The George Wright

FORUM

Volume 4 *1984* *Number 1*

The George Wright Society

Dedicated to the Protection, Preservation and Management of Cultural and Natural Parks and Reserves Through Research and Education

Volume 4 Number I

The George Wright Society, Inc. is chartered in the State of Delaware, in accordance with the laws of the State of Delaware and of The United States of America, as a nonprofit educational and scientific organization dedicated to the protection, preservation and management of cultural and natural parks and reserves through research and education.

 (ISSN 0732-4715), P.O. Box 65, Hancock, Michigan 49930-0065 USA. The George Wright FORUM is published quarterly.

The Editorial Board of The George Wright Society welcomes articles that bear importantly on objectives of the Society, and contributions from readers in the form of letters to the editor. Manuscripts, letters and news items (preferably double spaced typewritten) should be addressed to: Jean Matthews, Editor, The George Wright FORUM, 6060 NW Happy Valley Drive, Corvallis, Oregon 97330 USA.

Membership applications and other business correspondence should be sent to: The George Wright Society, P.O. Box 65, Hancock, Michigan 49930-0065 USA. Membership in The George Wright Society is open to those who are "interested in promoting the application of knowledge, understanding and wisdom to the management of the resources of natural and cultural parks, sites and equivalent reserves." Membership dues are: Regular Member, $25; Student Member, $15; Sustaining Member, $500; Life Member, $250. Dues and contributions are US tax deductible [Section 501 (c)(3) US Internal Revenue Code]. Additional information may be obtained by writing to the Society's P.O. box.

VESTAL FIRES AND VIRGIN LANDS:
A Historical Perspective on Fire and Wilderness

Paper presented at the Fire Management in Wilderness Symposium, Missoula, Montana, November 14-18, 1983.

Stephen J. Pyne

Abstract

The merger of a wilderness tradition with a fire tradition has dominated contemporary discussions of fire management. A simplistic conception of the problem holds that wilderness fire management only involves the restoration of a natural process to a natural environment. The reality is that one hybrid of nature and culture, fire, is being reconciled with another hybrid, wilderness. Because they evolved more or less independently, the conjunction of these two traditions has yielded a thicket of operational dilemmas and intellectual paradoxes. This association will not endure in its present form: there will continue to be fires in wilderness settings that require management, but wilderness fire as a special philosophical concern and as a domineering phase of wildland fire management will pass.

The association of fire and wilderness is at once ancient and modern. Within our solar system the Earth is the great fire planet. Only the Earth combines the essential components of combustion. Jupiter has lightning and the moons of the outer planets possess atmospheres rich in flammable hydrocarbons. But only the Earth contains all the essential constituents, the processes needed to mix them, and an environment suitable for their interaction. The process began with lightning. Lightning not only furnished a source of ignition, but it may have catalyzed the evolution of life, which in turn provided the other two essentials for combusion: atmospheric oxygen and fuel. As terrestrial life expanded, so did fire. To complement its ignition source, the Earth also has a suppressant, water. The Earth can start fire, sustain fire, and suppress fire. Testimony to the antiquity of fire can be found in the coal-bearing strata of geologic time. There is little argument that fire is fundamental to the natural history of the planet.

Yet with the appearance of the genus *Homo* the geography and natural history of fire changed dramatically. Humans assumed some control over the start, spread, and suppression of fire. They could manipulate fire in new ways and shape the fire environment to new effects. Free-burning fire was removed from areas where it had previously ranged, and it was introduced to landscapes that had not formerly known it. Just when this process began is unknown. Hearths from Africa have been dated at 1.8 million years before the present. Certainly by the advent of *Homo erectus* around 500,000 years ago, fire was carefully tended in caves in Asia, Europe, and Java. I find it inconceivable that it was not also applied, deliberately and accidentally, to the surrounding landscape.

Among the millions of species on the planet, one had assumed control over combustion. The capture of fire by the genus *Homo,* well in advance of the appearance of *Homo sapiens,* would become one of the really fundamental events of natural and human history. Wherever humans went, they would shape the fire regime of the lands they occupied. For some parts of the world, this process has continued for hundreds of thousands of years; for all of the globe, evidence of this process dates from at least the waning of the Pleistocene.

Equally, the acquisition of fire changed the character of the species that controlled it. The possession of fire became a defining trait of humans, and the manipulation of fire one of the universal foundations of culture. So long as humans persist, they will continue, through their various fire practices--which respond to culture as well as adapt to natural surroundings--to shape their environment. Few biota now exist that predate the presence of human fire practices. Our evolutionary ancestors made a pact with fire. It is an alliance that has profoundly shaped the planet, and it is a relationship that will not be quickly altered by new conceptions of land use or revivals of old moral enthusiasms.

Fire and Wilderness

It would seem that the association of fire and wildland, even through the medium of human agents, is again ancient. But *wilderness* is not the same as wildland or nature. It is a distinct idea, a product of the modern socioeconomic order, and an American invention. Modern day wilderness is an intellectual construction, and wilderness sites are cultural artifacts. This makes the question of wilderness fire very recent. In many ways, far from being a restoration of ancient associations, it represents a unique creation, unprecedented in natural and human history.

There are two great phenomena at issue here--fire and wilderness. Fire and wilderness stand for two powerful ideas, two great experiences, two distinct sets of practices. That ambiguities, paradoxes, even contradictions should appear when these two phenomena are joined is inevitable. No one conceived the wilderness idea with fire specifically in mind. The wilderness idea had other origins, ultimately in the realm of moral philosophy rather than natural philosophy. And it had proponents--special intellectual interest groups--who were not members of the fire establishment (Allin, 1982). Not until the passage of the Wilderness Act fixed the evolving concept of wilderness with legal rigor did the status of fire control in wild areas become a serious question. Quickly, however, the contradiction of fire suppression in wilderness areas was replaced by the paradoxes of fire management in those same sites.

From the beginning there has existed a naive view about the association of fire and wilderness. It states that fire is a wholly natural process and wilderness a completely natural environment; that the two are intrinsically compatible, and have been for geologic eons; that the question of fire management is simply to remove the impediments, all anthropogenic, that inhibit their natural interaction. According to this conception, to establish wilderness it is only necessary to remove the human presence, and to promote wilderness fire it is only necessary to abolish the intrusions of human fire practices. Consequently, wilderness fire management only amounts to a process of environmental restoration. This is, in my judgment, a simplisitc interpretation and, ultimately, an unmanageable one.

The reality is far more complex. With wilderness fire we are not dealing with a natural process and a natural environment, but with two hybrids of nature and culture. We are not simply putting a natural process back into a natural landscape, but trying to reconcile one natural and cultural hybrid, fire, with another hybrid, wilderness. Neither hybrid is a fixed idea or set of practices. Both have their own histories, and until very recently they did not overlap in ways that demanded attention. That the process of harmonizing the two should be perplexing--institutionally, intellectually, and operationally--goes without saying. It would be astonishing if the two had been rendered instantly compatible.

In recent years, these two traditions have come together in powerful ways, not merely coexisting but intersecting. Each has reshaped the other. Wilderness managers must accept the ancient symbiosis between humanity and fire, and fire managers, the more recent legal and conceptual status of wilderness. What seems to be a simple physical event, a fire burning in a wilderness site, can thus occupy two different cultural worlds--one formed out of a wilderness tradition and the other out of a fire tradition. So compelling has the merger of fire and wilderness become that it is possible to interpret the general history of contemporary fire management policy and programs as a response to it. This in itself is not unprecendented. From time to time fire management in the United States has organized itself around some dominent kind of fire problem. Catalyzed by the association of fire and wilderness, this type of reorganization has apparently occurred again. Call this most recent epoch the era of wilderness fire.

Thus the question of managing fire in wilderness areas, which might have remained a question of technique internal to fire management, has become something larger. It has acquired philosophical, legal, even moral connotations; and as that simple physical event, fire in wilderness, made the transition to a more metaphysical status--wilderness fire, it reformed fire management as a whole. Accordingly, it is possible to discriminate between *fire of wilderness,* whose identity is a relatively objective question of geography and fire management technique, and *wilderness fire,* whose meaning has the properties of a philosophical construction and whose character has informed an entire era in the history of wildland fire management.

The impact of wilderness fire, and the era it has shaped, has been ambivalent. On one hand, it has brought an intensity to the problem of fire in wilderness that had never been present before and that compelled fire agencies to rethink the goals of fire management. On the other hand, it has transformed a technical question in fire management into a Gordian knot of philosophy, law, technical expertise, and popular enthusiasms. It is important to recognize that this transfiguration of a fire problem, fire in wilderness, into a problem fire, wilderness fire, is a transient event.

The Wilderness Concept

Wilderness is not a universally recognized concept. It represents the encounter of Old World ideas with New World environments. It has been said that the greatest event in the history of the Old World was its discovery of the New. To be sure, the New World offered an abundance of natural resources whose plundering could enrich Old World coffers. But, equally, its discovery was a dramatic moment in intellectual history. It was as though the world had been remade, as though a second chance were being given to European peoples to start civilization over again.

Our evolving conceptions of wilderness have reflected this historical experience: WHATEVER PREDATED European discovery, no matter how profound the human component, could be considered wilderness. In particular, the American Indian was an indelible part of the natural order of the New World. Perhaps the incredible aspect of this perception is not that Indians were considered natural but that Europeans, as a result of their own definitions, were typed as unnatural. Almost certainly the origins of this perception are religious, reflecting the Christian belief in original sin, the fall of man from his original state of nature. Not mentioned in the Bible, the Indian seemingly escaped the consequences of the fall; and by the Romantic period, he could be envisioned as occupying a pristine state of precivilization. With regard to Indian fires, the essential division is not between "natural" man and "technological" man, but fallen man and prelapsarian man (Pearce, 1965).

The contemporary concept of wilderness is only the latest in a series of great ideas to emerge from the discovery of the New World. The Noble Savage, the Forest Primeval, the Virgin Land--all are ultimately moral parables by which to criticize the decadent civilization of the Old World and to exhort the New World to do better. They represent myths of a past Golden Age of natural and moral stability, relocated from a Mediterranean Eden to the New World wilderness. Such ideas are moral paradigms and literary conventions, not reports on the state of nature (Bury, 1932; Smith, 1950). Yet no one--least of all someone with aspirations in fire management--should doubt their power. Time and again, awakenings of moral sensibilities and religious enthusiasm have been accompanied by revivals and refurbishings of these ideas. Much of the power of the wilderness idea derives from its association with this heritage. These ideas are an inextricable part of our civilization. In some versions they constitute a national creation myth. In the final analysis, none of us would really wish them away.

Other values have been attached to the wilderness idea. That the land possesses information vital to science, that it offers the opportunity to reexperience the awe of Western explorers and the hardihood of pioneers, that it is a part of our landed heritage, the raw stuff out of which our civilization has evolved-all presuppose the values and institutions of an industrial civilization, a Western civilization, and an American civilization. The contemporary concept of wilderness is not intrinsic to natural environments; it was shaped, and continues to be shaped, by the society that defines it. Other societies do not have this conception of wilderness or wilderness preserves unless they have imported the idea and practice from the West, principally the United States. Even Latin America, which also represents the encounter of Old World and New, did not evolve a wilderness ethos and ideology.

Yet by shaping our conception of wilderness, even to the point of fixing it in legal language, these ideas have assumed the status of management goals. What is a state of mind is presented as a state of nature. Almost all of the paradoxes of wilderness fire derive from the fact that these culturally determined visions--together a creation myth--with their source in literary and philosophical traditions, have been mandated into management goals for field and office. There are many ways to preserve a myth, but land management is an especially intractable one.

The problem of accommodating myth with management, moreover, is doubly complicated because we are not dealing with one cultural tradition but two. Modern wilderness ideas have their origins in the humanities, while wilderness management looks to science. The two cultures--one sacred, the other secular--are not easily reconciled (Snow, 1964). The humanities deal with moral universes; the sciences, with natural universes. We cannot solve the questions of the one with the data of the other. Their purposes differ no less than their methodologies. The failure to answer scientific questions by humanistic, ethical, or theological methods is matched by the failure to answer moral questions by scientific processes. On their different purposes, one is reminded of a remark by George Bernard Shaw that science was one of the worst forms of knowledge because it was always changing its mind.

In the case of fire, this disparity has led to astonishing paradoxes. Fire is not simply a natural process, even in the New World. From at least the ebbing of the Wisconsin glaciation, no landscape has been spared from anthropogenic fire. No "natural" landscape has existed since the emergence of the Holocene. To remove anthropogenic fire from such landscapes is not to restore a pristine Golden Age of nature, but to fashion an environment which, in all probability, has never before existed.

It has not been my intention to outline the composition and history of the wilderness idea in detail. That has already been done brilliantly by Roderick Nash (Nash, 1983). My point is to emphasize the cultural foundation of the concept, to reiterate that wilderness is the outcome of positive human activity, not merely the withdrawal of human presence. Only the nature of that presence and the ideas that inspire it change. Recall, for example, the Leopold Report (1963) with its eloquent admonition that the National Parks be managed as "vignettes of Primitive America," preserving or recreating the scene that existed when the European first arrived. Just what such a scene looked like is not always easy to confirm. One is inevitably reminded of Bertrand Russell's observation that "'return to nature' means, in practice, return to those conditions to which the writer in question was accustomed in his youth" (Russell, 1929).

Wilderness Fire

The appearance of a wilderness ideology strong enough to dominate land use decisions has had, of course, enormous repercussions for wildland fire management. In one sense, the problem of fire in remote "wilderness" (backcountry) areas had always been around. But in another sense, until wilderness took on specific statutory and ideological meanings, wilderness fire lacked a unique identity. Fires in wilderness sites were no different from any other fires except that they were more difficult to manage because they were more remote. Their geographic location made them inaccessible, while the low value of the lands in which they burned made them distant from a market economy. Eventually, however, fires in wilderness sites acquired unique significance and established a kind of hegemony over virtually all aspects of wildland fire management at large. It is this issue--wilderness fire as a special phase of wildland fire--that provides the *raison d'etre* for this symposium.

How this came about is a story I have told elsewhere in greater detail, but a few points are worth emphasizing now. Fire came to America from three sources, and it was applied for four purposes. It came from nature, in the form of lightning; from Asia, at the hands of the American Indian; and from Europe, through a host of immigrants. It was used to support hunting and gathering economies, sedentary shifting agriculture, and an industrial order. Each required a different set of fire practices, purposes, and techniques that would direct the application and withdrawal of fire. It is the latest of these accommodations, to the industrial revolution, that has defined wildland fire history over the past century.

