TOP-DOWN VERSUS BOTTOM-UP

35 YEARS AS A FIELD-BIOLOGIST

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Desert bighorns are no longer endangered in New Mexico, and re-establishment of a statewide hunting season in 2012 is a classic example of how scientific management – a pillar of the North American Model – has led to recovery of this much sought-after big game species. Since the delisting, the New Mexico Department of Game and Fish has issued 63 desert bighorn sheep licenses.

"Is it mountain lion predation, or is it poor nutrition that has desert bighorn sheep on the state-endangered species list?" That was the principle question I was tasked with answering when I came to New Mexico 18 years ago to work on state-endangered desert bighorn sheep. In scientific parlance, the question would be: is it "top-down" or is it "bottom-up"? Wildlife biologists use the term top-down to describe the role of predation on the population dynamics of big game and the term bottom-up to describe the role of forage resources on these same dynamics.

I've been paid to hike for more than 40 years, 35 of those as a wildlife biologist, so I've had a lot of time to think about that question. I've worked as a research wildlife biologist and as management wildlife biologist, and I've looked at the issue from both sides. I worked for more than 15 years as a researcher on foraging dynamics of bighorn sheep, mule deer, and woodland caribou looking at the bottom-up side of the equation. I lived in the wild with bottle-raised mule deer and woodland caribou counting literally hundreds of thousands of bites to assess forage intake rate and bite size. More recently, I have spent the last 18 years working on the management of state-endangered desert bighorn sheep and their primary predator, mountain lions, on the top-down side of the equation. Since 1996, I have been to more than 125 radio-collared bighorn sheep mortality sites, most of them mountain lion kills.

As I reported in *Fair Chase* (Spring 2011) desert bighorns are no longer endangered in New Mexico, and re-establishment of a statewide hunting season in 2012 is a classic example of how scientific management – a pillar of the North American Model – has led to recovery of this much sought-after big game species. Since the delisting, the New Mexico Department of Game and Fish has issued 63 desert bighorn sheep licenses.

Top-Down and Bottom-Up

I use the term top-down to describe the role of predation, and the term bottom-up to describe the role of forage resources. There are opposing schools of thought among professional wildlife biologists, relative to the influence of predation on ungulate densities. Even

Chase A. Willis took his desert sheep in Socorro County, New Mexico, in 2012. It scores 191 points.

professional members within the Boone and Crockett Club fall on opposite sides of this debate. My position on this controversial topic is succinctly expressed in a quote from the late Dr. Stephen J. Gould that states, "Natural history, to a large extent, is a tale of adaptations to avoid predation". Although ungulates have many adaptations related to foraging; the great speed, auditory, visual, and olfactory acuity of ungulates are not evolutionary adaptations to find forage, but rather are adaptations to avoid predators.

Natural Experiments

A classic natural experiment was documented by Dr. A.R.E. Sinclair and his coauthors in the Serengeti of Africa. In my opinion, the results of this experiment shed considerable light on the relative contribution of apex carnivore predation on ungulate densities. In a portion of the Serengeti, poaching and poisoning removed the majority of large carnivores including lions and hyenas for an eight-year period. During this time, the density of virtually all prey species increased dramatically relative to population densities in an adjacent area with no predator declines. In the case of Thomson's gazelle there was a ninefold increase in their density in the absence of the two primary large predators. However, as predators returned to the system, prey populations declined markedly. Predators were limiting prey far below the density that occurred when released from predation pressure. An interesting sidebar is the fact that predators rarely kill adult giraffes because of their large size and the giraffe was the only prey animal whose population did not increase during the period of predator lows. In North America, Dr. A. T. Bergerud, professor emeritus at the University of Victoria, working primarily on caribou in Canada, was one of the first wildlife biologists to recognize that caribou density could be a hundred times higher on wolf-free islands compared to adjacent mainland systems with wolves. These are but two examples of the profound influence predation can have on prey densities.

In the western United States and Canada, virtually all ungulate populations, outside the most severe portions of the Mojave Desert, are subject to predation from apex predators including mountain lions, wolves, grizzly bears, and black bears. Most predation by bears is on new-born ungulates, whereas mountain lions and wolves prey on all age classes of ungulates. In much of the West, historical wolf—grizzly dominated ecosystems have become mountain lion—coyote dominated ecosystems following the extirpation of wolves and grizzlies. The shift in this predator complex is not well understood and may contribute to low ungulate densities, particularly in desert ecosystems.

