9

Afterword

False Gods, Ecological Myths, and Biological Reality

CHARLES E. KAY

A SOLUTION TO THE PLEISTOCENE OVERKILL PROBLEM

The authors of this edited volume are in general agreement that native people had a significant impact on their environment, but Broughton (Chapter 3) and Martin (Chapter 1) apparently do not agree on why the Pleistocene megafauna went extinct. While Martin attributes their demise to overkill by America's original discoverers, Broughton has reservations. Broughton, moreover, is not alone in his criticism of Martin's Pleistocene Overkill hypothesis (Pielou 1991:251–266). At least three major objections have been raised to the idea that Paleoindians killed-off the American megafauna. First, critics point out that there are few documented aboriginal kill sites relative to the presumed megafauna population. In New Zealand, for example, where most scientists agree that humans killed-off the moas, there is archaeological evidence that thousands upon thousands of moas were killed and eaten by early Polynesian hunters (Anderson 1984, 1989b; Cassels 1984; Trotter and McCulloch 1984; Holdaway and Jacomb 2000). Yet in the Americas, there are but a handful of mammoth (*Mammuthus* spp.) and mastodon (*Mammut* spp.) sites with spear points embedded in the animals (Pielou 1991:251–266, Stuart 1991). Simply put, if Paleoindians killed-off the American megafauna, why are there not more documented kill sites?

Second, the available evidence indicates that there were relatively few Paleoindians (Pielou 1991)—there certainly were not the human population densities that occurred later. Thus, critics of Pleistocene Overkill wonder how so few people could have killed-off so many megafauna. And third, there are many megafauna species that went extinct for which there is no evidence of aboriginal hunting; i.e., there are no known kill sites for many megafauna species (Pielou 1991; Stuart 1991). There is also a fourth, though usually not stated objection to Martin's hypothesis—how could humans kill such large animals with such "primitive" technology? After all, Paleoindians had only spears and atlatls and the megafauna were huge, and presumably very dangerous. It is my contention, however, that these objections to Pleistocene Overkill appear valid only because all participants in this debate, and I do mean all participants, even Paul Martin who has studied this subject the longest, have made a fundamental biological error.

Although not explicitly addressed by Martin, he and virtually everyone else, who have studied this subject, have *assumed* that America's megafauna were food-limited. That is, they assumed that predators had no significant effect on herbivore populations, and thus the herbivores were exceedingly numerous. Artistic renditions of the American Pleistocene *invariably* depict a landscape teeming with large numbers of megafauna species. These depictions, however, are little more than "Garden of Eden" mythology. Instead, as I explained in Chapter 8, the American megafauna were predator-limited, not food-limited (Geist 1989, 1998). There was, after all, a suite of very large, and presumably very fierce, carnivore predators during the Pleistocene, including short-faced bears (*Arctodus* spp.), the American lion *(Panthera leo)*, sabertooth cats (*Smilodon* spp. and *Homutherium* spp.), and the dire wolf *(Canis dirus)*, among others (Geist 1989; Pielou 1991; Stuart 1991). The short-faced bear *(A. sinus)*, for instance, was more than twice the size of a modern grizzly *(Ursus arctos)* and could run at speeds approaching 60 km/hr (Geist 1989; Pielou 1991).

Elsewhere, I have explained how predators limit ungulate populations (Kay 1996), and as shown in Table 9.1, predators have a significant effect on prey densities. In the case of caribou (*Rangifer* spp.), wolves *(Canis lupis)* and bears (*Ursus* spp.) can decrease the herbivore's density by more than two orders of magnitude. That is, carnivore predation alone can reduce caribou population densities to only 1 percent, or less, of what the habitat is capable of supporting. While across northern Canada and Alaska, wolves and bears commonly keep moose *(Alces alces)* populations at only 10 percent, or less, of habitat carrying capacity (Kay 1996, and references therein; Bergerud and Elliott 1998). Thus, if American Pleistocene herbivores were predator-limited, as Geist (1989, 1998) and I contend, then there may have been only 1–10 percent of the megafauna populations generally assumed by others. That is, unlike New Zealand where there were no predators

TABLE 9.1. The Impact of Carnivore Predation on Caribou Populations in North America

Caribou Population	Predation Intensity	Mean Caribou Density (number/km²)
Island herds	None	7.45
Migratory herds	Low	1.08
Mountain herds	Moderate	0.15
Eastern-forest herds	High	0.03

Note: In eastern Canadian forests where caribou have no effective antipredator strategy, wolves can take caribou populations to very low levels, especially in areas where wolves have alternative prey such as white-tailed deer *(Odocoileus virginianus)*. By dispersing to high-elevation areas to calve, mountain caribou avoid some of the effects of wolf predation, but wolves still have a significant impact on those herds. By migrating long distances, caribou can avoid most impacts of carnivore predation, but those populations still have lower densities than herds on islands without predators. Long-distance migrations primarily evolved as a strategy to avoid predation, not as a strategy to secure additional food (Bergerud 1990, 1992; Seip 1991; Crete and Huot 1993:2295). Mean caribou densities from Seip (1991:47).

(Anderson 1984, 1989), the megafauna in North and South America were kept at low population densities by the combined activities of many different carnivorous predators. Moreover, the climate during the Pleistocene was much colder, and therefore less productive than it is today both in terms of basic plant productivity and in the number of animals those habitats could support (Pielou 1991).

Given the above, what would happen when a super-predator, Paleoindian, entered the scene? Figure 9.1 is the graph of predator-prey interactions in Alaska that was discussed in Chapter 8. First, it is important to recall that initially the moose population was kept well below habitat carrying capacity by the combined action of wolves and grizzly bears, and that predation had a similar, though smaller effect on Dall sheep *(Ovis dalli)*. Second, note that only a few moose hunters are involved, and that there are relatively few moose killed by humans—archaeologically there would be few moose kill sites. Next, note that the hunters never kill a single Dall sheep—archaeologically there would be no Dall sheep kill sites. Finally, note how the addition of a small amount of human predation on one species, moose, caused the entire system to collapse. This is called a cascading trophic effect—where the addition of one factor, in this case human hunting, causes the entire system to change. This is similar to what I believe happened when aboriginal people first entered the New World. This idea, in fact, was originally proposed by Janzen (1983), but has largely been ignored by those involved in the Pleistocene Overkill debate.