Industrialization set in motion changes that have utterly transformed our conception of nature and our use of natural resources. Among the resulting ideas relevant to this symposium were industrial forestry and wilderness, and among the significant revisions in land and resource use was a process of reserving forest and range lands that might be termed the *counterreclamation,* because it denied access to these areas for traditional agricultural pursuits. Modern fire management in America dates from the time of these reservations, principally the

National Parks and the Federal and State forest reserves. Only at this time was wildland fire really distinguished from rural fire, and only in the past couple of decades has wilderness fire been segregated as a separate form of wildland fire. It is a matter of singular importance to the history of wildland fire in the United States that the group of professionals who took charge of these lands, principally the forest reserves, were foresters.

Naturally, foresters looked to European precedents for inspiration. The preliminary efforts--from the concept of a timber famine to the establishment of a Bureau of Forestry and a system of forest reserves--can be viewed as a colossal episode of technology transfer from developed countries, notably Germany, to a developing nation, the United States. The transfer of German forestry was only one small part of an astonishing influx of German culture, from philosophy to physics, that had swept over the United States during the 19th century and only faded with World War I (Goetzmann, 1973). Many German intellectuals immigrated to the United States, and American students in search of graduate training pilgrimaged to German universities, much as Third World students now flock to American schools. Even the French forestry school at Nancy to which American aspirants like Gifford Pinchot went for instruction was set up by Dieterich Brandis, a German in the service of the British Empire. In general, American foresters found little precedent for their fire problems, but they did leave with the shimmering vision of a carefully manicured, fire-free forest.

An excellent example of what happened is the story of *Bambi.* The original book by Felix Salten was set in an Austrian forest preserve dedicated to game. The villans are poachers. There is no hint of a fire that might sweep through the woods. But when the story was relocated to America by Walt Disney Studios, an apocalyptic fire was inserted. It was as unimaginable for an Amercan forest story not to have a fire as it was for a German forest story to include one. Similarly, the need to accommodate fire was the first requirement of American forestry.

Naturally, American foresters sought to establish a new regime by breaking down the traditional fire practices that had characterized the westward settlement. The easiest method was to eliminate anthropogenic fire by excluding settlers (and Indians, now securely on reservations) from specific areas, and to suppress what fires did occur. Not everyone was pleased with the outcome. Not all traditional usage was excluded from the National Forests, but without traditional fire practices such usage was often made difficult. Much of industrial logging moved into the West Coast from the South, and it frequently brought with it fire experiences learned from coping with the southern rough. Other intellectuals, unimpressed with the professional credentials of foresters, wanted to promote the "Indian way" of forest management. Most of these groups wanted more fire, controlled underburning, in the woods.

The question of fire management smoldered until 1910, when the light-burning debate in California went public that summer, and the famous Big Blowup swept the Northern Rockies. The timing of these fires, even more than the destruction they caused, changed the course of American fire history. Understandably, confronted by hostile critics from without and by fires within, the U.S. Forest Service got tough with fire. It was engaged in a great crusade to save the country from a timber famine; its ranks were composed almost wholly of young men; and in an era that urged the "strenuous life," it had a fire in its eye--some would say a fanaticism--not unlike that of many wilderness proponents of the past few decades. It was in no mood to compromise. The Weeks Act of 1911 gave it a mandate to expand its land base and to promulgate its fire protection message through state cooperators. The modern wildland fire protection system of the United States was underway.

From the events of 1910 onward it is possible to divide the modern history of wildland fire management into four eras. Each of these eras focused on a particular kind of fire problem, each developed its own intellectual and institutional solutions to this special fire problem, and each sketched appropriate roles for fire control and fire use. Each, that is, established a suitable set of fire practices. Wilderness fire is the most recent phase of this evolution. In one sense, this progression was continuous. Fire management expanded in range, it intensified in practice, and it amalgamated new techniques as needed. Each era flows readily from the preceding era. In another sense, however, these eras do represent fundamental transformations in purpose and practice. Each developed not simply from an internal momemtum within fire protection, but in response to other events, often unrelated to fire management and unimaginable before they actually occurred. Superimposing discontinuities on fire history, moreover, accents the critical role of chance events, the influence of personalities, and the connections fire management has with the larger society that sustains it.

Naming these periods according to their problem fires, these four fire eras might be called the *frontier fire* (1910 - 1929), the *backcountry fire* (1930 - 1949), the *mass fire* (1950 - 1969), and the *wilderness fire* (1970 - present). The details regarding each era are unimportant here. I have told the story elsewhere at some length (Pyne, 1982). Of special pertinence are those events surrounding wilderness fire--its arrival, its peculiar achievements, and its prospects.

The origins of the wilderness fire era can be traced to a wilderness ideology that has been articulated with increasing clarity and that has, through legislation, rewritten the statutory authority of the Federal land agencies. The wilderness idea was not a metaphysical aberration or a social fad, though elements of each could attach themselves to it. Rather it consolidated old concepts into a *weltanschaung* for new lands. Herbert Butterfield has observed that the essence of the scientific revolution did not lie in new evidence so much as a new way of looking at well-known facts (Butterfield, 1957).

Something like this happened with wilderness fire. Its revelations were not based so much on new data as a reinterpretation of old data; not the facts but their cultural context--the promulgation of a wilderness ideology--had changed. Translated into legislation, these ideas compelled new concepts and techniques from fire management. Like other catalyzing events in American fire history, the crystallization of a wilderness ideology did not originate from within the ranks of fire management. Instead it challenged the fire establishment. This made accommodations difficult, and it required the identification of suitable traditional concerns that could bridge old practices and new.

The Legacy of Wilderness Fire

The consequences of this charge have affected wilderness management and fire management equally. The conundrum of wilderness fire has sharpened our appreciation for the concept of wilderness, particularly its paradoxes and limitations, and it has served to refine our wilderness management skills. Unlike so many wilderness problems, it could not be solved by limiting human access; on the contrary, it demanded human intervention, though of particular sorts. Unlike other wilderness dilemmas, it could not be shelved indefinitely or tabled for further study. It would not go away. It was not entirely a human technology. It was as effective by being withheld as by being applied. There was simply no neutral position.

Similarly, wilderness fire represented a new phase in the historic symbiosis of humanity and fire. It was a new category of fire, and it compelled new concepts for understanding and new practices for management. Surely fire belonged in wildlands. On that almost everyone could agree. But under what conditions--conceptual and practical both--fire could be encouraged was far more difficult to answer. The problem was not merely to introduce fire into the landscape, but to do so in harmony with the peculiar tenets of the wilderness concept. Most of the intellectual paradoxes and operational quagmires associated with wilderness fire result from approaching the question from the perspective of wilderness.

Viewed from the vantage point of fire, answers seem obvious. Of course fire must be actively managed in these sites; of course prescribed fire of all sorts--underburning and crown fire, scheduled and unscheduled ignitions--must be used. Answers become possible because the question of fire in wilderness has been disentangled from wilderness fire. The focus has changed from wilderness fire, with its foundation in the wilderness concept, to fire in wilderness, with its roots in fire management. The defining relationship is that of people to fire, not people to wilderness. Disengaging to two traditions allows for a solution, but the price paid is that the question loses its vitality. The long-term consequences are thus ambivalent.

The accomplishments of the era of wilderness fire have been impressive. It established new norms for fire use and control, and new objectives for fire relative to land management. It inaugurated a massive, decade-long process of fire planning. It led to new fire policies. It reoriented fire research into biological topics and fire effects at large, both ecological and economic. It dramatically expanded fire-related skills. Principally, this meant handling fire in wilderness areas, but by a process of association it expanded into the realm of prescribed burning as well. It compelled a fundamental reclassification of wildland fire into two broad categories, wild and prescribed fire. Its precepts and techniques have become the training ground for the next generation of fire specialists.

Not all of these transformations owe their existence solely to the issue of wilderness fire. There were other arguments for reconstituting fire protection, quite independent of fire problems in wilderness, and there were ample reasons to accelerate prescribed fire projects. But wilderness fire gave these long-standing issues a focus and their reformation a moral energy. In some respects, too, these older problems provided a means of entry into the special conundrums posed by wilderness fire.

Historically, a fire protection system in the United States had thrived because it expanded into new, unprotected lands. By the 1970s, however, that expansion was virtually complete. All of the lands in need of protection were by and large protected; in some areas, the level of protection was shockingly intensive. Suppression and presuppression costs spiraled seemingly out of control. Fire protection was hardly alone in experiencing wildly escalating expenditures; government had been a growth industry, and nearly everywhere funding had gotten out of hand. Fire control, however, had its own peculiar mechanism for escalating costs, and it experiences, through the wilderness challenge, a special form of control. In actuality, several processes came together at roughly the same time. Wilderness concerns rewrote the statutory authority of the Federal land agencies.

The reality of diminishing return compelled some forms of administrative consolidation, especially interagency coordination. Reductions in the rate of Federal spending demanded institutional reforms and policy reconsiderations. But it was wilderness fire that provided a common fucus.

In the long run the most spectacular achievement of wilderness fire may be its vindication of prescribed buring. If fire could be used for some purposes, like those in wilderness sites, then it could be used for other purposes and in other locations. If fire was essential for wilderness areas, then it could also be good for other, less pristine environments. In a sense, through the medium of fire, the goodness of the wilderness could be brought to other lands. This was the ideological component. Obviously, there were other, practical considerations. There always had been. Fire use had never been abolished during the evolution of modern fire protection, but is potential usage had always been circumscribed by the particular problem fire that informed the era. Light burning, for example, had been repudiated not because it was worthless, but because it too closely resembled laissez-faire practices of the frontier with their extravagant waste of resources and their hostility to government bureaus. Stacking and burning were encouraged, but not broadcast underburning. Every era had found its own range of potential fire use.

It was not until the effects of wilderness fire justified a general conviction that fire was beneficial and necessary in ecosystems that the fervor grew for a general program of prescribed burning. There were practical concerns, like a buildup of fuels in some environments, and there was an accelerated awareness about the potentials for prescribed fire, spearheaded by the Tall Timbers Fire Ecology Conferences. But fuels had built up implacably in some areas for decades without leading to the almost universal adoption of prescribed fire as a solution. Similarly, the range of applications for prescribed fire might have slowly expanded, site by site, purpose by purpose, without becoming a generalized solution to fire management problems. Instead prescribed fire became identified with wilderness fire. Consequently, it was not practical issues, like fuels, that led to the fervor for prescribed fire; it was conviction about the value of prescribed fire, inspired by the wilderness ideology, that encouraged a search for legitimate uses. It was as if distributing prescribed fire became a surrogate for distributing wilderness. The reduction of fuels and the maintenance of habitat channeled prescribed fire into areas of traditional concern to foresters, providing a conceptual and operational nexus between old concerns and new goals.

In brief, wilderness fire encouraged the use of fire, just as previous eras had generally discouraged it. Without wilderness fire as an informing problem, prescribed fire likely would have remained a local epiphenomenon, widely used but not widely promulgated as a national program. Something had to propel the idea into large circulation, to give it a powerful focus that would permit all forms of fire use to be lumped together under the rubric of prescribed fire and all other manifestations of fire to be labeled wildfire. The idea of wilderness did just that.

But to match its accomplishments, the era of wilderness fire has created an equally impressive array of operational dilemmas and intellectual paradoxes. At first wilderness fire, like other problem fires, was defined and promoted in terms of the problems it solved; eventually, it will be repudiated because of the problems it creates. The issues debated at this symposium did not really exist as public questions when wilderness fire began to challenge the era of mass fire. Wilderness fire could resolve issues that mass fire could not, and nagging doubts about finer points of philosophy, such as the question of Indian burning, were swept aside. As wilderness fire reorganized fire management in general, however, those minor points have become more and more insistent. Now they tyrannize discussion about fire management.

The dilemmas will not be overcome solely by appeal to technical information. They will not be solved by inventing a new terminology, nor by more elaborate definitions, nor by shifting the burden of meaning from one intangible philosophical concept to another. The epistemological clarity of "real world" is, after all, no better than that of "natural." It may matter little to a tree whether the fire that burned it had its origin from lightning or from the hands of an American Indian, a research ecologist, an arsonist, or a careless camper. But that fire is not burning in a wholly natural environment. It burns within a cultural environment, too, and the source of the fire does matter to the society that sustains it. One could make the same argument that it hardly matters to a person killed by gunshot who pulled the trigger or why. It matters enormously to society. This is not simply a scientific question; it depends, ultimately, on the values and institutions of the culture within which the event occurs.

The myths are real, vital to our national identity. The paradoxes associated with wilderness fire are real. They will only be resolved when wilderness fire no longer dominates fire management at large, when pragmatic field operations replace the philosophical debate because the metaphysics no longer matters in the same way. Such problems are not solved in any technical sense; they are simply bypassed. They become academic issues, not live ones.

The Future of Wilderness Fire

It may seem perverse, within the context of a symposium dedicated to the general successes of wilderness fire, to speak about the termination of the era. But if the metaphysical issues will only vanish when the era does, then there is a practical as well as a theoretical point to the discussion. Wilderness fire will not endure forever as an informing problem fire. Each of the four phases of fire management outlined previously lasted only about 20 years. And, if one wished to begin wildland fire management with the establishment of the forest reserve system (1891), another epoch could be added precisely 20 years before the era of frontier life.

Why this periodicity should exist, I cannot say. It is especially puzzling when one considers the many chance events that have shaped American fire history. A partial explanation derives from the circumstances under which the Forest Service was established. It was created virtually overnight as a result of the Transfer Act and it began with a homogeneous population of young men rather than a general distribution of age groups. The 20 year period might correspond to a bureaucratic cycle of generations. Temperamentally, I don't believe in cycles of history, and for present purposes it is enough to ascribe the cycle to chance. My point is that wilderness fire, too, will pass. It does not really matter whether the change comes at 20 years, or 25 years, or 18 years. It will come. There will continue to be fires in wilderness, but wilderness as a metaphysical concern and wilderness fire as an informing problem will give way to other issues. If the periodicity holds, then the era of wilderness fire will expire formally around 1990. If this analysis is correct, we are already on the downhill side of the era.