Predator-free Ungulate Density versus Ungulate Density with Apex Predators

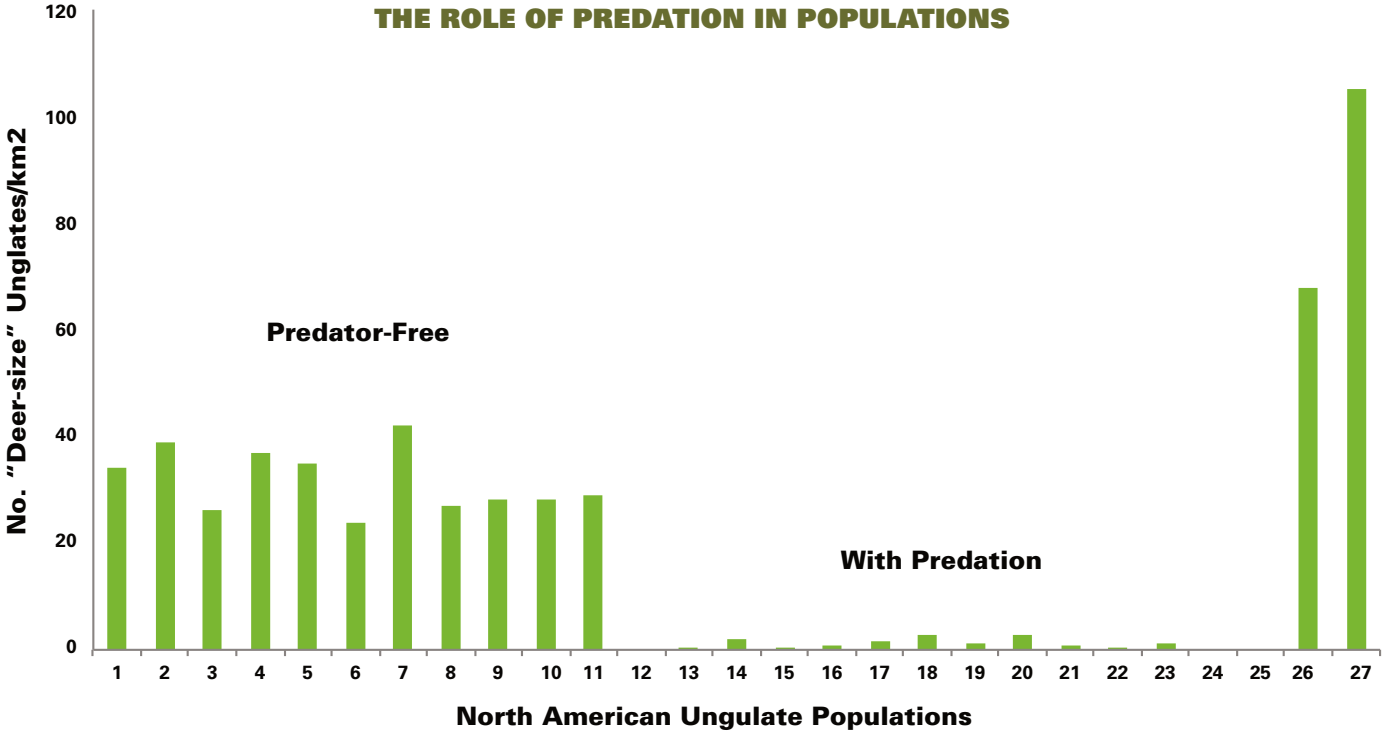
Ungulates living in predator-free exclosures (penned facilities designed to exclude predators) and on predator-free islands escape the effects of apex predators and therefore offer an outdoor laboratory to assess the role of predation. The chart below shows data, collected by many wildlife biologists, on North American ungulate densities in predator-free fenced exclosures as small as 2.6 square kilometers (1 square mile) to predator-free islands as large as 8,000 square kilometers (3,080 square miles). Examples of larger landmasses are predator-free New Zealand and the wolf/lion-free whitetail deer habitats of the eastern United States. In these systems, it is an overabundance of ungulates that is the problem rather than extremely low ungulate densities found in some western North American regions.

What I find remarkable about these predator-free systems is that in every situation, regardless of the ecosystem, maximum ungulate densities increase to levels virtually never observed in the presence of predation. I find it even more remarkable that when the various species on these islands (mule deer, whitetail deer, bighorn sheep, reindeer, moose, and bison) are converted to a "deer-sized" ungulate weights (176 pounds/80 kilograms), the maximum densities only vary between approximately 25 and 40 deer-sized ungulates per square kilometer. This large data set, derived from various ecosystems, suggests to me that based on forage resources alone, maximum ungulate densities should rarely vary by more than a factor of two.