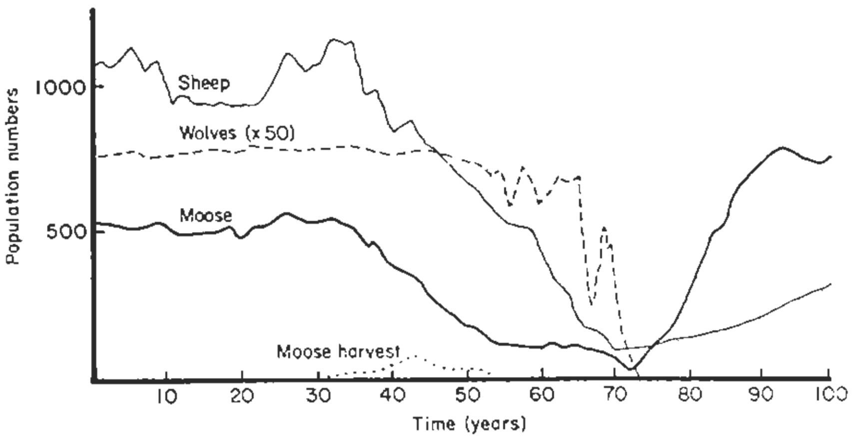

Figure 9.1. Model of Alaskan wolf-ungulate interactions simulated under circumstances in which human harvest of moose triggered a catastrophic decline in both predator and prey. Without hunting, wolves, moose, and Dall sheep numbers are low but relatively stable. The addition of a small amount of human moose harvest, however, destabilizes the entire system. Even after hunting is halted, wolves continue to drive the moose population downward. The wolves then switch to Dall sheep and drive those numbers down as well. In this simulation, wolves go extinct before they can kill the few remaining ungulates, allowing prey populations to recover. This would not be the case, though, if humans continued to prey on the ungulates. Grizzly bear predation on newborn moose calves, and to a lesser extent adults, is also important in this system, but the factor was not modeled separately. Instead, grizzly predation was included in the calculation of moose survival rates internal to the model. Note that few moose are actually killed by human hunters and that hunters do not take even a single Dall sheep. Adapted from Haber (1977) and Walters et al. (1981).

Figure 9.2 depicts the cascading trophic effect that I believe occurred when Paleoindian hunters entered an already predator-limited ecosystem. Moreover, this model accounts for all the major objections to the standard Pleistocene Overkill hypothesis. First, very few Paleoindians are required. Second, there are relatively few megafauna kill sites, and third, even if Paleoindians focused on only a few especially large prey, that was enough to trigger a cascade effect where other megafauna were decimated by Pleistocene predators.

This also explains why places without predators, like New Zealand, have large numbers of aboriginal kill sites and large numbers of kills, while the Americas do not. In New Zealand, not only were herbivore (moa) densities much higher than they were in America's predator-limited Pleistocene

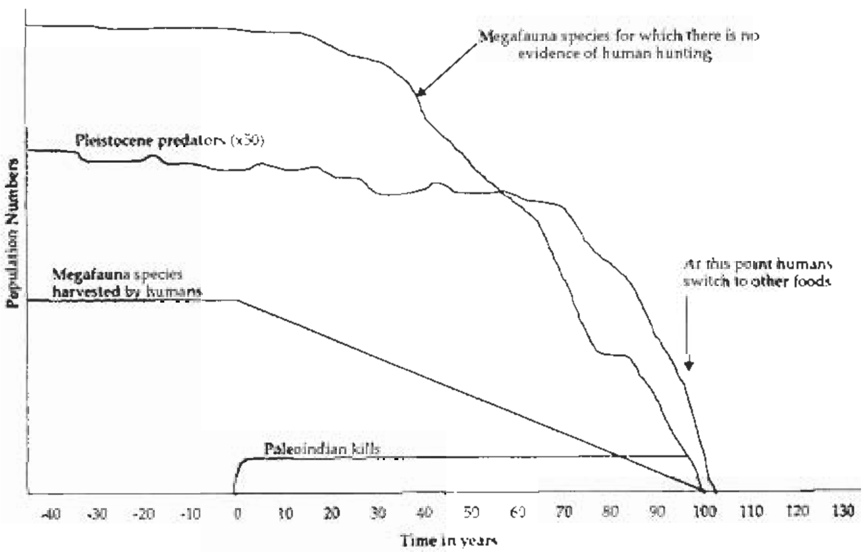

Figure 9.2. Proposed model of predator-prey interactions when Paleoindians first encountered America's Pleistocene megafauna (based on Figure 9.1). Depicted is a cascading trophic effect caused by the addition of a super-predator, Paleoindians, into an already predator-limited ecosystem. Note that (1) there are few Paleoindians, (2) there are relatively few megafauna kills, and (3) for some species there are no kill sites. Humans enter the system at t = 0.

systems, but in New Zealand, humans had to kill *all* the large flightless birds. In North and South America, however, once humans pushed the system beyond a threshold, Pleistocene carnivores did most of the actual killing. By cascading down the list of available prey species, Pleistocene carnivores were able to take species after species to low levels, which Paleoindians and the few remaining carnivores then hunted to extinction, as per the optimal-foraging models discussed in this volume. Bergerud and Elliott (1998) reported a similar cascading trophic effect in northern British Columbia where wolves took species after species to very low levels. As Fisher (1996) and Ward (1997) have explained, there certainly is no evidence that the Pleistocene megafauna died out due to a lack of food, as is required by all climatic change models (see Chapters 1 and 8).

What then about Broughton's suggestions that humans could not have killed-out the Pleistocene megafauna because native hunters did not kill-off moose, elk *(Cervus elaphus)*, deer (*Odocoileus* spp.), and other species (see Stuart 1991:522)? According to Geist (1987a, 1987b, 1996, 1998), many of the remaining megafauna, including moose, elk, and grizzlies, are of Old World ancestry and only recently entered the New World. Thus, those species were able to coevolve with earlier hominids and most likely were not as naive as indigenous American megafauna. *Odocileus*, on the other hand, are all New World species, but they are generally smaller than the megafauna animals that went extinct—since smaller species usually have higher rates of intrinsic increase than larger animals, that fact alone may have saved them from extinction (Diamond 1984, 1989). In addition, as discussed in Chapter 8, post-Pleistocene hunters caused numerous local extinctions. Aboriginal hunting, for instance, controlled the biogeography of moose throughout western North America (Kay 1997f). Moreover, Hildebrandt (pers. comm. 1998) has suggested that elk only persisted in California where they had local refugia, where they could at least partially escape human hunters. That is, Hildebrandt has observed that elk remains are only found in California archaeological sites that are near tule swamps (see Kay [1994a] for an example of how elk used tule swamps for escape cover)—elk remains are not found in the California foothills or mountains, where elk now commonly occur.

Other species such as modern bison *(Bison bison)* may have actually been created by aboriginal hunting. According to Geist (1996), the Pleistocene long- or big-horned bison *(B. latifrons)* evolved into today's smaller, shorter horned bison solely as a response to human predators. That is, the reason modern bison look the way they do and behave the way they do is because of intense selection pressure exerted by native peoples. Even seemingly low levels of human hunting can have major impacts on the numbers, distribution, and behavior of wildlife, especially the larger sized animals most favored by native people.

Since the early 1960s, Diamond (1984, 1992b, 1997) has spent large amounts of time in remote areas of New Guinea with people armed only with bows and arrows, and other "primitive" technology. Thus, Diamond's (1984:846–847) observations are extremely instructive as to the impact "primitive" people have on wildlife.

> While virtually all of New Guinea is within the hunting territory of some human group, the hunting impact would seem nevertheless to be minimal in much of New Guinea. Human population density often averages less than one person per square mile, and parts of a territory are visited only every year or two for a short period by a small band of hunters. Not until I entered the Gauttier (Foja) Mountains by helicopter in 1979 and 1981 was I able to appreciate the impact that even this low hunting pressure exerts. The Gauttier Mountains are an isolated range rising steeply from the swamps of the Meervlakte and the north New Guinea coastal

plain. Today no humans live in these mountains, and except in the foothills they are never visited by people from the adjacent swamps. . . . Thus, the Gauttier Mountains may be one of the few forested areas in the modern world whose animals are still naive to man.