Ponder for a moment the implications of this conclusion. One is that the philosophical issues which seem so intractable today will become less so as the ideology of wilderness fades from the fire scene. This is not altogether an occasion for rejoicing. It suggests that about 5 to 8 years remain for wilderness managers to work out in practical terms just how to manage fire on their sites. After that, fires will continue, but fire management will no longer possess the philosophical conviction necessary to devote special energies to them. We will then witness fires in wilderness, but not wilderness fire. The techniques of wilderness fire management must be availalbe and, for most areas, already in place for use by that time. Those areas that do not have operational wilderness fire plans by then may never have them. The scope of fire management is far vaster than wilderness fire, or even of wildland fire; the problems and potentials posed by fire will not long be confined to wilderness arenas. It is vital that pragmatic solutions be found, that after the metaphysical energy vanishes there remains a residuum of field techniques and concepts that can cope with fire in wilderness. Fortunately, the techniques of wilderness fire management are well advanced. The future of wilderness fire may look bleak, but the future of fire in wilderness looks excellent.

Exurban Fire

In this scenario it does not matter much what supersedes wilderness fire. But of course simple curiosity compels one to hazard a guess. There are two dangers in any such forecast. One is that you are laughably wrong. Epecially when one considers the role of chance events--all orginating outside fire management proper--in the evolution of fire policy, any future projection is troublesome. The other hazard, more flattering, is that one is believed, that the imagined future becomes a blueprint for action, that the forecast becomes a self-fulfilling prophecy. Still, there is reason to guess, if only to emphasize the ephemerality of wilderness fire.

My suspicion is that the next problem fire will deal with the question of residential developments in wild or rurual lands, what I would label exurban fire. This isn't really a rural fire problem, though it resembels one in some respects. The population is not engaged in agriculture; the developments are residential and recreational. Nor is it really an urban-wildland interface problem after the Los Angeles model. The encroachment of the megalopolis against true wildlands is relatively slight, though occasionally spectacular; most cities expand at the expense of rural land. Rather this encroachment is by an exurban population, searching after ever more remote suburbs. The outmigration from farms to cities ended decades ago in the United States; it persists now in select cities, like Los Angeles, due to immigration, legal and illegal, from rural areas outside the United States. Instead, this is a secondary migration from urban to exurban sites, from industrial core regions to less populated areas. A good many such areas occur in wildlands, and some abut wilderness.

The expansion is actually twofold, because wilderness, as formally designated, is also being insinuated into less remote sites, many of them once settled or located near settlements. Either way there is a natural point of transition from wilderness fire to exurban fire. The problem is ubiquitous across the United States, but this in itself is no guarantee that it will assume the stature of a problem fire than can, in turn, inform the national fire management departments effort. There are several candidates, and if history is a guide, one will be selected, in part, on the basis of chance events.

Under such an exurban fire regime the changes would be many. We would witness a revival of suppression and prevention programs. Planning would emphasize county zoning rather than land management principles. Fuels would more likely be treated through fire codes or mechanical devices than through prescribed burning. Engine companies could be more important than smokejumpers, local volunteer fire crews more than interregional suppression crews. The interagency integration of fire resources would be extended down to rural areas. Research would explore new fuel complexes, investigate new burning attributes, and test new strategies for suppression. The transformation would not abolish the management of fire in wilderness, but it would demote wilderness fire from the status of a philosophical interrogation to a routine field operation. The moral energy that has sustained much of the quest for wilderness fire would vanish or become merely quaint.

Conclusion

At the moment, however, my concern is less with the future than with the past. The association of wilderness and fire--at an intellectual level so readily asserted and at an operational level so intractable--is a great event in our history. It is an idea and a practice that will spread, in modified forms, to all parts of the world that adopt versions of the American concept of wilderness. But we should ponder the uniqueness of this association, not assume its inevitability.

We are a people who represent the contact of Old World civilization with New World nature. The character of that pre-columbian landscape is problematical, but we have come to call it wilderness. We preserve it because it is part of the raw stuff that has made us a people, a nation, and a culture. All of this is, of course, an American notion. Nature looks different to other peoples. They do not define themselves as wilderness societies. So powerful has the idea become in recent decades in the United States, however, that it has dictated all manner of land use legislation and practices.

Amidst the enthusiasm for *wilderness* values, we should not forget that there is another value at risk in the question of wilderness fire. That is fire. Our relationship to wilderness may define our character as a civilization, but our relationship to fire has defined our identity as a species. Only recently have we become keepers of the wild; but for all of our existence as a species we have been, and will continue to be, keepers of the flame. Some peoples will preserve wilderness, some will not. But all will manage fire. We cannot completely subordinate fire to the demands of a wilderness ideology, nor should we want to. We ought to remember that fire, as an ecological process and a cultural phenomenon, is different from other threats or challenges to wilderness; we must also mold our concept of wilderness to suit the reality of fire. Obviously, there is an urgent need to reconcile fire and wilderness. But there is a value, too, in keeping them separate. Both, in their own ways, are testimonies to creation myths: wilderness, to our existence as a nation; fire, to our existence as a species.Each will shape our perception of the other.

From the earliest times societies have maintained sacred fires. These were motivated by practical concerns originally, but in time the fires assumed ceremonial identities as well. They became national fires, symbols of the entire people. Perhaps the best known is the vestal fire maintained at Rome by a cadre of priestesses and virgins, a symbol of the Roman state. The role of fire keeper has become a good deal more secular over the centuries, fortunately for all of us no longer identified with a cult of virginity. But the role remains a special trust. Fire managers should see in wilderness fire an opportunity to preserve a distinctive kind of fire and set of fire practices. Fire researchers should welcome wilderness fire as a unique laboratory, a chance to study fires that, as utilization intensifies, may vanish elsewhere. Fire historians will recognize in wilderness fire a variety of national fire, an eternal flame to the settlement of the New World, a vestal fire for America's virgin lands.

References

Allin, Craig. 1982. *The Politics of Wilderness Preservation.* Greenwood Press, Westport, Connecticut.

Bury, J. B. 1932. *The Idea of Progress.*

Butterfield, Herbert. 1957. *The Origins of Modern Science.* Free Press, rev. New York.

Goetzmann, William H. 1973. *American Hegelians: an intellectual episode in the history of the American West.* Knopf, New York.

Nash, Roderick. 1983. *Wilderness and the American Mind.* 3rd ed. Yale University Press, New Haven.

Pearce, Roy. 1965 rev. *The Savages of America: a study of the Indian and the idea of civilization.* Johns Hopkins University Press, Baltimore.

Pyne, Stephen. 1982. *Fire in America: A Cultural History of Wildland and Rural fire.* Princeton University Press, Princeton.

Russell, Bertrand, 1929. *The Scientific Outlook.* Norton, New York

Smith, Henry Nash. 1950. *Virgin Land: The American West as Symbol and Myth.* Harvard University Press, Cambridge.

Snow, C. P. 1964 rev. *The Two Cultures: and a Second Look.* Cambridge University Press, Cambridge.

Stephen J. Pyne is Professor of History, University of Iowa, Iowa City.

WESTERN PARKS AND THE AMERICAN CHARACTER

Keynote Address, Parks in the West Conference Sun Valley, Idaho, August 1984

William E. Brown

Savant Joseph Campbell recently stated that ". . .mythologies differ as the horizons, landscapes, sciences, and technologies of their civilizations differ." Though he speaks in broad anthropological terms, I apply the idea narrowly to the historical evolution of the American West. To give point to this idea of myth-making horizons and landscapes, and the effects of evolving science and technology, I turn to the Lewis and Clark Expedition, and to the commentary of one one of its students, Roy Appleman, who trod the explorers' trail 170 years after them. The journals of the expedition are restrained and factual. But not and again the drama of the journey shines forth, as in this passage by Meriwether Lewis, written the night of April 7, 1805, as the two captains prepared to leave their winter camp at Fort Mandan to reach the unkown, beyond the missouri:

> . . .we were now about to penetrate a country at least two thousand miles in width, on which the foot of civilized man had never trodden; the good or evil it had in store for us was for experiment yet to determine, . . .however, as the state of mind in which we are, generally gives the colouring to events, when the imagination is suffered to wander into futurity, the picture which now presented itself to me was a most pleasing. . .I could but esteem this moment of my departure as among the most happy of my life.

Implicit in these expectations is the yearning for Eden in the first days of God's creation. The captains' subsequent adventures, marked by discoveries and revelations beyond imagination, fulfilled that yearning.

But their chronicler, 170 years later, found that ". . .an industrial-technological America has wrought vast changes along the route of Lewis and Clark." Then he tolls the changes:

> That the rampaging Missouri River Lewis and Clark knew would be tamed, that many of their campsites would be submerged, that most of the native trails they traversed would disappear from the plains and mountains, that the majestic Great Falls of the Missouri would be reduced to a trickle--all would seem unbelievable to the two captains. That the vast herds of buffalo, elk, and antelope, as well as the numerous grizzly, would be all but extinct, except where sanctuary exists, would seem equally as preposterous. The disappearance of the great falls of the Columbia would be beyond comprehension.

In these words can be read the end of dreams, the domestication of mythic horizons and landscapes. The loss is twofold. Eden's people, who shared their spirit world with Lewis and Clark, are gone as well. A few place-names survive to suggest rich cultural geographics that died with the elders.

I share the belief that the Westering dreams of an earlier age--the age of our grandparents--formed a core element of our national psychology. It is the romantic, effective element that pulls us asunder as our lives become evermore controlled by numbers, diminishing space, and the inhuman scales and threats of our creations. Compared to yesterday's clear dawning and the adventuring lives that greeted it, our time is hazy and crowded and constrained. So we burst out in other ways.

We have yet to adjust to the new world of our own making. Scholars have demonstrated the pertinacity of those earlier myths, despite closing horizons and right-angled landscapes. Perhaps, as some say, our mythic needs are purely psychological and will atrophy in time. But perhaps they are biological, reflecting, as Colin Turnbull asserts, our "lost identity" as hunters and gatherers. Whichever, the tension remains. Nostalgic films and books satisfy some seekers. Intense, death-beckoning adventures, in what is left of the wild, call others. Meditation, often mixed with sorrow over what is lost, consoles a few.

Parks and other preserved lands in the West are reliquaries where the old myths find sanctuary. They are the places left to us for escape from a progressively deteriorating and almost wholly urban daily-life environment. In their backcountry reaches these places, whether near-regional park or far-Alaskan wilderness, offer companionship with Lewis and Clark. They give us opportunity--sensory, effective, logical--to adventure, to trod untrodden ground, to see the creation again. They attract scientists who want to see how the real world works. They are refuge for poets and climbers, for naturalists and river-runners, for children who have no choice but to accept what is left.

The parks and preserved lands, once buffered and remote, become islands--eroded and transformed by their advancing surroundings. In the minds of some they are threatened symbols of transcendent meaning, beyond utilitarian measure. They are last links with the world before. They are spiritual havens. These parklands, in all their diversity of types and sizes, keep alive the kinds of human experience that once occupied all of human experience.

The American character (assuming some validity in that concept, and discounting its unavoidable ethnocentricity) was largely shaped by a new continent, lightly peopled and rich beyond Old World measure. This circumstance allowed a replay of history. Modern people, at the dawn of the industrial age, could go back in time to that first dawn. Through the publicized adventures of the pathfinders who pushed beyond the fringes of settlement and brought back stories of vast spaces peopled by neolithic civilizations, a partly active, partly vicarious national experience took place. But all too soon, George Catlin's vision of a trans-Mississippi preserve was sullied, the garden desecrated.

An enlightened few saw the tradegy abuilding and set aside parts of the land to allow that national experience to continue. Today, these places with varying success, depending on the human impacts they have suffered, perpetuate that national experience.

Is the Myth of Eden sustainable? Is the American character--still moved by the evocations of remnant horizons and landscapes--sustainable? Some would agrue that it is essential to maintain these things--land, myth, character. It could as well be argued that there is no rule in the future for a character so shaped. It causes unwanted stress in a world that trends toward blotting out Eden altogether.

As for me, I confess to Romantic tendencies. I want my myths. I want horizons and landscapes that nurture them. I want to be with people who want these things.

William E. Brown, Historian, Alaska Region, National Park Service; author, *Islands of Hope.*

URBAN SOILS OF WASHINGTON, D.C.

John R. Short and *James C. Patterson*

Urban soils, or highly man-influenced soils, have become more commonplace with the extensive earth moving and manipulating activities of man. Highly man-influenced soils are not limited to urban areas, but may be found wherever activities of man result in disturbance of soil profiles. Disturbance may consist merely of compaction of an existing soil by foot traffic, or may result from large scale manipulation of soil materials to create an entirely new land surface. The mode of formation of these soils, and the magnitude of impact the soils receive will surely result in soils with unique properties. It is important to understand the properties of urban soils in order to effectively manage them as a resource, whether the soils are situated in an urban or a rural setting. The study of urban soils is a new branch of soil science, so that there is much work to be accomplished to characterize these impacted soil systems. The National Capital Region has been interested in expanding the level of knowledge of these soils because of the largely urban nature of its parks.

The physical characteristics of soils in most urban environments are often unfavorable for plant growth. Use of soils for paths, trails, roadways, campgrounds, picnic areas, and recreational areas create compacted soil systems. Bulk density, which is the weight of soil material in a given volume is increased by compaction. The bulk density of an "ideal" soil is approximately 1.33 grams/cubic centimeter (g/cc), while bulk densities as high as 2.22 g/cc have been found in highly man-influenced soils. Studies have shown that soils with bulk densities of 1.67 g/cc or greater are often inhospitable environments for plants. The main result of compaction is a loss of pore space. While an "ideal" soil will contain approximately 50% pore space, evenly distributed between soil air and soil water, an impacted soil will often have 20% or less pore space. The lack of sufficient pore space usually causes plant stress. The packing of soil particles also results in increased difficulty for root penetration, contributing to the stressed conditions of plants in the urban environment. The limited root systems which develop in impacted soils are unable to take up sufficient water and nutrients to meet the needs of plants during dry periods. Storage of energy reserves in the root system also is inhibited.

Soil texture is important for support of plant growth. Soils with greater amounts of sand will tend to drain more quickly, will not retain as much water for use by plants during dry periods, and will tend to contain fewer nutrients. Clayey soils are able to retain greater amounts of nutrients and water, but the slower rate of water movement (hydraulic conductivity) in such soils may be limiting to plant growth during wet periods. A loamy soil, which is a soil with a relatively balanced distribution of sand, silt, and clay, may provide a reasonable compromise with respect to drainage and nutrient retention. However, soils of this texture are susceptible to compaction because the relatively even particle size distribution permits small particles to readily fit into voids between larger particles. Studies have shown that the highly man-influenced soils in Washington tend to be coarse textured (loamy), and susceptible to compaction.

