meager when compared with the large present day information on fire and the forests, grasslands, and savannas of the world.

Even less is known about the fire ecology of invertebrates. That there are profound relationships can certainly be recognized in the few papers that are concerned with the subject. Papers in the Proceedings of Tall Timbers Fire Ecology Conferences have shown that grasshoppers in both America and Africa have intricate fire relationships as do certain Hemiptera. That some insects even have an infrared detector system is now well known. One sub-genus of fire beetles has on its hind leg a "dish" with up to some 70 spines (waveguides). It is also known that certain groups of flies conduct their "mating swarms" only in swirling smoke from organic fires. Some other insect fire relationships are also mentioned not only in the Fire Ecology Proceedings but also in the Tall Timbers Ecological Animal Control by Habitat Management Proceedings as well.

That the lives of certain species of earthworms are intimately interwoven with fire environments of the Southeast is becoming apparent. The southeastern states, and roughly south of the Ohio river, along with a narrow strip along the coast of Washington and Oregon contain the native earthworm fauna of the United States. These are the regions where earthworm species remained after the last glacial epochs which eliminated the earthworm fauna elsewhere. Today the earthworm species of the rest of the States and about one half of those in the South, are all exotics transported there by man from Europe and Asia. In the Southeast, the most general species covering the largest areas are native species of *Diplocardia (mississipiensis, floridana,* and *longa*) whose natural habitat is the regularly burned coastal plain pine forests. In fact, only the latter two have spread out to man-shaped habitats but all three are still found in the more natural condition, that is in regularly burned pine forests. The exotic species, both in the Southeast and the rest of the United States are found almost entirely in man-made habitats and only rarely in natural environments.

The fire relationships of the invertebrate fauna all over the world is much in need of serious study. There certainly is enough empirical knowledge and observation to indicate that the fire relationships of invertebrates are many and may even be more important to the welfare of man than those of the vertebrates.

MANKIND

Man and his relationship to fire has been a primary interest to me for sometime. The bones of our ancient ancestors have always been found in grassland or savanna habitats along with animals that were grazers and browsers, inhabitants of fire environments. That man evolved from some other races of Homo in such an environment seems to be without question from studies in Africa and Asia. That being the case, early man, and his predecessors, must have scoured the burns for food much as the baboons and other animals do in Africa and Asia today. He likewise must have been attracted to the assemblages of birds and other animals to grassland fires where they fed on the insects and other small creatures ahead of the fire as well as those killed on the burn. He must have learned early that many animals were attracted to the green forage that results on burned grassland and most naturally ate the seeds of the various grasses, legumes, and other plants that could only be perpetuated by periodic burning. The ancestors and near relatives of our cereals of today, wheat, rye, barley, oats, rice, millet, sorghum, and maize are still found in burned over grasslands and savannas, and many have distinct fire-selected characteristics. The ancestors of the animals that provide an important source of protein today, both herbivores and browsers, as well as such fowl as the chicken have left their living descendents, again in such regularly burned environments.

Mankind must have long witnessed the lightning stroke as well as lightning fires as we and other animals do today. It appears that for most of his early evolutionary period he was a creature of fire environments.

Perhaps the longest records of man's fire relationships may be found in the dim history of mankind's religion which has been passed on from generation to generation for a million years or more. Investigations into the religions of the world, ancient and modern, have led me into many interesting bypaths in connection with this interface between man and fire—the fire ecology of man himself. All religions we have studied thus far, and there have been a great many, appear to have fire as a theme within their history and range from bonfires, and the burning of an entire mountain, Wakasukayama in Japan (recorded to have been burned annually for over 400 years) to the candles and other lighting effects in the most modern churches of today.

Sun worship was essentially fire worship and in these ancient theologies fire was the sun on earth and so sacrifices and other rites were performed by fire in worship of the sun in all parts of the world. Many facets of these early religions were closely tied to daily living so that not only were various rites performed at certain times but as part of religion, instructions were given by religious officials on when to burn, where to burn, and even how to burn. The oldest modern continuous religion, and one which many present day theologians call the "mother" of our modern religions, is Zorastarism which is essentially fire worship. Cremation and sacrifice by fire is also an ancient practice.

Long before man learned to make fire, he learned how to take care of it. He essentially "domesticated" this worshipping force. I have said that man, as we know him, *Homo sapiens,* began when some ancestor had the courage to pick up and hold a flaming brand or coal. From that moment the creature became human and with that flame began to assume a dominating influence over other animals as well as his own habitat. It would appear that this may have even given him dominance over other species or strains of *Homo.* Certainly when this event occurred fire must have become man's most valuable possession and so this required a "fire-keeper" to protect this cherished and important "artifact" from wind, rain, and other catastrophies. Was this the beginning of human culture? Was this the beginning of housing?