Elsewhere in New Guinea the largest native mammals, tree kangaroos, are nocturnal, uncommon, and extremely shy. I have never seen one in the wild outside the Gauttiers. In these mountains the tree kangaroo *(Dendrolagus matschiei)* is common and diurnal and permitted me to approach it openly within 10 meters. Wallabies elsewhere in New Guinea are also very shy. In twenty-four months I had glimpsed about six individuals as they fled after being surprised. In the Gauttier Mountains I found the wallaby *(Dorcopsulus vanheurni)* abundant, saw it daily, and was again able to approach within 10 meters. Displays of *Uamblyornis* bowerbirds elsewhere in New Guinea have been witnessed only by concealed observers. In contrast, a male *A. flavifrons* in the Gauttiers displayed for twenty minutes to a female, while I stood in full view at the bower.

The contrast between my experience in the uninhabited Gauttier Mountains and everywhere else in New Guinea suggests that even infrequent visits by hunters eventually transform the behavior of surviving prey species. Until I had worked in the Gauttiers, I was mystified to understand how the few Maoris in the vastness of New Zealand's South Island could have killed *all* the moas, and how anyone could take seriously the Mosimann-Martin hypothesis of Clovis hunters eliminating most large mammals from North and South America in a millennium or so. I no longer find this at all surprising when I recall the large kangaroo *Dendrolagus matschiei* remaining on a tree trunk at a height of 2 meters, watching my field assistant and me as we talked nearby in full sight. The low densities of these mammals elsewhere in New Guinea, even in areas visited annually only by nomadic hunters, illustrate how susceptible large, K-selected mammals with low reproductive rates are to hunting pressure.

PERSISTENCE VERSUS ABUNDANCE

Broughton (Chapter 3) acknowledged that native people had a significant impact on wildlife populations but only when and where human populations were particularly dense. Optimal-foraging models, however, suggest that even relatively low native populations still had major impacts on high-ranking species. As Smith and Wishnie (2000) explained, persistence, in and of itself, does not imply conservation or that people had no impact on their environment. Contrary to the common notion that Native American diets were primarily meat (McCabe and McCabe 1984:28), it has long been noted by anthropologists that aboriginal people should more appropriately be called gatherer-hunters, instead of hunter-gatherers, because historically and for the preceding 10,000 years as well, 80 percent to 90 percent of aboriginal diets were nonungulate foods, primarily lower-ranked vegetal resources, fish, and small animals (Kay 1994a; Kelly 1995). This means that large mammals were not common and that ungulate densities were significantly lower than presently found in National Parks and other areas.

At current winter densities of 20 to 40 elk per km^2, optimal-foraging models predict that aboriginal diets in Yellowstone should have been nearly 100 percent elk but since elk are rarely found in Yellowstone or any other western Intermountain archaeological sites, this can only mean that today's ungulate densities are not representative of earlier times. Elk are a little more common in Pacific coast archaeological sites only because those animals had a partial refugia from native hunters in thick, usually wet, coastal forests (Kay 1994a). The fact that elk and other ungulates may persist in some archaeological records does not mean that those species were as abundant as they are today (Smith and Wishnie 2000). Whatever the site-specific circumstances might be, though, I think both Broughton and I would agree that unhunted wildlife populations are *not* the condition which prevailed at any time since native people entered the Americas.

RACISM

If, as the authors in this edited volume contend, the evidence is so overwhelming, why then have ecologists, resource managers, and the general public turned a deaf-ear and a blind-eye to what aboriginal peoples really did? Stewart (1963:119, 121) addressed this issue, as relates to native burning, over 35 years ago, and his comments are instructive.

> Views of peasants and country folk belonging to the same race and culture as the investigators are placed below consideration, but ancient practices and explanations of red Indians and black Negroes warrant no serious thought, even if known. Usually the white scientists refuse to learn the ways of the colored aborigines, whether New World or Old World because it is assumed such children of nature could contribute nothing to modern scientific inquiry.
>
> The fact that even the more historically minded American ecologists have started their evaluation of the influence of man upon nature with the landing of the Pilgrims follows from the view that American Indians were part of nature like other animals. Aborigines could be ignored more

> easily than buffalo as forces of nature. . . . Not only scientists, but all whites of European ancestry have always found it difficult to take the Indians seriously enough to learn from them. The relationship between Indians and whites started with the assumption that the Indians were only part of the natural environment. This logically led to the point of view that the American natives had nothing to teach sophisticated Europeans. One would not ask the deer and antelope about scientific problems! Europeans whether still living in Europe or in colonies in America, Australia, or New Zealand, have similar attitudes toward all aborigines.

Although Stewart (1963) did not spell it out, it is clear what he was talking about—racism. People today universally *assume* that they are superior to earlier people and especially to natives (Sluyter 2001). Diamond (1997:19–22) is the only ecologist I know who claims that hunter-gatherers, on average, were smarter and genetically more fit, than human populations today. Instead, "primitive" societies are invariably equated as "backward," or worse (Waller 1999; Rasmussen 2000; Foreman 2001). While some readers may object to the use of the term racism, which is defined by Webster as "usually involving the idea that one's own race is superior," this clearly describes how aboriginal people in the New World and elsewhere, were treated by colonial powers, as well as the nation states that followed (Cronon 1992; Pratt 1992; Demeritt 1994; Wishart 1997; Kearns 1998; Sluyter 2001).

From discussions with various ecologists and the lay public, it is clear to me why they look to climatic change instead of Pleistocene Overkill to explain megafauna extinctions—racism. We, after all, are certainly "superior" to Paleoindians, yet we lack the intestinal fortitude and knowledge to hunt modern elephants with spears, and stone-tipped ones at that. Thus, it is inconceivable that aboriginal people could have killed-off mammoths, mastodons, and the other megafauna employing such "primitive" technology (Johnson et al. 1980). Besides, experimental tests using Clovis weaponty on African elephants have shown that stone points are relatively ineffective if they strike ribs or other bones (Frison 1989).

In reality, though, killing mammoths with stone-tipped spears was exceedingly simple, despite modern depictions to the contrary. In fact, if you gave me 100 stone-tipped spears, I would *guarantee* 95 dead mammoths. Absurd? Not at all. Today's ethics demand that animals be killed quickly and cleanly. On most animals this requires heart-lung shots with high-powered rifles. But on elephants, heart-lung shots do not produce instantaneous kills and thus can allow the beast to injure the hunter before the animal actually expires. Instead, safari hunters prefer brain shots with solids (nonexpanding, copper-jacketed steel bullets) in a .458 or larger rifle—most countries that still allow sport hunting mandate .375 as the minimum allowable caliber—they do not call them elephant guns for nothing. Stone-tipped spears are incapable of penetrating the bone needed to reach an elephant's brain, and even the 3–4 ft of penetration required for a killing heart-lung shot is doubtful (Frison 1989). How then did Paleoindians routinely and safely kill mammoths and other Pleistocene megafauna? Simple, they stuck them in the guts. One spear—one mammoth.

While a gut-shot is the last thing modern hunters even want to do, it is the simplest way to safely kill such large animals with spears. Even when gut-shot with large-caliber modern weapons, such wounds do not instantaneously kill because no vital organs are struck—and the animal can travel a long distance before he or she succumbs. Gut-shots often take days to kill an elephant-sized animal, but they will *always* kill the animal, any animal, due to peritonitis. In fact, most any spear wound will kill an elephant, because the animal's large bulk closes the wound. This prevents the wound from draining and the animal dies from blood poisoning or some other secondary infection (Moss 1988).