The type and amount of coarse fragments present in the soil, such as building rubble, chunks of concrete, glass, bricks, etc., have an effect on the soils as they weather. Concrete, for example, may release lime which tends to raise the pH of the soil, or make it more alkaline.

The manipulation of material to form new land surfaces is characteristic of urban development and it results in soils with unusual properties. Materials of unlike textures, mineralogy, and other properties may be placed adjacent to or on top of each other. Often, sharp delineations between these contrasting soil materials (lithologic discontinuities) are found in these soil profiles. Water movement through the soil may become impeded at these boundaries, because water will not move from one soil texture to a different one until the first layer becomes saturated. Poorly drained soils, therefore, are of common occurrence in the urban environment.

The chemical properties of manipulated soils are often different from those of natural soils. The pH of soils in several cities has been shown to be higher than in associated non-impacted soils with alkaline soils being common in impacted soils. Runoff from streets has been found to increase the salt and heavy metal content in nearby soils, often to a level which may have adverse effects upon vegetation. Heavy metal content may be a concern where the soils are used for vegetable production, as in "victory gardens."

The presence of organic matter in soils is highly beneficial. A favorable environment for soil fauna, such as worms, and for microbial populations, such as mycorrhizal fungi is provided by organic matter. Nutrients become available as organic matter decays, with organic matter essentially acting as a slow release fertilizer. Organic matter tends to improve the soil structure, combining the individual soil particles into larger aggregates, or peds. This tends to improve the drainage, aeration, and water infiltration capabilities of fine-textured soils, and increases the resistance to compaction for most soils. Organic matter also increases the ability of the soil to retain nutrients, and to prevent nutrients, such as those applied as fertilizer, from leaching through the soil. The organic matter content of urban soils tends to vary with depth, and is often lower than that of natural soils throughout the entire profile.

The ability of a soil to retain nutrients is referred to as its cation exchange capacity (CEC). The CEC has been found to be similar in natural and highly man-influenced soils. The base saturation, which is a measure of the percentage of nutrients the soil can potentially hold is often much higher for urban soils than that of nearby natural soils. Higher base saturations may result from breakdown and dissolution of inclusions of concrete, mortar, or similar materials.

Urban Soils and NCR

Parkland of the National Capital Region (NCR) receives heavy visitor impact, with many soils occuring on highly manipulated landforms. The heavy visitor impact these soils receive, plus the need to maintain high quality, attractive plantings provided the incentive to intensively study the soils of the Mall.

The Mall is located on filled material between the US Capital to the East and the Washington Monument to the West (Figure 1). The soils of the Mall typify highly man-influenced soils because they were formed in fill material deposited by man in a swampy area, and have been continually impacted through pedestrian and vehicular traffic.

The objectives in studying these soils were to: (1) determine the physical and chemical properties of these soils; (2) determine the variation of these properties; (3) develop a soil map based upon obserable soil properties; (4) attempt to classify the Mall soils in a manner indicative of their highly man-influenced nature; and (5) provide information to the Park which will help meet their management objectives.

A transect sampling system was used in studying these soils to ensure representative sampling. One hundred profiles were excavated and described using accepted soil survey terminology. One hundred profiles were determined to be necessary to adequately characterize the mean of most properties. Samples were obtained from each morphological horizon for laboratory analysis, while bulk density samples were obtained only from the surface and at 30 cm (12 in).

The Soils of the Mall and Input to Management

The soils of the Mall appear to have developed in miscellaneous fill applied to a depth of about 6 m (20 ft.). Most profiles (95%) contained at least one lithologic discontinuity, where unlike soil materials were applied. These lithologic discontinuities have resulted in poorly drained soils. Poorly drained soils can often be identified by mottling in the soil matrix. Object artifacts of man, such as brick, glass, cinders, concrete, and slag, were found between 25 cm and 100 cm in 94% of the profiles. The presence of artifacts within the soil profile is significant as they illustrate that man has been instrumental in accumulation of the parent material of these soils and that the soils themselvels may have unique properties.

Further evidence of manipulation of the soil materials was shown by the presence of buried A horizons (42% of the profiles studied) and the variation of percent organic matter with depth in the profiles (Table 1). A horizons are generally considered to be surface horizons, and are characterized by accumulations of organic matter. These horizons are usually darker in color than underlying horizons, with a softer, more friable, consistence. When additional fill material was applied to the soil surface, any A horizon which may have been present at the time of filling would have been buried. That soil formation occured in this fashion on the Mall is evidenced by the presence of buried A horizons in many of the profiles.

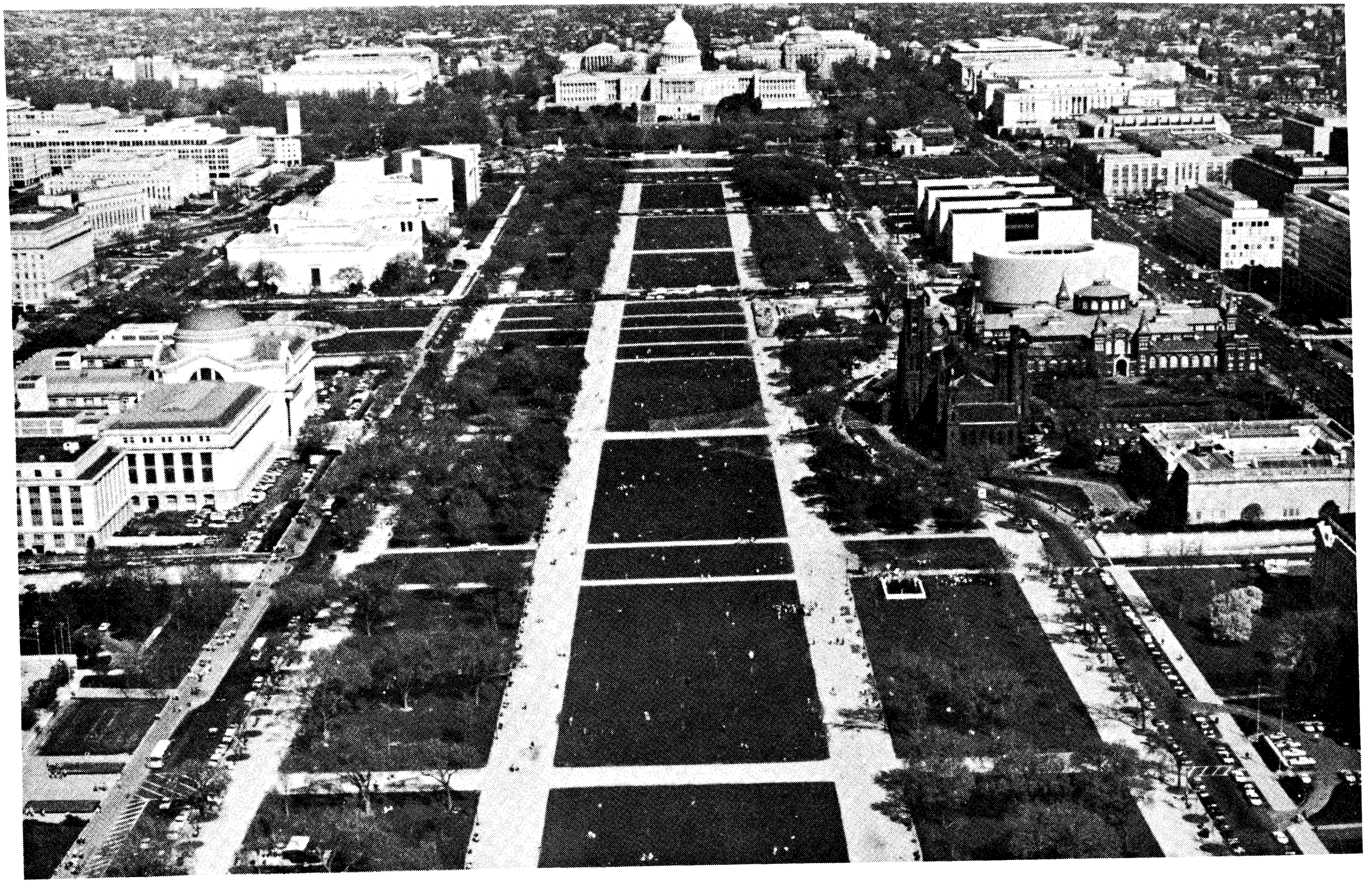

Figure 1. The Mall, as viewed from the Washington Monument. Photo by Bill Clark, National Capital Region, US National Park Service.

Table 1. Mean of Selected Chemical Properties of Mall Soils by Horizon.

Horizon (from surface)	pH	Organic Matter %	CEC meq/100g	Base Saturation %
1	6.39	1.97	11.22	88.86
2	6.52	1.08	9.51	88.19
3	6.57	0.73	8.88	117.95
4	6.64	0.50	8.24	113.87
5	6.67	0.41	8.80	94.30
6	6.59	0.66	7.51	139.36

The soils were found to be predominately coarse textured, with 99% of the soils fitting either the coarse loamy or fine loamy families of *Soil Taxonomy*. One profile was sandy in texture. Such textures are very susceptible to compaction, as discussed previously. The bulk density (Table 2) at the surface was a mean of 1.61 g/cc, and 1.74 g/cc at 30 cm. However, bulk densities up to 2.03 g/cc were found. Percent pore space was reduced from that of an "ideal" soil to mean of 36.6% at the surface and 32.8% at 30 cm. The maximum percent pore space was 50%, and was found in the surface horizon. Clearly, these soils are compacted.

The National Capital Region is following a soil management program which includes aeration of these dense, compacted soils and topdressing with organic matter such as composted sewage sludge. Restriction of visitor access in the most heavily impacted areas has been accomplished through the use of post-and-chain, with the result that some highly impacted elm trees have exhibited signs of recovery. Addition of woodchips in heavily impacted areas where turf cannot tolerate the extreme wear from visitor use has proven successful in minimizing the adverse effects of soil compaction.

Table 2. Bulk Density and Percent Pore Space of surface Horizon and 30 cm Depths

Depth cm	Mean	n	Min	Max
		Bulk Density (g/cc)		
surface	1.61	100	1.25	1.85
30	1.74	100	1.40	2.03
		Pore Space (%)		
surface	36.6	100	2.80	50.0
30	32.8	100	21.0	45.1

The mean pH of Mall soils ranged from 6.39 in the surface horizon to 6.67 in the 5th horizon (Table 1). However, pH values for 32% of the samples obtained were 7.0 or greater. These alkaline pH values may be a result of inclusion of lime-bearing artifacts, such as concrete, compost, or mortar, within the profile. Lime should not be applied routinely to highly man-influenced soils such as these. These soils should be tested to determine the need for lime application. The value of a soil testing program is not limited to urban soils, but is applicable to any soil resource. The alkaline nature of many highly man-influenced soils may result in significant savings from limited lime applications.

The mean organic matter content tended to be low, less than 2% in the surface horizon, and decreased with depth (Table 1). Most natural soils in the Washington D.C. area contain from 3% to 5% organic matter in the surface horizon. The low organic matter content, in conjunction with the loamy textures, caused these soils to be quite susceptible to compaction. Much of the buffering capability of organic matter is lost because of the low level of organic matter present in the soils.

The cation exchange capacity (CEC) was greatest in the surface horizon (Table 1), and tended to decrease with depth. This decrease with depth is to be expected since organic matter makes a significant contribution to the CEC of a soil. Perhaps of more immediate interest in the urban environment, however, is the base saturation of these soils (Table 1). The minimum mean base saturation found was 88.2%, with values up to 139.4% being found. Values over 100% may reflect the presence of soluble salts, or ammonia fixation may have resulted in slightly low values for CEC in some horizons. Analysis indicated that calcium was the dominant cation held within the soil, possibly resulting from inclusion of lime bearing artifacts within the soil profile.

The soluble salt content for most soils of the Mall was low. Mean soluble salt content was less than 300 parts per million (ppm) in 80% of all horizons, and 80% of the surface horizons contained less than 300 ppm. However, over 1000 ppm soluble salts were found in some horizons. Soluble salt levels greater than 600 ppm can cause problems for plant growth.

Mall soils were analyzed for heavy metal content (Table 3). Lead content was 184 micrograms/gram (ug/g) in the surface horizon and decreased with depth in the profile to a low of 110 ug/g in the 4th horizon. Background levels of lead in natural soils of about 10 ug/g have been reported. Cadmium content was the lowest, ranging 0.7 ug/g at the surface to 0.3 ug/g in the 6th horizon. Background levels of cadmium found in unimpacted soils have been reported to be between 2.2 ug/g and 0.3 ug/g. Zinc, nickel, and copper contents were intermediate. The Mall soils appear to have elevated levels of heavy metals. The source of these metals may be from vehicle exhaust, from incorporation of composted sewage sludge as an organic amendment, or other sources. But this may not be a concern in this instance as these soils are not intended for crop production.

The Mall soils varied greatly in the number of samples required to estimate the mean for the properties examined. The physical properties tended to require fewer samples to estimate the mean at a given level of accuracy. Determination of mean bulk density could be accomplished with only one sample, while less than 50 samples were required to estimate the mean soil texture. The chemical properties, on the other hand, required far more samples than are usually obtained. The mean pH of the Mall could be realibly estimated with fewer than

Table 3. Mean Heavy Metal Content of Mall Soils by Horizon.

Horizon	Pb	Zn	Ni	Cd	Cu
	ug/g				
1	184	67	13	0.7	23
2	141	56	21	0.5	20
3	146	60	25	0.5	24
4	110	73	8	0.4	22
5	111	68	9	0.4	18
6	129	77	13	0.3	31

10 samples, but estimation of the mean organic matter content required nearly 500 samples. The increase in the number of samples necessary to estimate mean organic matter content is likely to be a result of inclusion of buried A horizons at depth in the profile. Estimation of cation exchange capacity could be accomplished with 41 samples or less. The most variable properties, and therefore the properties which required the most samples to estimate the mean, were the heavy metals. For example, lead required from 227 to 1965 samples, and estimation of nickel content required up to 7171 samples.