Certainly it was much more important to protect the burning coals from climatic conditions than himself. And woe betide the "fire-keeper" who let the fire go out for it then could only be rekindled from another natural fire for man did not learn to make fire until recently, relatively speaking.

Long before man was able to "domesticate" fire he must have become an applied fire ecologist as a result of his scrounging and scavenging of burned areas. In fact he like all the other life of the grassland-savanna had to be fire-selected for those that did not have the necessary characteristics were simply eliminated. He, however, was different for somehow or other this creature learned how to "domesticate" this worldly force for fire both fascinated as well as terrorized him. But he became its master, and no longer its slave. He must have learned early that animals were attracted to burns, and to greened burns, that seeds and insects were easier to gather, that the grass or forbs themselves were more palatable. He knew not the "why" of these things, and probably cared but little, for food, as it is even now, was a prime requisite for survival. However, with his marvelous brain, computer-like, he certainly recorded information on natural experiments and observations of trial and error.

He later noted that various seeds, tubers, roots and other foods grew more prolifically, produced bigger and better seed, not only where the vegetation had been burned but even was more abundant where there were concentrations of ash. Later some ancestor noted that plants that produced seeds or tubers could be planted and tended, the beginning of farming. It is thus no matter of chance that the ancestors or ancient relatives of our cereals as well as our domestic animals came from fire environments for this has always been mankind's major habitat.

Our studies on the major foodstuffs of man have led us without exception to fire environments and fire was the beginning of our civilization and culture. It perhaps should be pointed out here that those of us concerned with modern science sometimes appear to give science a "halo" of knowledge. However, let me state that it was so-called primitive man that gave us our modern cereals and our domestic animals. Modern science has yet to produce a major new cereal or domestic animal. All it has accomplished is to make these plants or animals yield more per acre but we are still beholden to our ancient fire and intelligent ancestors. Without intelligent individuals in our ancestory, all the way back to that first one that picked up and thus controlled a flaming brand, we would not be here.

That the fire practices of our early peoples has been generally not only looked down upon but even ridiculed can be pointed out with clear examples. One such is the burning of crop residues. Two Roman poets, Virgil and Varro, according to the early Roman Agriculturist Cato, argued about the merits of cropland burning in 20 B.C. This practice has been universally condemned by so-called educated people ever since. Why has it taken modern science 2,000 years to prove or disprove this practice? Experiments in the last decade or so show that it is indeed a most useful practice. Not only has this been found to be a good practice but today on the highest quality and most productive improved or cultivated pastures of the Southeast, fire is used for insect control, to obtain higher yields of hay and with more protein, higher grazing capabilities again with higher protein content. Recent recommendations are to place the high nitrogenous fertilizers necessary for such yields directly into the ash for it has been found that the ash inhibits the enzyme urase which otherwise would cause some of the ammonia nitrogen to be lost into the atmosphere.

Most of our attitudes on fire have been fostered because man throughout his long history used fire to destroy the forest so that he could eat. With the development of the industrial civilization, starting with the discovery of smelting of ores, wood took on a different character. Forests were literally stripped, as they are even in Africa today, to make charcoal for smelting as well as heating and cooking purposes. This was followed by the development of the steam engine with its amazing thirst for wood which stripped much of central Europe of its forest. The wave then continued to the New World and here again the forest was not only cleared and destroyed for farms, but was also stripped of trees to furnish energy for transportation, for mining, and for other industrial technologies. This forest destruction began first for man's need for food—farming and grazing. Then it was accentuated with the industrial development. As early as the Phoencians we have records of timbers of the near East being shipped around the Mediterranean. Because of this forest destruction, fire became to be considered the "scourge" of the forester and in doing so mankind forgot, in at least the so-called developed nations, that man himself is a fire creature, that he evolved and was fire-selected in a fire environment, that his major food supplies are fire related. Even today his civilizations depend on fire of some kind or other to such an extent that if by some event all fires were extinguished on earth I do not believe man could exist.

Certainly it is now evident that Stoddard's statement of over 40 years ago that: ". . . fire may well be the most important factor in determining what animal and vegetable life will thrive in many areas " has been well substantiated in the last few decades.

This, the 14th Fire Ecology Conference has also shown that man can be the master of fire and not its slave and that fire can best be controlled by proper "Fire and Land Management."