Moreover, wounded animals, and especially speared elephants, often flee into water or swamps (Moss 1988), as this usually affords them some protection from their pursuers and allows them to quench their wound-driven thirst. This is why many of the mammoth kill sites that have been unearthed in North America were originally bogs or swamps when the animals died. It is *not* because healthy animals became stuck in the mud when they attempted to drink, as is commonly believed and portrayed in contemporary drawings. In fact, African elephants seldom became bogged, except perhaps when starving during periods of extended drought (Douglas-Hamilton and Douglas-Hamilton 1975; Moss 1988).

Thus, the easiest and least dangerous way to kill an elephant, or any other megafauna, is to spear it in the guts and then follow it until it dies or until the animal becomes so decrepit that it can be safely killed by other means. This is an exceedingly deadly strategy, especially on naive animals that have never before seen a human predator, such as occurred when Paleoindians first discovered the New World—especially large mammals that, like moose (Kay 1997a), probably evolved a strategy to stand and hold their ground when faced by carnivore predators. Standing your ground and defending against predators was a very effective strategy when megafauna species had to protect themselves and their young from Pleistocene carnivores, but it was certain death when employed against human predators who could strike a deadly blow without direct physical contact—something the animals had never before experienced; i.e., humans, unlike carnivores, kill at a distance (Kay 1994a).

If the spears or atlatl darts were poisoned, they would have been even more effective. Poisons do not preserve archaeologically, so we may never know, but at European contact, native people in Africa did use poisoned weapons to kill elephants (Johnson et al. 1980). In fact, that practice was so deadly, it was quickly banned by colonial administrators (Adams and McShane 1992). Hunter-gatherers in Africa still use poisoned arrows to kill giraffes (*Giraffa* spp.) (O'Connell et al. 1988), while Alaskan Aleuts once used poisoned harpoons to kill whales. They would simply strike the whales from open kayaks and sooner or later the whale would die and wash up on some beach, where the animal would be found. Poisons are not ethical by today's standards, but nonetheless, they are exceedingly effective.

EXPONENTIAL GROWTH RATES

Several authors in this edited volume discussed how wildlife populations rebounded after the animals were freed from native hunters, and how Europeans later misinterpreted the abundant wildlife that they saw as the "natural" state of the pre-Columbian Americas. Preston's account of California and Neumann's discussion of the passenger pigeon *(Ectopistes migratorius)* myth were especially telling. Still, it is difficult for some to imagine how a system could go from so few animals to such abundant wildlife in only 100–150 years or less. Table 9.2, though, provides insight into how quickly populations can actually increase due to exponential growth. Passenger pigeons, for example, had an especially high intrinsic rate of natural increase (r) because they often produced two or more clutches per year (Neumann 1985). If we assume a 40 percent annual rate of increase, which undoubtedly is low for this species, and if we start with 100 birds in year one, by year 50 there would be 48.5 billion pigeons, and in 100 years 23,500 trillion birds (Table 9.2)—clearly more than enough to darken the skies. Even deer and elk commonly have rates of increases of 10–30 percent per year; i.e., r = 0.10 to 0.30 (McCorquodale et al. 1988; Unsworth et al. 1999).

Similarly in Chapter 8, I discussed the 60 million bison myth. Assuming that the American Holocaust first decimated native people on the Great Plains ca. A.D. 1600, as reported by Ramenofsky (1987) and Kornfeld (1994:198), how long would it take a pre-Columbian population of 1 million bison to expand to 60 million animals? If the herd's annual increase was 30 percent per year, only 14 years; r = 0.20, 21 years; r = 0.10, 41 years; and r = 0.05, 82 years (Table 9.3). That is, even at only a 5 percent yearly increase, a population of 1 million animals would grow to 60 million in just over 80 years. Moreover, r values for free-ranging, modern bison have commonly been reported in the 10–20 percent range (Houston 1982; Van Vuren and Bray 1986; Gates and Larter 1990; Clow 1995:267). Thus, the wildlife population irruptions postulated by Preston and others are biologically feasible due to the animals' potential for exponential growth. This also applies to the original peopling of the New World.

TABLE 9.2. Rate of Population Growth for Various Intrinsic Rates of Natural Increase (r)

	r					
Time (yrs.)	0.025	0.05	0.10	0.20	0.30	0.40
5	13	128	165	272	448	739
10	128	165	272	739	2009	5460
20	165	272	739	5460	40,343	298,095
30	212	448	2009	40,343	810,308	1.62x10^7
40	272	739	5460	298,095	1.62x10^7	8.88x10^8
50	349	1218	14,841	2.20x10^6	3.26x10^8	4.85x10^{10}
80	739	5460	298,095	8.88x10^8	2.64x10^{12}	7.89x10^{15}
100	1218	14,841	2.20x10^6	4.85x10^{10}	1.07x10^{15}	2.35x10^{19}
150	4252	180,804	3.26x10^8	1.07x10^{15}	3.49x10^{21}	1.14x10^{28}
200	14,841	2.20x10^6	4.85x10^{10}	2.35x10^{19}	1.14x10^{28}	5.54x10^{36}
300	180,804	3.26x10^8	1.06x10^{15}	1.14x10^{28}	1.22x10^{41}	1.30x10^{54}
500	2.68x10^7	7.20x10^{12}	5.18x10^{23}	2.68x10^{45}	1.34x10^{67}	7.22x10^{88}
600	3.26x10^8	1.06x10^{15}	1.14x10^{28}	1.30x10^{54}	1.48x10^{80}	

Note: $N_t = N_0e^{rt}$ (Pianka 1983:117). Initial population No = 100. 10^6 = one million, 10^9 = one billion, 10^{12} = one trillion.

Some object to the very idea of Pleistocene Overkill because they cannot imagine how quickly the Americas were colonized by Paleoindians. As Diamond (1997:45) noted, though, if the Americas were first colonized by as few as 100 Paleoindians, and assuming an annual rate of increase of only 1.1 percent per year, then within just over 1,000 years there would have been 10,000,000 native people in the New World. If, on the other hand, the rate of increase had been 2.5 percent per year—a rate that has been reported for modern hunter-gatherers (Hill and Hurtado 1996), then in 500 years there would have been 26.8 million natives in the Americas (Table 9.2). And if those people had migrated south at an average distance of no more than 10 miles per year, within 1,000 years humans would have occupied all of South and North America (Diamond 1997:45). In geologic time, this is only an instant, and in the archaeological record would appear as near-instantaneous overkill. Thus, there certainly would have been more than enough people to accomplish that task (Alroy 2001).

TABLE 9.3. Rate of Bison Population Growth for Various Intrinsic Rates of Natural Increase (r)

	r			
Time (yrs.)	0.05	0.10	0.20	0.30
5	1.28×10^6	1.65×10^6	2.72×10^6	4.48×10^6
10	1.65×10^6	2.72×10^6	$7.39 \times \times 10^6$	20.09×10^6
13.67	1.98×10^6	3.92×10^6	15.39×10^6	60.34×10^6
15	2.12×10^6	4.48×10^6	20.09×10^6	90.02×10^6
20	2.72×10^6	7.39×10^6	54.60×10^6	403.43×10^6
20.5	2.79×10^6	7.77×10^6	60.34×10^6	
25	3.49×10^6	12.18×10^6	148.41×10^6	
30	4.48×10^6	20.09×10^6		
40	7.39×10^6	54.60×10^6		
41	7.77×10^6	60.34×10^6		
50	12.18×10^6	148.41×10^6		
70	33.12×10^6			
80	54.60×10^6			
82	60.34×10^6			
100	148.41×10^6			

Note: $N_t = N_0 e^{rt}$ (Pianka 1983:117). Initial population N_0 = 1,000,000; 10^6 = one million.