A soil map was prepared of the Mall using taxonomic criteria developed for use with highly man-influenced soils (Figure 2). Subgroups previously developed for use with highly man-influenced soils were used in conjuncion with standard soil taxonomy to classify these soils. These subgroups are the "urbic" and "spolic" subgroups. The urbic subgroups contain object artifacts within the soil profile. These artifacts were used to define the subgroup because of their effect upon soil characteristics. The spolic subgroup does not contain the artifacts within the profile, but is soil created by earth moving activities of man. These soils may be identified by topographic position, random orientation of coarse fragments, and historical records. Examination of the soil map of the Mall shows that the majority of the soils of the Mall contain artifacts of man. Soil development, while limited, has also occurred. The majority of soils on the Mall exhibit only limited profile development, and are delineated as Urbic Udorthents and Spolic Udorthents. More developed soils are delineated as Urbic Eutrochrepts, Spolic Eutrochrepts, and Urbic Dystrochrepts.

Conclusions

The characteristics of these soils have an impact upon management practices. Plant management is made more difficult by the compacted nature of these soils with the resulting reduction in pore space. The texture of these soils make them susceptible to compaction and, therefore, less able to support activities without being adversely affected. Layering of the soils during filling, with formation of lithologic discontinuities, has resulted in soils with poor drainage, moisture holding capacity, and soil aeration, in some areas. The chemical properties of the Mall soils are influenced by their highly impacted nature. Heavy metal content, though high, is not limiting the use of these soils. The great variation in some of the properties required over 7000 samples in order to estimate the mean. Clearly, it is impractical to routinely perform sampling of this magnitude! However, no matter where these soils are found, the great variability of highly man-influenced

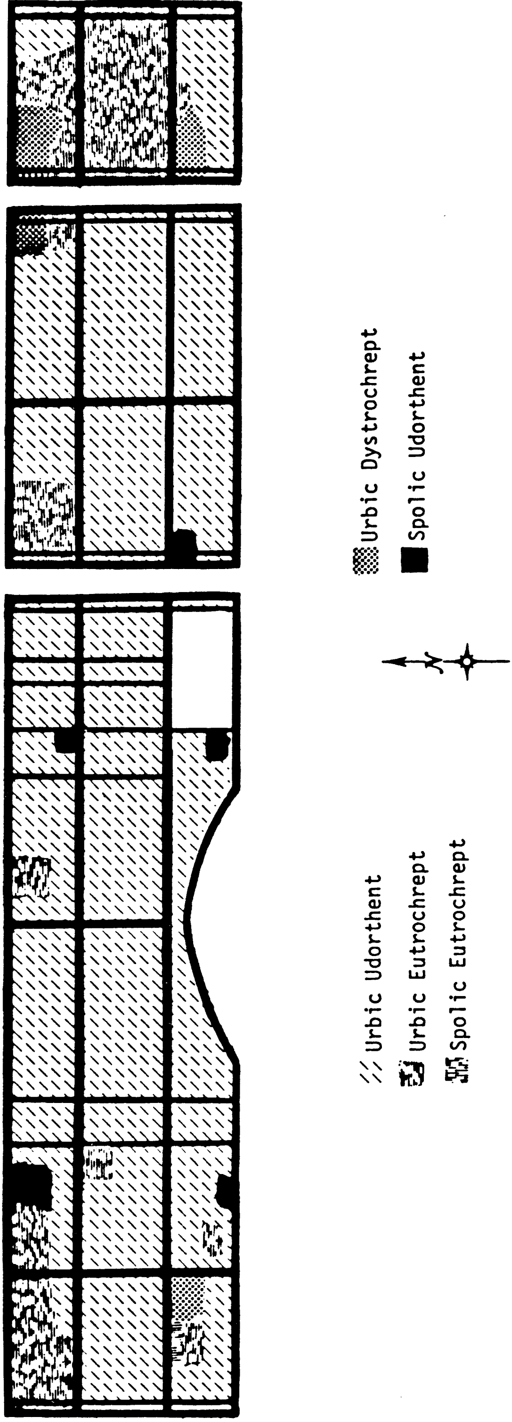

Figure 2. Detailed soil map of the Mall.

soils will require more intensive sampling than natural soils to gain the same information for effective management. This study provides an example of how gathering basic data upon a Park resource can be utilized to supply management with information needed to more effectively manage a challenging resource problem. Although the results of this study were obtained from a park in an urban area, the principles obtained are applicable to any park situation where impacted soil systems are located.

There is need for further research on the formation of crusts at the soil surface through destruction of soil aggregates. Formation of soil crusts limits the infiltration of water and gases into an already poor soil system. Orientation of soil particles in surface layers may contribute to the formation of these crusts, and research on such occurrences in impacted and nonimpacted soils should be undertaken. Evaluation of successful techniques to mitigate such impacts on highly man-influenced soils in park situations should occur. These investigations are a concern to the natural science research and management program of NCR.

For Further Reading

Brady, N.C. 1974. *The Nature and Properties of Soils,* 8th Edition. McMillian Publishing Co., New York.

Craul, P.J., and C.J. Klein. 1980. *Characterization of streetside soils in Syracuse, New York.* Metro. Tree Impr. Alliance (METRIA) Proc. 3:88-101.

Garcia-Miragaya, J. and S. Castro. 1981. *Zinc solubility in contaminated roadside soils from Caracas, Venezuela.* Commun. Soil Sci. Plant Anal. 12(3):219-225.

Gunnerson, C.G. 1973. *Debris accumulation in ancient and modern cities.* J. of the Environ. Engin. Division, ASCE, 99:229-243.

Legg, MH., and G. Schneider. 1977. *Soil deterioration on campsites: Northern forest types.* Soil Sci. Soc. Am. J. 41:437-441.

Patterson, J.C. 1976. *Soil compaction and its effects upon urban vegetation.* Better Trees for Metropolitan Landscapes Symposium Proceedings. USDA For. Serv. Gen. Tech. Rep. NE-22.

Short J.R. 1983. *Characterization and Classification of Highly Man-Influenced Soils of the Mall in Washington, D.C.* M.S. Thesis, Univ. of Md. 126 pp.

Smith, H. 1976. *Soil Survey of District of Columbia.* SCS, U.S.D.A., and U.S.D.I., National Park Service, National Capital Parks, Washington, D.C.

Soil Survey Staff. 1951. *Soil survey manual.* USDA Handbook No. 18.

Soil Survey Staff. 1975. *Soil taxonomy.* Argi. Handbook No. 536. SCS. USDA.

Stein, C.E. 1978. *Mapping, classification, and characterization of highly man-influenced soils in the District of Clumbia.* M.S. Thesis, Univ. of Md. 170 pp.

Zemlyanitskiy, L.T. 1963. *Characteristics of the soils in the cities.* Sov. Soil Sci. 5:468-475.

John Short and *James C. Patterson,* Ecological Services Laboratory, National Capital Region, National Park Service, Washington, D.C.

NATURAL RESOURCES MANAGEMENT--TREND OR FAD?

Presented at Fourth Conference on Social Research in National Parks and Wildlands, Great Smoky Mountains National Park, Tennessee, March 16-17, 1984

Roland H. Wauer

John Naisbett (1982) recently described ten "megatrends" of our American Society that are changing the way that we all do business. His book implies that if we are to be successful and prosper we should understand these generic trends and make use of this new perspective. Within this context, Naisbett differentiated between fads and trends. He wrote that fads are top-down events which usually have their origins in New York City or Washington, D.C.; they live a short life and fade. Trends, on the other hand, are bottom-up events that have their roots in local communities. They are long-lived and affect every one of us in some manner or another every day of our lives.

I interpret the recent emphasis on resources management within the National Park System as a trend and not as a fad. It is a grass-roots event that seem to be increasing in scope. It is an event that in my mind is crucial to the long-term perpetuation of park values. It is closely intertwined with the well-being of the land and Americans. It suggests a reawakening of true land stewardship. And it places the care of the land into the twenty-first century, so that resource managers become the trend-setters rather than the followers.

Background

The National Park Ranger has long been responsible for the care afforded the park's resources. Caretaker duties range from protection of people and facilities to the intricate natural processes for which the national parks were established. During the first half of the 20th Century, law enforcement was rarely more than monitoring, and resources management usually was little more than policing the environmental *status quo* (Wauer, 1980). The Park Ranger was able to adequately budget his time to be an effective "jack-of-all-trades."

Societal influences began to change these activity patterns during the 1960s, and Park Rangers began to spend more and more of their time and energy dealing with acute law enforcement issues (Philley and McCool, 1981). The resources management portion of their duties became secondary in an overwhelming number of areas. Park Ranger recruitment standards were changed to attract individuals with more law enforcement background. And on January 1, 1978, Public Law 94-458 took effect, that required all Park Rangers with law enforcement duties to be commissioned. This required 200-hour police training initially, and annual 40-hour refresher courses for recertification. Many Park Service employees see this as a step toward the "derangerization" of the Service (Charles, 1982). It unquestionably favored law enforcement interests, and devalued interests and expertise in the natural resources.

These changes within the National Park System happened during a period of time when (1) park visitation more than tripled, (2) the Park Service experienced a significant decline in the total number of its employees, (3) many of the parks' natural buffers became seriously eroded by increasing adjacent land uses, and (4) environmental pollutants were increasing exponentially with each passing year.

Some of the more enlightened park managers hired scientists or resource specialists to help them address these concerns. However, the majority of the scientists found themselves dealing with resources management issues rather than science, and the majority of the resource specialists found themselves overwhelmed with the technicalities and magnitude of the problems with which they were expected to deal. Most of the resource specialists did not possess a level of expertise to adequately understand the technological issues that existed. Most of these individuals were former Park Rangers or Park Interpreters with little state-of-the-art education or training. Although some possessed special skills, such as back-country, wildlife or cave management, few could relate to the more holistic problems such as air and water pollution.

Such were conditions within the National Park Service during the mid-1970's.

State of the Parks and Aftermath

In the March and April 1979 issues of *National Parks and Conservation Magazine,* the National Parks and Conservation Association (NPCA) reported on information they had obtained in a 1978 survey of 203 parks, under the title of "NPCA Adjacent Land Survey: No Park is an Island." These articles revealed a multitude of both internal and external threats affecting park resources. In summary, the authors stated that, "Unless all levels of government mount a concerted effort to deal with adjacent land problems in a coordinated manner, the National Park Service mandate. . .will be completely undermined."

At the same time, in December 1979, The Conservation Foundation published an "Issue Report" entitled, "Federal Resource Lands and Their Neighbors" (Shands, 1979). This document summarized responses of questionnaires that they had sent to a variety of Federal land managers. It stated that adjacent land development was the principle threat to national parks and other protected lands.

These combined efforts in developing these reports did not go unnoticed by the Park Service and members of Congress. In fact, in July 1979, the Director of the National Park Service received a letter from Congressmen Phillip Burton and Keith G. Sebelius that asked the Service to prepare a "State of the Parks Report." The request stated, "What we have in mind is in the line of factors such as increasing air and water pollution, encroaching developments, troublesome visitor use pressures, legally on-going or rights to exercise incompatible use within the parks, and the like."

Since I was the Washington Office Chief of Natural Resources at the time, I assumed the responsibility for developing the Park Service response. Questionnaires were sent to all 333 park units. We asked, "In the light of the enabling Legislation, the Legislative History, and the Statement for Management, What Threats are Impacting the Park Resources and to What Extent?" And members of my staff began to research materials that could be utilized in writing the report.

On May 6, 1980, "State of the Parks - 1980, A Report to the Congress," was sent to the Congress by the Director (N.P.S., 1980). It represented the first time the Service had undertaken a complete evaluation of the conditions of its natural and cultural resources. The report stated that none of the parks was immune to the vast array of threats that were bombarding the resources from every conceivable direction. The report documented the magnitude of the threats from within and outside of the parks, and stated that the large natural areas, America's crown jewels, were most seriously threatened. The report focused attention on the resources as never before, and reminded the Service of its primary mandate to protect the significant resources within its area of responsibility. It provided the very best "hook" available for the Park Service to obtain the support necessary to initiate the kind of sound natural resources management program essential to addressing the ever-increasing spiral of threats.

As a follow-up to the May 1980 report, the Service was requested by Congressmen Burton and Sebelius to prepare a second report that would outline a strategy for preventing and mitigating the myriad of internal and external threats that were identified in the first report.

This second report--"State of the Parks: A Report to the Congress on a Servicewide Strategy for Prevention and Mitigation of Natural and Cultural Resources Managment Problems" (N.P.S., 1981) -- was sent to Congress in Janaury 1981. It identified numerous prevention and mitigation activities underway and anticipated within the parks, and also listed a number of generic programs--from new guidelines to an expanded in-Service training program--planned for the Service. One of these was the development of a Servicewide Natural Resources Management Trainee Program.

This training initiative was implemented in the summer of 1982 as a multifaceted trainee development program for three dozen park units, to train a cadre of newly-hired resource specialists. It incorporated training plans specifically tailored for the individual trainee and benefitting park over a two-year period. This program has succeeded exceptionally well, and after the first two-year program is completed this summer, it will be repeated, with a few modifications, starting in the fall 1984.

What has been most important about this program is the visibility it has received both within and outside of the Park Service. It has created a greater recongnition of the necessity for the type of specialists the program was designed to produce. Several additional park units have since hired natural resource management specialists or realigned their organization to give resources management functions the attention it so richly deserves.

Facts and Figures

During 1979, a good deal of information on NPS personnel was accumulated in preparation of the 1980 State of the Parks Report; most was not utilized. That personnel database, however, provides an excellent point of reference on the status of various types of employees on duty with the Service on December 1979.

One hundred and fifty-four individuals were identified as natural resource specialists within the 333 park units. This total represented only 1.6% of the total NPS work force of 9,319 permanent employees. The 154 natural resource specialists were stationed within 62 of the park units; 271 units (81%) were without a natural resource specialist. The total of 154 is skewed, however, because 51 of these were stationed at only two areas, Everglades and Redwoods national parks; both parks were recipients of significant natural resource programs through special appropriations. It is obvious that a considerable shortage in natural resources management expertise existed within the Park Service in December 1979.

Three years later, in fall 1982, a second survey of all the parks was undertaken through the pertinent regional offices to assess the current natural resources management capability of the Service (Form 1). Information was requested on (1) the number of employees actually spending 51% or more of their time doing natural resources management, (2) their academic training, (3) the number of field employees that received in—Service training in natural resources-oriented courses, (4) the park's organizational placement of natural resources management, and (5) the status of resources management planning efforts.