ABORIGINAL BURNING

In addition to the materials reviewed by Williams in Chapter 7, there are several ecological data sets that suggest aboriginal burning once accounted for most fires in the West, as well as in eastern forests. Brown et al. (1994), for instance, compared the U.S. Forest Service's Prescribed Natural Fire Program with pre-European settlement fires in the Selway-Bitterroot Wilderness Area along the Montana-Idaho border. Based on stand-age analyses and fire-history maps, Brown et al. (1994) were able to determine how frequently various forest types burned in the past and then they compared those data with how frequently the same vegetation types burned from 1979–1990 when lightning-caused fires were allowed to run their course. Brown et al. (1994) reported that, on average, the area burned during pre-European times was nearly twice as great as the area burned by lightning fires alone today. Moreover, low-elevation montane areas that once had the highest fire frequency, now seldom burn. Since the overall climate has not changed significantly, it is unlikely that lightning-caused fires burn less area today than they did in the past. Instead, it is likely that there are fewer fires today because native people no longer fire the land like they once did.

A similar situation exists along the east slope of the southern Canadian Rockies. In the past, fires were exceedingly frequent, while today lightning-caused fires seldom occur (White 1985; Kay et al. 1994, 1999; Kay 1995a, 1997d, 2000; Kay and White 1995; Barrett 1996; White et al. 1998; Heathcott 1999). In some vegetation types, fire-return intervals are now 100 times greater than they were in the past. Lower montane valleys that once burned every five years or less now do not burn at all. Based on this and other evidence, Parks Canada has concluded that native burning, not lightning-caused fires, was critical in maintaining what heretofore was believed to be the "natural" vegetation mosaic of the southern Canadian Rockies (White et al. 1998). That is to say, there simply are not enough lightning-caused fires to account for historical burn and vegetation patterns (Heathcott 1999).

Before European settlement, aspen (*Populus tremuloides*) burned at frequent intervals throughout western North America, and it is generally assumed that those fires were started by lightning (e.g., Houston 1982). Research and experience, though, have proven that aspen is extremely difficult to burn (Brown and Simmerman 1986). "Asbestos type" and "firebreak" are terms often used to describe aspen (DeByle et al. 1987). Crown fires in conifers drop to the ground when they encounter aspen and, before autumn leaf-fall, spread only short distances into aspen stands (Fechner and Barrows 1976). DeByle et al. (1987) noted that "wild fires that had burned thousands of acres of shrubland or conifer types during extreme burning conditions usually penetrated less than 100 feet into pure aspen stands." Lightning-fire ignition rates for aspen are also the lowest of any western forest type, and overall ignition rates are less than half that for all other cover types, including grasslands (Fechner and Barrows 1976).

Aspen readily burns only when the trees are leafless and understory plants are dry—conditions that occur in early spring and late fall (Brown and Simmerman 1986; Peterson and Peterson 1995). Before May 15 and after September 15, when aspen is normally dry enough to burn, however, there are few lightning strikes and virtually no lightning fires in the Northern or Southern Rocky Mountains (Nash and Johnson 1993) (see Figs. 9.3 and 9.4). So if aspen burned at frequent intervals in the past, as fire-frequency data and historical photographs indicate it did, then the only logical conclusion is that those fires had to have been set by Native Americans, who used fire to manage various plant communities (Kay 1995a, 1997d, 1997b).

Similarly, prior to park establishment, Yellowstone's northern range had a fire-return interval of once every 25 years (Houston 1973, 1982). Yellowstone has had a "let burn" policy for nearly 30 years now, yet during that period, lightning-caused fires have burned practically none of the northern range. In 1988, fire did burn approximately one-third of the area, but

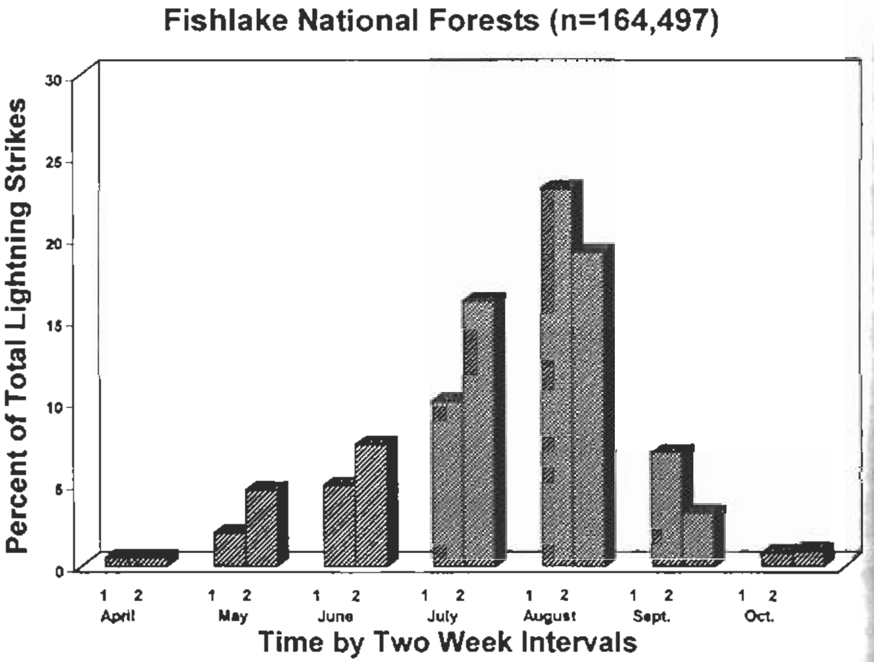

Figure 9.3. Frequency distribution of lightning strikes on the Fishlake National Forest, south-central Utah. When aspen is normally dry enough to burn during early spring and late fall, there are few lightning strikes. This is true throughout western North America. Graphed are 164,497 lightning strikes, 1985–1994. Lightning data from the Bureau of Land Management Automatic Lightning Strike Detection System, Boise, Idaho, as provided by the Fishlake National Forest, Richfield, Utah.

according to agency definitions, that was "unnatural" because the fire was started by man, not lightning. Besides, the 1988 fires are thought to be a 100–300 year event (Schullery 1989a, 1989b), so similar fires could not have caused the original 25-year fire frequency.

Despite a series of recent droughts, why has Yellowstone's northern range remained virtually unburned? Park biologists contend that this is because "lightning has chosen not to strike very often on the northern range" (Despain et al. 1986:109). That assertion, though, is not supported by data from the Bureau of Land Management's Automatic Lightning Strike Detection System, which shows that, on average, lightning strikes the northern range four times per km^2/yr (Kay 1990:136–137). So lightning strikes, but why doesn't the range burn? The answer is that when most lightning strikes occur, the herbaceous vegetation is too green to carry a fire (Kay 1995a).

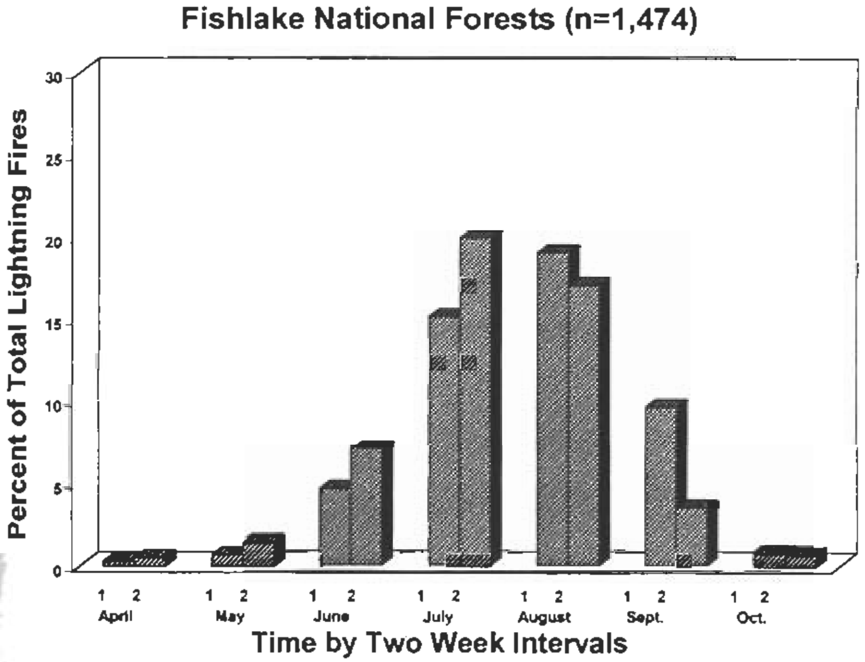

Figure 9.4. Frequency distribution of lightning-caused fires on the Dixie and Fishlake National forests in south-central Utah. When aspen is normally dry enough to burn during early spring and late fall, there are few lightning strikes (Figure 9.3) and virtually no lightning-started fires. Although there are virtually no lightning fires capable of burning aspen, historical photographs (Kay 1997b) and fire-history data indicate that aspen burned frequently in the past (Bartos and Campbell 1998). This suggests that these earlier fires were set by native people. Forest fire data (1960–1996) from the Dixie National Forest, Cedar City, Utah, and the Fishlake National Forest, Richfield, Utah.

Thus, it is likely that the park's original 25-year fire frequency was *entirely* the product of aboriginal burning.

At European contact, ponderosa pine *(Pinus ponderosa)* forests in Arizona, New Mexico, and throughout the Rocky Mountains were open and park-like, but have since developed into impregnable thickets due to the ingrowth of smaller trees, which, in turn, has created the current forest health crisis (Covington and Moore 1994; Fule et al. 1997). The open nature of the original forests, as well as the more recent proliferation of smaller trees, is generally attributed to modern fire suppression and the lack of lightning fires. That is to say, it is commonly believed that lightning historically was the primary ignition source, not native people (Seklecki et al. 1996; Swetnam and Baisan 1996a). This interpretation, though, is not supported by lightning frequency data or time of fire-scar analyses.

In the Southwest, over 95 percent of lightning strikes occur after July 1 (see Fig. 9.5a), while, historically, 85 percent or more of ponderosa pines were scarred by fire during April, May, and June (see Fig. 9.5b). Now, despite the relatively low incidence of lightning, fires early in the season do burn a disproportional area due to generally dry conditions at that time of year (Barrows 1978; Baisan and Swetnam 1990:1562; Swetnam and Betancourt 1990), but lightning fires alone still cannot account for the magnitude of early-season fire scarring seen during pre-European times (Barrows 1978). In many mountain ranges today, there simply are not enough lightning fires to have caused the high fire frequency observed prior to European settlement (Baisan and Swetnam 1997:3). Thus, it is logical to assume that a large proportion of the "natural" fire regime in pine forests and other regions of the Southwest was actually due to aboriginal burning (Bonnicksen 2000).

There are several lines of evidence which indicate that aboriginal burning was also common in eastern deciduous forests (Hamel and Buckner 1998; Bonnicksen 2000). These include the lack of lightning fire, the original structure of the forests, and species composition changes that have occurred since European settlement, among others.

Although lightning is common in most eastern forests, lightning-started fires are very rare (McCarthy 1923; Barden and Woods 1974, 1976; Harmon 1982; Bratton and Meier 1998), because when lightning strikes are most frequent during July and August, eastern deciduous forests are too green to burn. Like western aspen communities, eastern deciduous forests will readily burn only when the trees are leafless and the understories dry—conditions that generally occur only early in the spring or late in the fall, and during both those periods there are few lightning strikes and even fewer lightning-caused fires. Fire history studies, however, have shown that prior to European settlement, fires were common in the eastern U.S.—many more than can be accounted for by lightning alone (Bratton and Meier 1998; Bonnicksen 2000:259–269). Therefore, the only logical conclusion is that burning by native people was once widespread in many eastern forests, similar to conditions in the West.

At European contact, many eastern forests were open and park-like, with little undergrowth (Day 1953; Olsen 1996; Bonnicksen 2000). Like ponderosa pine forests in the West, most eastern forests were once composed of large, widely spaced trees "so free of underbrush that one could drive a horse and carriage through the woods" (Botkin 1990:51). Like western forests, though, most eastern deciduous forests are now choked with dense underbrush and smaller regenerating trees. The only way to create open park-like stands in either western or eastern forests is for those areas to

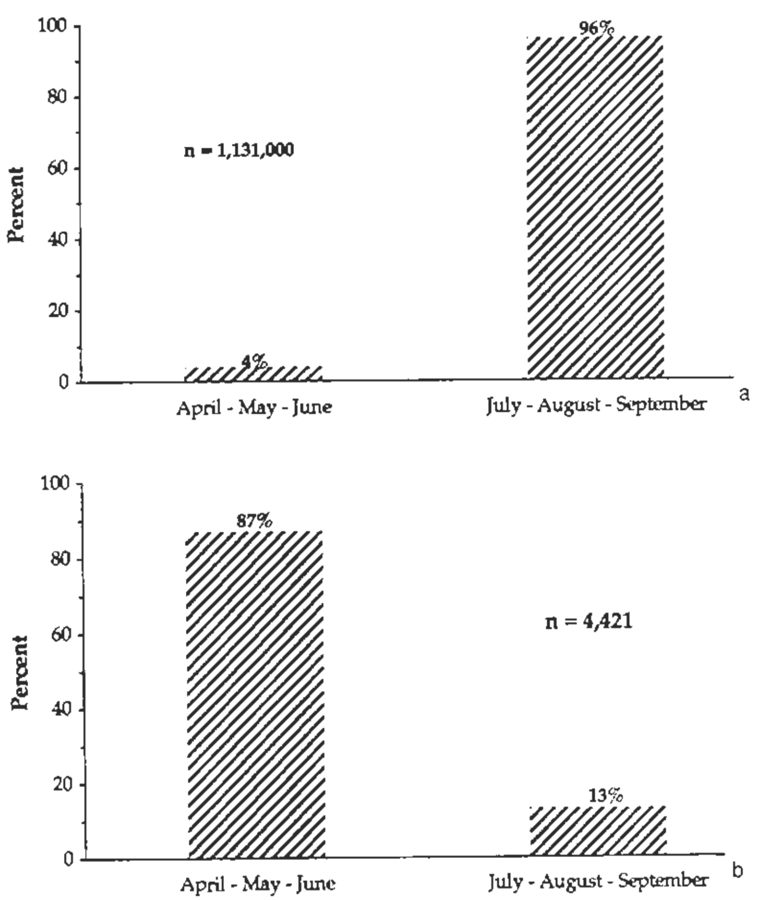

Figure 9.5. (a) Frequency distribution of cloud-to-ground lightning strikes in Arizona and eastern New Mexico during 1989 and 1990 (Watson et al. 1994:1720); (b) frequency distribution of fire-scar data for the Southern Rockies. Clearly most trees were scarred by fire when there were few lightning strikes. Timing of fire scars determined by microscopic analysis of fire damage to individual growth rings. From Brown and Sieg (1996), Fule and Covington (1999), Fule et al. (1997), Swetnam and Baisan (1996b).