The new database revealed a considerable increase in natural resources management expertise in the field during the three years. Ninty-three additional employees had been added to the natural resources management roles. A total of 247 park employees were identified within 112 park units, increases of 38% and 45%, respectively. Thiry-four percent of all park units now possess at least one specialist on their staff, compared with only 19% in 1979.

Educational levels of the 247 natural resource specialists varied. Fifty-one percent (125 individuals) possessed a Bachelor's Degree, twenty-five percent (63 individuals) possessed a Master's Degree, twenty percent (49 individuals) had not completed a college degree, and four percent (10 individuals) possessed a Ph.D. Although the number of graduate degrees was higher than expected, so was the number of individuals without a college degree. It is imperative that only highly trained personnel be hired for these highly skilled positions. We can no longer adequately address our resources management responsibilities with "good old boys" and "hobbyists." We must approach every resource problem with the expectancy that every project coordinator is likely to stand in a court of law to defend his program before it is solved. Any other position is inadequate and unrealistic.

Since 1979, thirty-three 40 to 50-hour courses in natural resources have been provided through Servicewide or regional in-Service training programs. A total of 459 trainees participated in the 33 courses, that varied from general natural resource subjects such as "Management of Natural Resources for Superintendents and Mid-level" employees, or "Introduction to Natural Resources Management," and "Planning Natural Resources Management Programs," to more specific ones such as "Prescribed Fire Management," "Coastal Zone Management," and "Air Quality Monitoring."

Training has long been a highlight of NPS operations, and the increased emphasis on natural resources has helped to focus attention on the importance of professionalism in natural resources management like never before.

Of the 112 park units with at least one employee involved with natural resources management during the majority of the work time, thirty-six (32%) of these programs were aligned directly under the park's superintendent or assistant superintendent. Fifty-nine (53%) of the 112 programs were aligned directly under the park's chief ranger. Seventeen (15%) of the 112 natural resources management programs were aligned directly under one of the following park offices: interpretation and resources management, professional services, park operations, resources management and planning, resources management and visitor protection, or facility management.

In twenty cases (18%), Resources Management was considered a separate division within the park unit; in thirty-nine cases (35%) it had been given branch status, and in fifty-three cases (47%) it had been combined as only a function of a division and not given separate identity.

Resources Management Plans (RMP) are one part of the Service's General Management Planning Process, but usually are prepared independently by the park staff. The RMP's document all of the park's management, monitoring and research activities relating to the area's natural and cultural resources. These plans describe all of a park's resource problems and discuss a full range of resource-related activities underway and anticipated. RMP's are the park's single most important document for the management of its natural and cultural resources.

Although RMP's have been a required part of a park's planning process since the 1960's, few parks complied. In fall 1979, only 94 park units possessed an approved plan. By winter 1982, a total of 222 (an increase of 128 plans) park units possessed an approved plan, and an additional 16 were in final draft stage.

Conclusions

While natural resources management has come a long way in recent years, it is obvious that it still has a long way to go to receive the status it must have if it is to remain a viable and effective program for the long-term management of national park resources.

It is clear that threats to park values will not decline in the foreseeable future. It is unlikely that the abundant issues that require constant attention within the parks will decline; rather, they are likely to increase. It also is probable that the Park System will continue to be seriously pressed for funds and manpower to address the varied natural resource issues.

The most likely inroads into preventing and mitigating the abundant resource problems of the parks will come with increased quality of attention. That CAN be accomplished with recruitment of well-educated and enlightened personnel, a continued training program in natural resources, and the placement of the responsibilities for natural resources management within the parks where it will receive the attention and clout necessary to compete against the additional areas of concern within the parks. The care and attention afforded the natural and cultural resources of the parks will determine the long-term value of national parks as a symbol of American achievement and respect.

Literature Cited

Charles, Nichael I. 1982. The Yellowstone Ranger: the social control and socialization of Federal law enforcement officers. *Human Organization,* 41, 3:216-226.

Naisbitt, John. 1982. *Megatrends.* Warner Books, Inc., N.Y.

National Park Service. 1980. *State of the Parks - 1980 A Report to the Congress.* U.S.D.I., Wash., D.C.

National Park Service. 1981. State of the Parks: A report to the Congress on a Servicewide strategy for prevention and mitigation of natural and cultural resources management problems. (unpubl. report).

National Parks and Conservation Association. 1979. NPCA Adjacent Land Survey: No Park Is An Island. *National Parks & Conservation Magazine,* March and April, 1979.

Philley, M. Peter, and Stephen F. McCool. 1981. Law enforcement in the National Park System: Perceptions and Practices. *Leisure Sciences,* 4, 3:355-371.

Shands, William E. 1979. *Federal Resource Lands and Their Neighbors.* The Conservation Foundation, Wash., D.C.

Wauer, Roland H. 1980. *The role of the National Park Service natural resources manager.* N.P.S., Coop. Park Study Unit, Coll. Forest Resources, Univ. Wash., B-80-2

Roland H. Wauer, Assistant Superintendent, Resources Management and Science, Great Smoky Mountains National Park, Tennessee.

EXTINCT CARNIVORES ENTOMBED IN 20 MILLION YEAR OLD DENS, AGATE FOSSIL BEDS NATIONAL MONUMENT, NEBRASKA

Robert Hunt

Careful research of museum archives and early publications in the science of paleontology led to the discovery at Agate Fossil Beds National Monument, western Nebraska, of the oldest known record of denning behavior in large mammalian carnivores. In September 1981, paleontologists of the University of Nebraska State Museum found the 20 million year old dens by relocating an abandoned fossil site which in 1905 had produced unusual numbers of carnivore bones. The fossil remains of carnivores are usually rare at such sites because, in life, carnivores make up a much smaller percentage of the mammalian fauna than the plant-eating mammals. We do not expect to find many carnivore bones relative to the proportion of herbivore bones at a given site. But before we explain how this situation was resolved, let us first briefly mention the significance of the Agate Spring Quarries.

The Agate Spring Quarries have been known for eighty years as one of the greatest fossil mammal deposits in North America. Buried in stream-laid sandstone of Miocene age, the 20 million year old bone bed, exposed in two hills (Carnegie Hill, University Hill) overlooking the Niobrara River valley of northwest Nebraska, has produced thousands of bones of extinct herbivores to paleontologists excavating for North American museums and universities. So abundant are the fossil bones of mammals that a man could walk on a pavement of bones without touching the sediment in some areas in these quarries.

The bones are found in a stratum or bed about 0.5 meter thick at the base of an ancient Miocene stream channel (the Miocene is an epoch of geologic time that extends from about 5 m.y. to 24 m.y. ago). Fine sand is closley packed around the bones, most of which are no longer connected in the framework of a skeleton, but have come apart (the technical term is disarticulated), so that the bone bed is a logjam of individual bones. Partial skeletons, or fully articulated skeletons, are not common but do occur. By examining the enclosing sediment under the microscope, we find that the sand grains are either the minerals quartz and feldspar or fragments of volcanic glass, each making up about one-third of the sandstone. Many sharpsided unworn sand grains made of quartz and feldspar can be seen, some with small pieces of volcanic glass still fused to their surfaces. The absence of wear indicates these angular sand grains have not been transported great distances and/or for long periods of time by streams. Probably more than 50% of the sediment in the ancient stream channel was originally brought into the region by wind from distant volcanic centers to the west.

The presence of both stream-deposited and wind-worked sediment in the Agate stream channel (and other channel fills of similar age elsewhere in the region) lead us to believe these are ephemeral streams, flowing only in times of abundant rainfall, probably in short bursts of considerable volume, interspersed with long periods of inactivity when the dry sandy bedload of the stream is worked by wind.

Bone at the bottom of the channel is often fragmented and the individual pieces well-rounded. Much of this type of bone is unidentifiable in terms of the kind of animal it represents. Earlier collectors frequently reported that the floors of these quarries were often rich in these worn bones and bone fragments, the edges smoothed by abrasion over some unknown time interval. These pieces of worn bone have been abraded by periodic floods. They represnet the end product of a process of disassociation and breakdown of the original skeleton by biotic agencies such as scavengers, carnivores, the trampling of ungulates; by stream processes; and by seasonal climatic fluctuations.

Associated with the fragmented bones are vast numbers of whole bones, unattached to any other bones, but complete and relatively unabraded. Surprisingly, these whole bones generally belong to only three kinds of mammals.

By far the most common mammal in the quarries is a small lightly-built rhinoceros (*Menoceras*) about the size of a pony. We judge it to be a good open-country runner from its skeletal anatomy. Males carried a paired horn on the tip of the nose, but females were hornless. Because both sexes among the living Old World rhinos have horns, paleontologists first believed they had discovered two distinct species, but soon the absence of horns in the female *Menoceras* became apparent as a large sample accumulated.

Next in abundance in the quarries is a bizarre claw-footed browsing chalicothere (*Moropus*), with large curved terminal toe bones. These toe bones or phalanges originally were mistaken for the claws of giant ground sloths. The bones of *Moropus* have tended to be concentrated in particular areas within the quarries. As with the small rhinocerous, young, middle-aged and old individuals are present.

Last, occasional remains of the giant entelodonts (*Dinohyus*) occur scattered throughout these quarries, usually as isolated bones, often worn and fragmented. However, two nearly complete skeletons of entelodonts have been found, one in each of the two major hills at Agate.

Other mammals are represented in the quarries only by rare remains such as isolated teeth, jaw fragments, and occasional limb and foot bones. Small horses and camels, oreodonts, birds, protoceratid antelope, moschid deer, and a few carnivores are known. Interestingly, the known number of carnivore bones from the quarries of the two main hills (Carnegie Hill, University Hill) totals less than 30, whereas the bones of herbivores (*Menoceras, Moropus, Dinohyus*) number in the thousands.

As I studied the records of the early excavations, it became evident that one quarry, called Carnegie Quarry 3 (Fig. 1), located on a small hill (Beardog Hill) about 180 to 275 meters southeast of the main quarries was atypical in producing only rare fragmentary bones of herbivores. Yet for some reason, numerous carnivore bones had been found in this quarry. I became curious about this reversal of the usual carnivore/herbivore ratio. The site had been reported by its discoverer, Olaf Peterson of the Carnegie Museum, to be in the same Miocene stream channel deposit as the quarries in the main hills.

Specifically, Peterson in 1905 had found the first fossil remains of a rare amphicyonid carnivore or 'beardog' at Quarry 3, which he named *Dephoenodon superbus* (Fig. 2), More than one beardog was discovered at the site. In addition, he also found a small true dog or canid (*Phlaocyon annectens*) about the size of a small fox, and a mustelid carnivore (*Paroligobunis simplicidens*) about the size of a living wolverine. Two of the beardog skeletons were nearly complete, and partially articulated in the sediment. What was the explanation for this unusual aggregation of extinct carnivores?

In 1977, I mapped the geology of the Agate National Monument for the National Park Service, and confirmed at that time that the uppermost 6 to 7 meters of Beardog Hill were originally part of the same Miocene stream channel

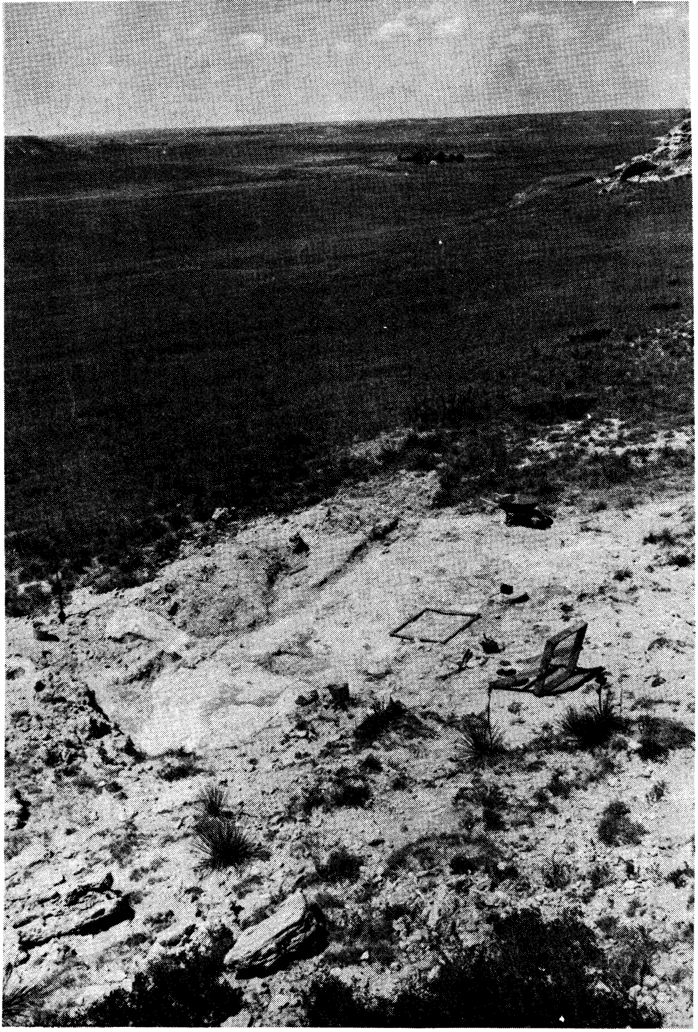

Figure 1. Carnegie Quarry 3 in foreground at Beardog Hill, Agate Fossil Beds National Monument, Sioux Co., Nebraska. Carnegie Hill with its mammal bone bed appears at extreme upper right.