have been subjected to a high frequency of low-intensity surface fires. In eastern deciduous forests this would have required fires either early in the year before the trees leafed-out or in late autumn after leaf-fall. During both those periods, though, lightning-caused fires seldom occur. Thus, the only way for eastern foresrs to have displayed the open-stand characteristics that were common at European settlement is if those communities had regularly been burned by native people as part of aboriginal land management activities.

An even more compelling piece of evidence is the species composition changes that have occurred in eastern forests since European colonization (Bonnicksen 2000). For the last 3,000–4,000 years, or longer, much of the eastern United States was dominated by oak (*Quercus* spp.), American chestnut *(Castanea dentate)*, and pines (*Pinus* spp.), all fire-tolerant, early successional species (Myers and Peroni 1983; Delcourt et al. 1986, 1998; Clark and Royall 1995; Cowell 1995, 1998; Olson 1996; Delcourt and Delcourt 1997, 1998, 2000; Bratton and Meier 1998; Hamel and Buckner 1998; Bonnicksen 2000). Since European contact, however, oaks and pines have been replaced by late-successional, fire-sensitive species, such as maples (*Acer* spp.) (Botkin 1990:51–71; Abrams 1998; Bonnicksen 2000). That is to say, the species composition of many eastern forests had been maintained for thousands of years by frequent fires—fires, as we have seen, which could only have been set by native people. It is equally clear that aboriginal burning created the many eastern prairies and "barrens" reported by early Europeans (Campbell et al. 1991; Belue 1996; Barden 1997; Bonnicksen 2000). Canebrakes *(Arundinaria gigantean)*, too, likely owed their existence to native burning and other aboriginal land management practices (Platt and Brantley 1997). Today, eastern canebrakes are an endangered vegetation type (Platt and Brantley 1997)—all because land managers continue to deny the importance of aboriginal burning (Boyd 1999).

In Australia, where aboriginal people still actively manage parts of their ancestral lands, Yibarbuk et al. (2001) compared the biological effects of human ignitions with those of lightning-caused fires in an adjacent national park, and reported that native burning maintained the area's original high biodiversity, while lightning-caused fires were having severe negative effects in the national park where human ignitions were banned. "We attribute the ecological integrity of the site [outside the park] to continued human occupation and maintenance of traditional fire management practices. . . . The implication of this study is that the maintenance of the biodiversity of the Arnhem Land plateau requires, intensive, skilled management that can be best achieved by developing co-operative programmes with local indigenous communities" (Yibarbuk et al. 2001:325–326).

ABORIGINAL POPULATIONS

This subject, no doubt, will be debated by anthropologists for years to come, and as evidence continues to accumulate, I predict that the generally accepted number of native people in the New World at Columbian landfall will rise and then rise again. One-hundred million native people in North America and 150 million more in South America, may be the upper estimate today (Chapter 8), but in time, I suspect those figures will become more widely accepted. What has not been generally recognized by most participants in this debate is the fact that human population densities in parts of the Americas may actually have been considerably higher than they were in Europe at comparable points in time, because as we have already seen, the New World lacked the crowd diseases common in other parts of the world (McNeill 1976; Crosby 1986). Preston (Chapter 5) suggested that there may have been 1,000,000 native people in California alone, but I suspect the final number may be as high as 2–3 million or more. After all, it was not until Stannard (1989) completed a detailed archaeological reconstruction of the pre-European population in Hawaii that the world realized those islands contained as many as 1,000,000 native inhabitants, and how, within 150 years of European discovery, that number had fallen to 50,000.

According to Stannard (1992:xi–xiii),

> Just twenty-one years after Columbus's first landing in the Caribbean, the vastly populous island that the explorer had re-named Hispaniola was effectively desolate; nearly 8,000,000 people—those Columbus chose to call Indians—had been killed by violence, disease, and despair. It took a little longer, about the span of a single human generation, but what happened on Hispaniola was the equivalent of more than fifty Hiroshimas. And Hispaniola was only the beginning.
>
> Within no more than a handful of generations following their first encounters with Europeans, the vast majority of the Western Hemisphere's native peoples had been exterminated. The pace and magnitude of their obliteration varied from place to place and from time to time, but for years now historical demographers have been uncovering, in region upon region, post-Columbian depopulation rates of between 90 and 98 percent with such regularity that an overall decline of 95 percent has become a working rule of thumb. What this means is that, on average, for every twenty natives alive at the moment of European contact—when the lands of the Americas teemed with numerous tens of millions of people—only one stood in their place when the bloodbath was over. To put this in a contemporary context, the destruction of the Indians of the Americas was, far and away, the most massive act of genocide in the history of the world.
>
> . . . But since the genocidal component has so often been neglected in recent scholarly analyses of the great American Indian holocaust, it is the central purpose of this book to survey some of the more virulent exam-

> ples of this deliberate racist purge, from fifteenth-century Hispaniola to nineteenth-century California, and then to locate and examine the belief systems and the cultural attitudes that underlay such monstrous behavior.
>
> Moreover, the important question for the future in this case is not "can it happen again?" Rather, it is can it be stopped? For the genocide in the Americas, and in other places where the world's indigenous peoples survive, has never really ceased. As recently as 1986, the Commission on Human Rights of the Organization of American States observed that 40,000 people had simply disappeared in Guatemala during the preceding fifteen years. Another 100,000 had been openly murdered. That is the equivalent, in the United States, of more than 4,000,000 people slaughtered or removed under official government decree—a figure that is almost six times the number of American battle deaths in the Civil War, World War One, World War Two, the Korean War, and the Vietnam War combined. Almost all those dead and disappeared were Indians, direct descendants ... of the Mayas, creators of one of the most splendid civilizations that this earth has ever seen. Today, as five centuries ago, these people are being tortured and slaughtered.... The murder and destruction continue, with the aid and assistance of the United States, even as these words are being written and read. And many of the detailed accounts from contemporary observers read much like those recorded by the conquistador's chroniclers nearly 500 years earlier.

There is also another factor we need to consider—how many people are required to have a significant impact on their environment? The answer is surprisingly few. Alroy (2001) recently developed a computer simulation model for the original human colonization of North America and how those people interacted with the Pleistocene megafauna they hunted. Alroy (2001: 1893) assumed "slow human population growth rates, random hunting, and low maximum hunting effort," so his model is extremely conservative. Nevertheless, North America's original inhabitants still hunted the megafauna to extinction without any necessity of invoking climatic change. Moreover, the maximum human population was only slightly more than 500,000 people. That is to say, 500,000 people were sufficient, in and of itself, to account for the megafauna extinctions. Thus, even if you discount Stannard (1992) and all the others, who have repeatedly revised pre-Columbian native populations upwards, and cling to the low estimate of 2 million natives in North America, that was still four times more people than were likely required to eliminate the Pleistocene megafauna. If 500,000 people could have wiped out the megafauna, just imagine what 2 million people could have done, or 10 million, or 100 million.

Another way to determine what size aboriginal population would have been necessary to have had a significant impact on prey populations is to compare wolf and human population densities. Studies in North America have shown that wolf populations commonly range between 10 and 40 animals per 1,000 km^2 (Messier 1994; Bergerud and Elliott 1998; Eberhardt and Peterson 1999) and that such densities can keep ungulate populations at 10 percent or less of what the habitat could otherwise support (Kay 1996). This translates into an estimate of 220,000–875,000 wolves for all of North America, well below any estimate of pre-Columbian aboriginal numbers. Moreover, as explained elsewhere (Kay 1994a), humans are much more efficient predators than wolves, or other carnivores. So if this number of wolves kept ungulate numbers at 10 percent or less of what the habitat could support, the addition of even two million native people would have taken prey populations significantly lower. In short, whatever aboriginal population estimate you favor, there were more than enough native people to account for the impacts discussed in this book. In fact, if it had not been for various prey refugia, such as the aboriginal buffer zones discussed earlier, there likely would have been no large mammals left at all.

POLITICAL IMPLICATIONS

After years of study and internal debate, I have come to the conclusion that "wilderness" must be purged from our legal system and the American psyche. Not only am I opposed to the "creation" of any more officially designated wilderness, but all existing wilderness areas should be deauthorized, and the Wilderness Act repealed, because it is racist legislation. By permitting this deception to continue, not only do we ignore the genocide of the past, but we allow it to color our ongoing treatment of America's original owners. This does not mean that the bulldozers should be turned loose, but that we need to seriously rethink man's role in nature. We could simply choose to call them Roadless Areas, but if those lands are to maintain the biological diversity they had prior to European arrival, which appears to be the generally accepted standard (McCann 1999:16), then they *must* be actively managed, as was done by aboriginal people. To do otherwise will only lead to the ecological destruction of the very areas society is trying to protect (Buckner 2000; Yibarbuk et al. 2001). Yellowstone National Park, for example, now contains some of the worst overgrazed riparian areas in the nation (Kay 1997e, 1997g, 1997h; Kay and Walker 1997; Keigley 1997) because park managers and environmentalists refuse to abandon misguided concepts of "wilderness" and "natural regulation," while ignoring the fact that aboriginal people were once a critical component of that and other ecosystems (Keller and Turek 1998; Spence 1999; Burnham 2000; Foreman 2001). Not only is this biologically incorrect, it is also morally indefensible (Spence 1999).

Almost all environmental activists have enthusiastically supported the reintroduction of wolves into Yellowstone (Kay 1996). Claims that wolves need to be restored, though, because "every species that was in the park when white men first came to the region is still there, except one [the wolf]" (Dawidoff 1992:40) are racist in character, as are similar claims about restoring the wolf as the system's top predator. Native Americans were the ultimate keystone predator, not wolves, and native people once structured Yellowstone and other ecosystems (Kay 1998; Kay et al. 1999). If we really want to restore Yellowstone's preeminent predator, then the public should be lobbying for the return of the park to Native Americans. Instead, by inference, they denigrate native people by assuming they were irrelevant, or worse, that they were America's original conservationists (Keller and Turek 1998; Spence 1999; Burnham 2000; Foreman 2001). While calling native people conservationists may appear to be the only kind thing people of European, Asian, or African ancestry have ever had to say about aboriginal people, in reality, it only serves to hide the genocide that befell America's original owners (Spence 1999; Sluyter 2001). Moreover, the fact that native people were generally *not* conservationists actually strengthens aboriginal land claims. By modifying the land, they clearly established ownership even by European standards—and make no mistake about it, *all* the land was owned and occupied prior to the events set in motion by Columbus (Keller and Turek 1998; Krech 1999; Redman 1999; Spence 1999; Thornton 1999; Whelan 1999; Burnham 2000).

No doubt some native people may find this book offensive because, in part, it deals with data and science, not religious views of nature, be they Christian or Native American (Deloria 1995). So be it, but without a factual understanding of what happened in the past we will never know where we have been or where we may be headed. The desired result is not some preordained management philosophy, be it liberal or conservative, but a better understanding of humans and our place on this planet. Science, after all, has steadily replaced other interpretations of the natural world only because time has shown that it more accurately predicts the future than any other method. Science is not perfect, because humans are not perfect, but until a method with greater predictive power is discovered, science certainly is better at interpreting the past and predicting the future than other alternatives. Just because people in the past may not have conserved resources we now value, that is no indication their ancestors today will do the same.

Finally, to paraphrase Smith and Wishnie (2000:516), this book's critical examination of aboriginal conservation, or the lack thereof, is not meant to provide any support for those who believe that preservation agendas take precedent over human rights, or that environmental protection justifies political or economic disenfranchisement of native people. Land claims and other indigenous rights should not be predicated on environmental preservation. Conservation, after all, is not a criterion for property rights employed by any modern state, so it is unethical, as well as unjust, to impose that condition on native people.

Wilderness and Political Ecology

ABORIGINAL INFLUENCES AND THE ORIGINAL STATE OF NATURE

&

Edited by Charles E. Kay
and Randy T. Simmons

The University of Utah Press
Salt Lake City

07 06 05 04 03 02
5 4 3 2 1

Library of Congress Cataloging-in-Publication Data

Wilderness and political ecology : aboriginal influences and the
original state of nature / edited by Charles E. Kay and Randy T. Simmons
p. cm.
Includes bibliographical references and index.
ISBN 0-87480-719-0 (hardcover : alk. paper)
1. Nature—Effect of human beings on—America. 2. Indians—
Economic conditions. I. Kay, Charles, 1946– II. Simmons, Randy T.
GF500 .W55 2002
304.2'8'097—dc21 2002005965

Contents

Acknowledgments ix

Preface xi
Charles E. Kay and Randy T. Simmons

1. Prehistoric Extinctions: In the Shadow of Man 1
Paul S. Martin

2. Evolutionary Theory, Conservation, and Human Environmental Impact 28
Michael S. Alvard

3. Pre-Columbian Human Impact on California Vertebrates: Evidence from Old Bones and Implications for Wilderness Policy 44
Jack M. Broughton

4. Depletion of Prehistoric Pinniped Populations along the California and Oregon Coasts: Were Humans the Cause? 72
William R. Hildebrandt and Terry L. Jones

5. Post-Columbian Wildlife Irruptions in California: Implications for Cultural and Environmental Understanding 111
William L. Preston

6. The Role of Prehistoric Peoples in Shaping Ecosystems in the Eastern United States: Implications for Restoration Ecology and Wilderness Management 141
Thomas W. Neumann

7. Aboriginal Use of Fire:
Are There Any "Natural" Plant Communities? 179
Gerald W. Williams

8. Are Ecosystems Structured from the Top-Down or Bottom-Up?
A New Look at an Old Debate 215
Charles E. Kay

9. Afterword: False Gods, Ecological Myths, and
Biological Reality 238
Charles E. Kay

References Cited 263

Contributors 339