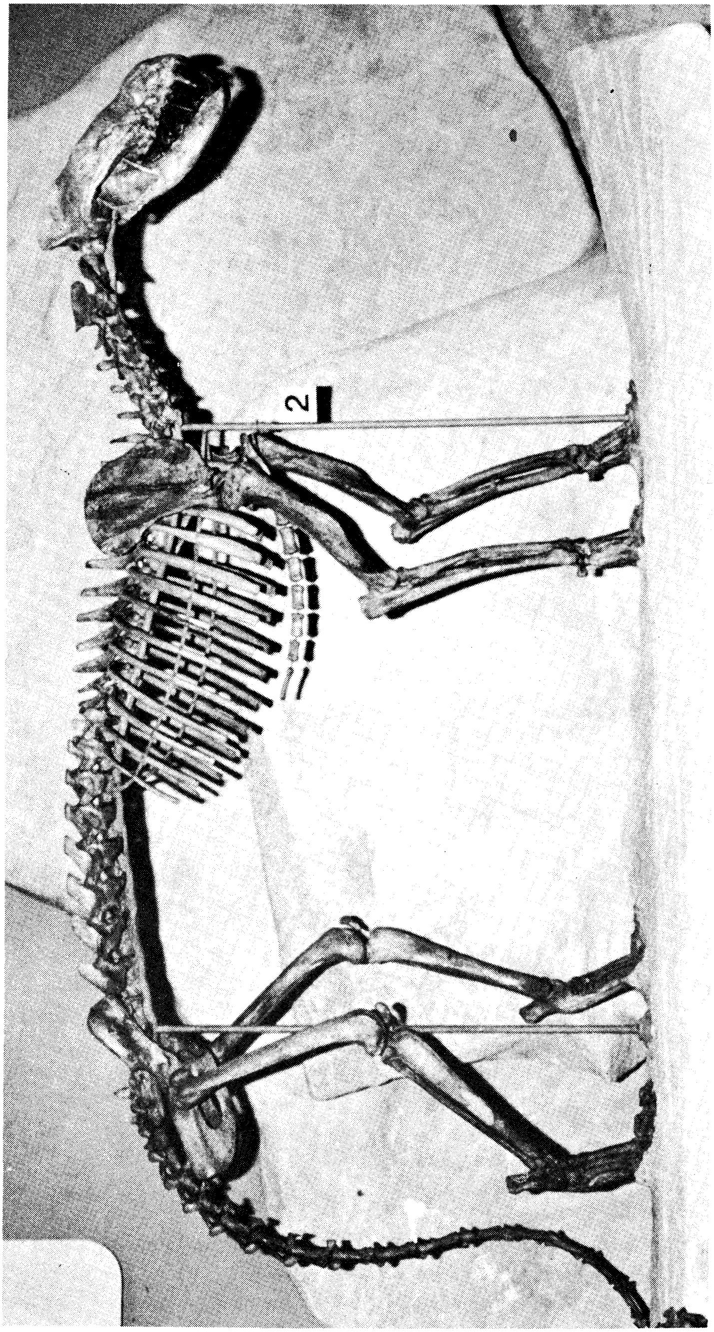

Figure 2. The female beardog *Daphoenodon* found by Olaf Peterson at Quarry 3 in 1905, presumably in Den I. Skeleton mounted at Carnegie Museum, Pittsburgh.

fill as the bone-packed channels in the main hills. Peterson had been right. It was clear that the quarry must be somewhere in the channel deposit making up the upper part of the hill. Mistakenly, I assumed that the Quarry 3 carnivores were buried within normal stream sediments deposited in a channel. Unfortunately, Peterson left no pictorial or written record on Quarry 3's location, other than a photograph published in 1910 indicating that it was somewhere on Beardog Hill. The best approach would be to carefully search the perimeter of the hill for evidence of a previous excavation.

In 1981, the Park Service granted permission for a preliminary excavation at Beardog Hill. A renewed search for records at the Carnegie Museum in Pittsburgh produced no conclusive result, so a test excavation at the hill became the logical next step. However, it now seemed to me that there was little proability of ever locating the exact site. There were a number of places around the periphery of the hill where the quarry could have been located. Adoption of a routine procedure in field paleontology, however, proved me wrong, and led to the discovery of the site.

When a fossil skeleton occurs in bedrock near the surface of the ground, fragments of the skeleton often graudally work into the soil that develops on the bedrock. Routinely, paleontologists pass the surface soil through screens to recover these bone fragments, which may include important parts of the skeleton that otherwise would be lost. Often such fragments in the soil are the first clues that a skeleton is present in the bedrock below the soil. Since the bone bed in the quarries of the main hills lay at the very base of the channel bed, we placed trenches at Beardog Hill so that they would intersect the base of this same bed. Two such trenches produced nothing of interest: no bone or bone fragments, no sign of earlier digging was found. For our third attempt, we moved about 8 meters north from our original trenches. Upon sieving the soil, carnivore bone fragments appeared on the screens: part of the shin bone or tibia. These were recognized as beardog bones, in fact the same species found by Peterson, and the work continued in some excitement. The probability that we had located the quarry was high, for since carnivore bones are scarce in most field settings, beardog bones of the kind found by Peterson in Quarry 3 were an improbable and thus a strongly confirming find. However, unknown to us at the time, the unequivocal evidence proving that this was Quarry 3 was not to be discovered until some months later.

When we sieved the surface dirt and recovered the fragmentary beardog bones, we had no thoughts that one of these pieces would match one of the Carnegie bone fragments found in 1905. One of the most exciting moments of the work on the Agate fossils was Carl Swisher's match of the partial tibia (UNSM 10-81) with one of the Carnegie fragments (CM 1589D), proving that they were once part of the same bone. The attempt to achieve such a match began in my office laboratory in Lincoln one afternoon in late April 1982. Josh Kaufman, Carl Swisher, and I had been trying to match the bone fragments sieved from the soil at Beardog Hill with fragments collected by Peterson in 1905. After working at this for more than an hour, Swisher returned to a box of fragments tried earlier, and on the second attempt, fitted a small fragment from 1905 to our partial tibia. The two pieces were collected 76 years apart!

Despite the lack of conclusive proof that we had relocated Quarry 3 in September 1981, the presence of *Daphoenodon* bones in the soil was reason enough to begin a thorough study of the locality. There was little doubt in our minds that we had found the place. Rather than cut into the bedrock, we began by removing all the soil over an area of about 9 square meters (Fig. 3). Removal of the soil exposed a west-sloping bedrock surface that merged at the south end of the quarry with a 1-2 meter-high vertical wall of Miocene sandstone. This sandstone wall contained a paleosol or ancient soil within the channel sediments, indicating that the land surface had stabilized for a time before renewed stream deposition. The paleosol occurs from 0.7 to 1.5 m above the base of the channel bed at about the same stratigraphic level as a paleosol in the main hills above the Agate bone bed. (Possibly these two paleosol horizons represent the same ancient soil.)

Extending downward about a meter from this paleosol into the sandstone wall at the south end of the quarry were two large burrows (burrows A and B, Fig. 4), found on the third day of the 1981 excavation (September 11, 1981). Each burrow was filled with sediment, primarily a fine gray ash-rich sand. The gray sandy fill contrasted sharply in tone with the white sandstone bedrock intruded by the burrows. In one of the burrows (burrow A, Fig. 4), the sand was distinctly stratified in thin layers about 1 mm thick, demonstrating that the sand had been progressively introduced into the burrow, filling it in over an indeterminate amount of time. Sets of this layered sediments were separated from each other in the burrow by erosion surfaces; thus some time was involved, time enough to deposit thinly layered sediment, then erode some part of it, and then deposit at least two similar sets of layers at a later time. A second burrow (burrow B, Fig. 4) contained 10 and 20 cm-thick layers of homogeneous fine gray sand separated by a 25 cm-thick rubble of poorly sorted sand and sand pebbles, suggesting breakdown and incorporation of part of the burrow wall. This same burrow also preserved a vertical steeply cut margin between two masses of sediment fill that could indicate reexcavation of the burrow after it had become partially filled. We traced the two burrows upward, but could find no openings on the present ground surface.

Next we examined the bedrock below the burrows. We had carefully removed the soil without disturbing the buried bedrock surface. To our surprise, there appeared a shallow hemispherical depression in the bedrock about a meter in diameter and 20 cm maximum depth. It was similar in shape to pits left by professional paleontologists upon the removal of a large block of sediment containing fossils. Immediately we remembered that Peterson had removed the two nearly complete skeletons of *Daphoenodon* in a single large block of sandstone (Peterson, 1910, p. 206). If this was the place from which the sandstone block had been collected, the two nearby burrows could explain why the two skeletons had been found together, one an adult female, the other a juvenile male about 6 months to 1 year old (Fig. 5, Den 1). Proof was lacking, but the circumstantial evidence seemed compelling.

The discovery of the burrows provided us with our first hypothesis as to the reason Quarry 3 had produced so many carnivores. Possibly Quarry 3 had breached an ancient den complex. But it seemed unlikely we could confirm this. We could see no bone in the fill of the two burrows that we had uncovered, and apparently Peterson had left no photograph of his removal of the two beardogs in the sandstone block. Furthermore, we thought that Peterson and his party would have extended the excavation to its limits, taking all fossils available, as was customary at such sites at the time.

More as a matter of professional thoroughness than with any real belief in finding more fossils, we extended the excavation to the north, meter by meter. To

Figure 3. Josh Kaufman (left) and Bob Hunt re-open Quarry 3 for the Nebraska State Museum in September 1981 by removing soil at the site. Photo courtesy of M. Swanson, Harrison, Nebraska.

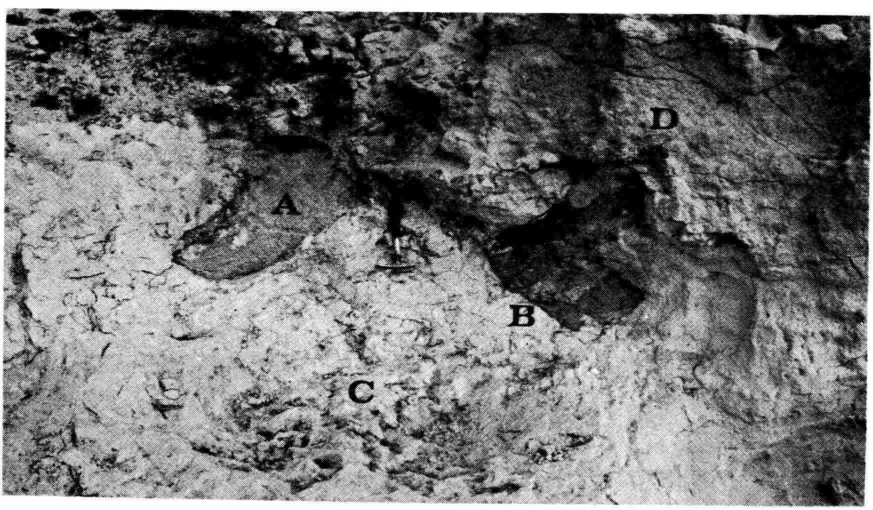

Figure 4. Burrows A and B of Den I exposed in wall of Miocene sandstone. (A) burrow A; (B) burrow B; (C) presumed location of Peterson's Den I chamber; (D) early Miocene paleosol. Hammer length, 28 cm.

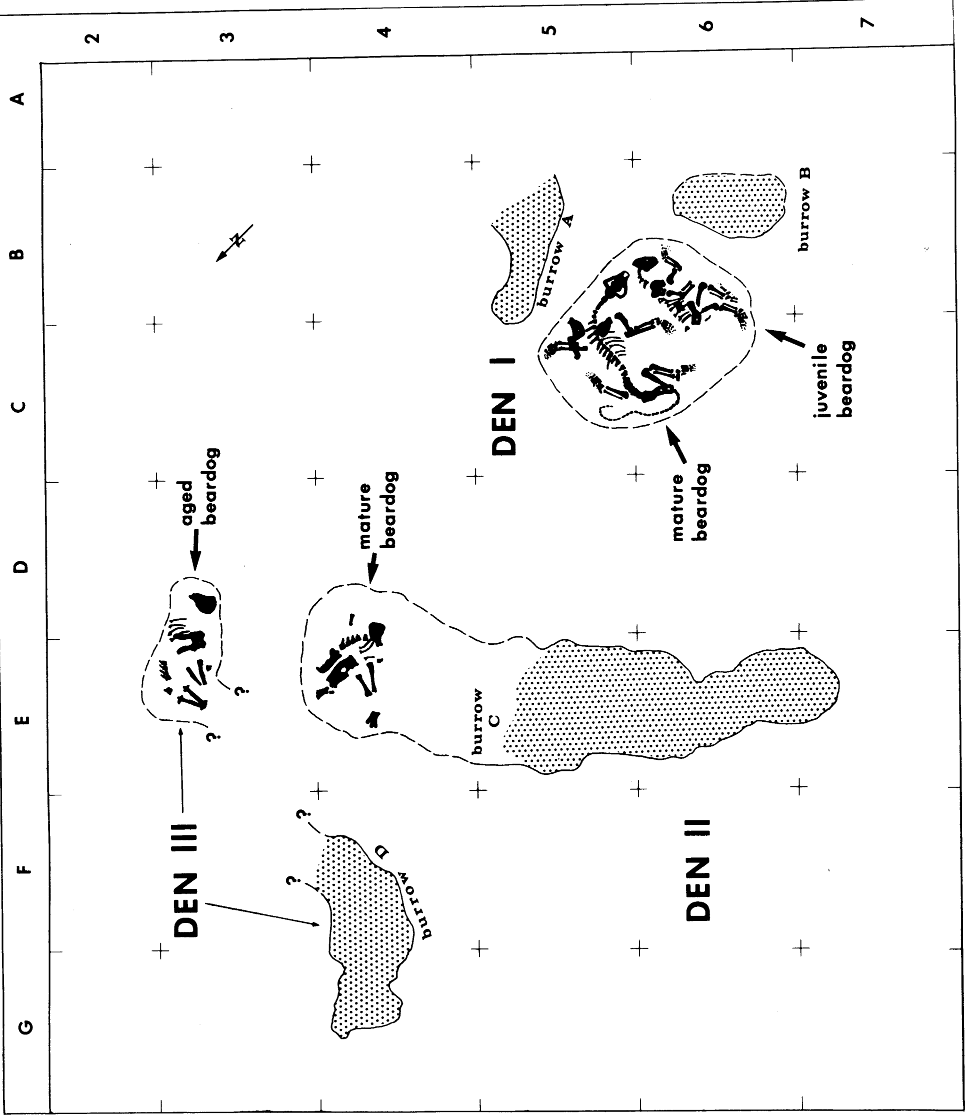

Figure 5. Plan map of early Miocene carnivore dens, Quarry 3, Agate Fossil Beds National Monument. Stipple pattern indicates Miocene burrow fill that also surrounds beardog skeletons. Dens I and III contained the beardog *Daphoenodon*; Den II produced a rare temnocyonine beardog. Excavation grid is in square meters.

my amazement, we came upon fragments of the skull of a temnocyonine beardog, a very rare carnivore belonging to a different lineage than *Daphoenodon,* about 3 meters north of the first burrows we had discovered (Fig. 5, Den II). Initially, we did not realize this animal was in a burrow, but this soon became evident when the skeleton was removed in a block of sandstone, and the contrast between burrow fill and burrow wall was plainly evident at the place where the block had been taken up.

Discovery of this animal in situ in a burrow brought home to us the significance of the find: here was proof that at least one carnivore had been entombed in a burrow, and here was support for the hypothesis that Peterson's carnivores could have been found within burrows as well.

The site was closed for the season after this discovery. We returned to the university to work over the data we had gathered, and to reexamine Peterson's carnivore sample of 1905 which the Carnegie Museum's paleontologists had kindly loaned us. I began to try to work out the position of the newly discovered beardog in the sandstone block that we had collected, using radiographs taken at a local hospital. Kaufman and I also began to learn as much as we could about denning behavior in living carnivores, helped by advice from Blaire Van Valkenburgh, a studnet of carnivore ecology at Johns Hopkins University. We learned that dens used by large carnivores are not always dug by them; rather, they often enlarge a preexisting hole made by another mammal. The beardogs found by us and by Peterson are the largest land carnivores of their time--only one other species is larger than the ones found in Quarry 3, and it is also an amphicynoid. Clearly if these beardogs had not excavated these burrows, they probably enlarged them to an acceptable and inhabitable size, since there were no other burrowing mammals of their bulk to accomplish this for them.

Furthermore, radiographs of the temnocyonine showed there was less than a complete skeleton present; bones were scattered through the block of sandstone indicating that the skeleton had been disarticulated prior to final burial. I could recognize the skull and even individual teeth in the radiographs, and a number of their bones of the skeleton, but discovered that the x-rays were not penetrating through the full thickness of the block. We would have to prepare the block manually to determine the extent of the skeleton.

In July 1982, the site was reopened. Almost immediately we found that a 2 to 3 meter-long burrow was associated with the temnocyonine beardog found the previous fall (burrow, C, Fig. 5). We had been walking over this burrow during the previous field season and had not even recognized it. Once exposed to view, it too contained the gray layered sandy fill present in the first burrows found. In this case, however, we were seeing the burrow cut in horizontal section, whereas the first two burrows (burrows A, B, Fig. 4) had been exposed in a vertical wall. Dimensions of these burrows are very similar to burrows of living wolves and hyenas, whose body size is also like that of the beardogs (gray wolves range in weight from about 27 to 80 kg; the spotted hyena ranges from 59 to 82 kg; striped and brown hyenas have weights from 27 to 54 kg, according to Walker, 1968).

Again removing only the soil, we extended the lateral dimensions of the excavation, and soon encountered a second beardog skeleton (Fig. 5, Den III) in the first day of work (July 12, 1982). It was also preserved in gray sandy burrow infill. The jaws of the beardog were the first part of the skeleton discovered. Heavy wear on the teeth showed it to be an aged individual of *Daphoenodon superbus,* the same species that Peterson had found. With our discovery of this second carnivore in burrow fill, the possibility that we had found a Miocene den complex changed in our minds to a strong probability. In addition, we now had evidence of a broad age spectrum of *Daphoenodon superbus;* young, mature, and aged individuals were all represented (Fig. 5).

Our second excavation at Quarry 3 ended on July 30, 1982, following very hot weather. We returned in the coolder weather of October and continued work (October 16 to 21, 1982), before early snowfall ended our efforts. We extended the site to the north and west, carefully removing the soil, and cleaning and examining the bedrock surface. Again, a new and relatively large den was discovered, terminating in what appeared to be three tunnels branching from a main den chamber. A beardog vertebra and mustelid food bone (*Paroligobunis*) were found in the fill of the burrow system at the surface. We did not excavate the fill, but decided to work it later in the 1984 seasons.

Here, however, the floor in each of the three terminal lobes of the den was nearly level with the bedrock surface. The upper parts of these burrow lobes and their fill had been stripped away, either by slope erosion, or possibly by the Carnegie excavators. This latter alternative is a resonable possibiltiy, especially since 3-4 additional individuals of *Daphoenodon* were discovered in Quarry 3 by Peterson. Although the dens found by us in 1981-82 show no tool marks (excavation picks used by paleontologists often leave narrow linear grooves in bedrock that persist for many years in the arid climate of the central Great Plains), we probably will never be certain how much of the area that we have uncovered was in fact first excavated by the Carnegie party of 1905 (some additional excavation was done by the Carnegie group in 1908 which resulted in the discovery of a superb *Daphoenodon* skull, lower jaw, and some associated skeletal material, CM 2774, but again no detailed record of the location of the find in Quarry 3 was kept).

The significance of the den complex is not only in the extinct Carnivora that were found there. It lies as well in what we have learned about the way of life of these animals. The discovery tells us for the first time that amphicynoid carnivores used burrows; amphicynoids are the lárgest and therefore presumably the dominant mid-Cenozoic terrestrial carnivores (the Cenozoic Era of geologic time extends from about 65 million years ago to the present). Prior to this find, we had known little about their ecology. Because member species of two diverse lineages have been found in the burrows, there is a good possibility that many amphicynoids could burrow and use dens, at least on occasion. Secondly, the great age (about 20 million years) of the den complex, based on its stratigraphic relation to two dated volcanic ash beds, places it as the oldest evidence of denning behavior of large mammalian carnivores.

A historical scenario summarizing what we presently know about these dens can be based on the size and form of the burrows, the ages of the carnivores (established by the degree of eruption and wear on teeth), the condition of the skeletons, and the nature of the sediment fill.

The number of tunnels and their considerable size suggest a major denning area, used by a number of animals. The presence of young, mature, and aged beardogs in the burrows tells us that whereas older animals could have died normally at the end of their customary lifespan, the young animals must have expired prematurely. After death, bite marks and the scattering of some bones show decomposition and scavenging of carcasses took place. Last, careful study of the sediment infill indicates that the dens filled episodically over a period of time, not continuously in one event. As noted earlier, there is evidence that some dens were partially filled, then reexcavated. Probably the dens were used by a succession of animals over time, as has been documented for some modern burrow systems.

Eventually the den complex filled completely with sediment, and a migrating Miocene stream entirely buried the burrows under at least 5 meters of later channel deposits. Nearly 20 million years would pass before this remarkable association of carnivores and their shelters would again see the light of day.

We plan to continue the work at Quarry 3 over the next years. The probability that more dens will come to light is high. If enough burrows can be found, then it will become feasible to work out the fill of several and thus come to an understanding of their content and manner of filling. To date, we have not disturbed the laminated sedimentary fill of the burrows since we do not know how rare such discoveries will be in the future. Perhaps prey carcasses will occur in some dens, or other associations of females with juveniles will be discovered. The possibilities are exciting, and made more so by the relationship of the den site to the great bone bed in the main Agate hills. Through such research efforts, the hard won understanding of the fossils at Agate, built over time by many dedicated paleontologists and their assistants, is gradually expanded and refined, added to and improved, until we are able to comprehend something of the prehistory of this site on the plains, which is a part of the large picture of the evolution of life on Earth.

References

Peterson, O.A. 1910. *Description of New Carnivores from the Miocene of Western Nebraska.* Memoirs, Carnegie Mus. Vol. 4(5): 205-278.

Walker, E.P. 1968. *Mammals of the World* (2nd ed.). Johns Hopkins Press, Baltimore, 2 volumes, 1500 p.

Robert M. Hunt, Jr., Department of Geology and State Musuem, Univeristy of Nebraska, Lincoln.

REVIEW

Ecological Conditions in National Forests and in National Parks, by C. C. Adams. 1925. The Scientific Monthly 20:570-593.

J. Robert Stottlemyer

If one reads the first seven pages of Adams' paper without noting the date it might be assumed that it was written during the last decade. Much of the paper is based on the author's 1924 visit to national parks of the west and southwest at the time he was with the New York State College of Forestry at Syracuse. While the many specific adverse environmental conditions he notes at parks such as Grand Canyon, Yellowstone, Sequoia and coterminous Forest Service lands are of historical value, the most noteworthy contributions in the paper are the author's opinions regarding the purpose of national parks in society and the limited perceptions and skills of the recently formed National Park Service in carrying out its mandate.

Adams notes that national parks have already existed for over fifty years. Yet it is remarkable that it has not been recognized that the successful management of such areas requires establishment of a new profession far removed from that of the city park manager and professional forester. Adams notes that in a much shorter period forestry had become a profession in the United States. Contributing factors were the professional forestry experience gained from Europe and the establishment of the Yale Forestry School in 1900. In addition he notes "the Forest Service has always been in charge of a forester, but the parks have never been headed by a similar technical man. The park officials...are without a professional tradition behind them. Even as important as is the position of the park naturalist...these men are not definitely devoted to technical research, but in the main to elementary educational work with the park visitors."

The author suggests that contributing to the situation was the fact there were very few who called themselves ecologists at this time, and the application of ecology to public policy could not progress any faster than the science. Adams innocently demonstrates one of the effects of neglect to this science when he takes issue with any consideration of the reintroduction of fire to natural systems, despite the then ongoing work of Chapman (1912) and others regarding its possible valuable role in natural systems. Unfortunately, many of the other environmental issues raised by the author have not seen a similar evolution in practice and remain controversial and largely unstudied yet today.

He is very critical of the intensive efforts and emphasis on getting successively larger crowds into national parks in view of the concepts forwarded by some of the earlier architects of the national park concept such as Muir and Olmstead. The inability of land managers within the Park Service and Forest Service to comprehend the inherent incompatibility between natural area preservation and practices such as grazing domestic animals and stocking of exotics demonstrated very early that there was need to fully understand and apply the basic principles of ecology to management. This inability probably remains today as the fundamental weakness in land management within the national parks. "It will perhaps require almost as much effort to protect the parks from their superficial unthinking and ignorant friends as from their commercializing enemies and the cheap politicians, who are looking out for their own personal advantage."

Another significant point brought out by this early author is that "the national Park idea is one of the few valuable American contributions to a policy of land use. It should be conceived in a broad comprehensive manner." Certainly the application of Park Service research to form the basis of the recent Coastal Barrier Resources Act is an example of such a contribution, and represents perhaps the most significant contribution to society such a bureau can make. Adams clearly saw this "higher use" role for the national parks, and recognized that "without question the educational and scientific and esthetic value of these parks is of supreme importance." He was quite critical of the even then "emphasis upon the minor and trivial recreational uses." Today, despite major contributions such as the classic work defining the ecological basis for managing barrier islands, the role of national parks in promoting, through research and principled resource management, scientifically-based land use policy remains both a minor budget item and a minor emphasis within the bureau.

As indicated earlier the author devotes much of his paper to a discussion of ecological conditions in national parks he visited in 1924. Despite a few conclusions made which have since been found to be scientifically incorrect most of his observations and criticisms are valid yet today. A particular concern of the scientific community then and today has been the deliberate introduction or passive acceptance of exotic species and gene pools into national park ecosystems. This issue was of such concern in 1925 that the Ecological Society of America passed a resolution condemning the Park Service for continuing this practice. H. M. Albright, then Superintendent of Yellowstone, was one official singled out for agreeing with the resolution, but due to an absence of professional counsel continued the practice anyhow.

The author's criticisms are rendered in a generally positive manner, and are well supported by text observations and photographs. Unfortunately, there are no literature citations. Nevertheless, the revelations are important considerations today especially in view of the statements made in the 1980-81 *State of the Parks* messages to Congress, the continued absence of a diversity of professional career ladders in the Park Service, and the increased awareness that the Park Service needs a fundamental realignment in carrying out its mission (Foresta, 1984). Adams' paper suggests the failure to recognize that successful management of the national parks would require a new profession with a "basal" knowledge of ecological principles was an error made with organization of the National Park Service. The influence of such people in a Federal land managing bureau can be profound. For example, one only need review the record of Dr. Richard McArdle, Chief of the U.S. Forest Service from 1952-1962, in setting the stage for principled land classification and use (The Multiple Use-Sustained Yield Act), and in diversifying the professions of the bureau.

In conclusion, Adams' observations regarding environmental issues and his central thesis concerning weaknesses in the establishment of the National Park Service are very germain today as units of the National Park System face an increasingly formidable array of threats to their integrity. Most of these threats are subtle, and external in origin. Their mitigation will require fundamental shifts in the bureau's attitude and emphasis toward promoting scientifically-based land use management, and the importance of longterm ecological baseline data collection in providing varification for research.

Literature Cited

Chapman, H. H. 1912. Forest fires and forestry in the southern states. Amer. Forests 18:510-517.

Foresta, R. A. 1984. America's national parks and their keepers. Johns Hopkins Univ. Press, Baltimore, Maryland.

J. Robert Stottlemyer is a research scientist with the NPS Great Lakes Area Research Studies Unit and a faculty member of the Michigan Technological University Department of Biological Sciences.

SOCIETY NOTES

TRIENNIAL MEMBERSHIP MEETING AND ELECTIONS

The Society's by-laws require a membership meeting, and an election of Officers and Board Members, to be held triennially. The next scheduled membership meeting and election is set for November, 1985, at a place and time to be announced in the next issue of FORUM (Volume 4, Number 2). To be elected are President, Vice President, Secretary, Treasurer, and four Board Members (Directors). A nominations committee is now being formed and an announcement of a slate will be made by 1 May 1985. Voting is by mail ballot. Suggestions for officer and director nominees are welcome, and may be sent to the chairman of the nominating committee (who will be announced in the next issue of FORUM).

THE GEORGE WRIGHT SOCIETY TRIENNIAL CONFERENCE

By tradition, a triennial Conference is held in conjunction with the triennial membership meeting. Because several snags developed earlier this year in planning the Conference scheduled for November 1985, the triennial conference has been rescheduled for July 1986. Ft. Collins, Colorado, is the likely site. More specific plans will be announced shortly—in the meantime, members and friends may wish to consider possible paper titles for delivery at the Conference and to align their field research and other duties to allow their attendance at the Conference in July 1986.

CHIT-CHAT FROM THE PRINTSHOP

The Society functions on a strictly volunteer basis. As is the way with all such volunteer organizations, unavoidable other duties (e.g., attending to one's wage-earning) occasionally or even often delays Society chores. This past year witnessed a six-month absence of your printer from his chores--and so, a big delay in publication. The printshop has since undergone extensive reorganization and expansion (with a few improvements, we hope) and publication will again proceed--hopefully catching-up sometime soon. To those who have inquired about delays, this is the only "excuse" we have. ...Bob Linn