The largest predator-free island in this data set is the nearly 8,000 square kilometer Anticosti Island in the Gulf of St. Lawrence. Boone & Crockett professional member Dr. David Hewitt pointed out in a "Trophy Points" article on the Boone and Crockett website (May 2009); the extremely high density of whitetail deer that has resulted in the extirpation of black bears because the forage resources required by bears are no longer present. Deer densities on the island are reported to be as high as 29 deer per square kilometer compared to approximately one deer per square kilomter on the adjacent mainland in the presence of wolves. These deer have been present on Anticosti Island for more than 115 years and continue to remain at very high density, despite poor forage resources and severe winter conditions.

It is much more difficult to estimate densities of ungulates outside exclosures and in mainland habitat adjacent to islands. However, estimates of ungulate densities in the presence of predators are available below. One does not have to rely on higher math skills to see that these densities are very different than those documented in the absence of predation. In this sample, the average ungulate density in the presence of predation is less than five percent of the average from these predator-free systems.

Experimental work has been done in Colorado and Oregon to test hypotheses related to density, competition, and bottom-up processes. These experiments have used elk densities that convert to 68 to 105



Predator Free

1. 3 -Bar, AZ
2. George Reserve, MI
3. Red Rock, NM
4. Wild Horse Island, MT
5. Slate Islands, ON
6. Kalgin Island, AK
7. Antelope Island, UT
8. St. Paul Island, AK
9. St. Matthews Island, AK
10. Isle Royale, MI
11. Anticosti Island, QC

With Predation

13. Pukaskwa N.P., ON
14. Outside 3-Bar, AZ
15. Outside Red Rock, NM
16. Outside Anticosti Island, QC
17. Moose--AK
18. Moose--AK
19. MD/Elk/BHS, NM
20. MD/Elk/BHS, UT
21. MD/Elk/BHS, AZ
22. MD San Andres, NM
23. California BHS, OR

Experimental Density Research

26. Stewart, et al. 2005
27. Hobbs, et al. 1996

HOBBS, N. T., D. L. BAKER, G. D. BEAR, AND D. C. BOWDEN. 1996. UNGULATE GRAZING IN SAGEBRUSH GRASSLAND: MECHANISMS OF RESOURCE COMPETITION. ECOLOGICAL APPLICATIONS 6:200-217.

STEWART, K. M., R. T. BOWYER, B. L. DICK, B. K. JOHNSON. 2005. DENSITY-DEPENDENT EFFECTS ON PHYSICAL CONDITION AND REPRODUCTION IN NORTH AMERICAN ELK: AN EXPERIMENTAL TEST. OECOLOGIA 143:85-93.

deer-sized ungulates per square kilometer to assess effects related to forage. These densities are more than 45 to 70 times higher than average densities in predator-dominated systems. The bottom line is that ungulate population density in the presence of wolves and/or lions is always a fraction of densities in the absence of apex predators.

Mountain Lions in Desert Ecosystems

Mountain lions have been determined to be the primary cause of mortality for desert bighorn sheep in much of the arid southwest. Peninsular bighorns and Sierra Nevada bighorns in California have been listed as federally endangered species, and New Mexico desert bighorn sheep were listed as a state-endangered species. The primary mortality factor for all these subspecies has been mountain lion predation. Some attempts to restore desert bighorn sheep to historical ranges in Texas, Arizona, and New Mexico have failed because of high levels of mountain lion predation. The successful restoration of state endangered desert bighorn sheep in New Mexico was predicated on the removal of mountain lions combined with a captive breeding and transplant program.

There are other natural experiments in the western United States that allow a comparison of ungulate densities with radically different predator management paradigms. In Texas, mountain lions are an unprotected big game species and intensive control occurs and populations are quite low as a result. In New Mexico, mountain lions are a protected big game species and in most desert mountain ranges very little sport harvest occurs. Desert mule deer densities in most mountain ranges in southern New Mexico have declined to about 10-20 deer per 100 square kilometers, and helicopter observation rates have declined from greater than 100 deer per hour prior to the mid-1990s to less than four deer per hour for the last 15 years. Hunter harvest and numbers of deer hunters have declined dramatically. In adjacent West Texas, desert mule deer densities are reported to be 1,200 deer per 100 square kilometers; even without supplemental feeding. This is 60-120 times more deer in nearly adjacent Chihuahuan Desert mountain ranges, where maximum densities should not vary more than twofold. Mountain lions are the primary predator of adult deer in both areas; however the lion to deer ratio is radically different.

In the deserts of New Mexico and Arizona, mountain lions have been described as a "subsidized predator" because of their ability to prey-switch to livestock, particularly beef calves. These subsidized lion populations continue to exert high predation pressure on native ungulates, despite declining prey numbers. It has been stated correctly that the absence of apex predators can adversely cascade throughout an ecosystem. However, I argue that the effects of a subsidized apex predator can also adversely cascade throughout the ecosystem. The result is a declining biodiversity with very low deer and bighorn sheep numbers and other prey species such as porcupines becoming extremely rare.

Conclusions

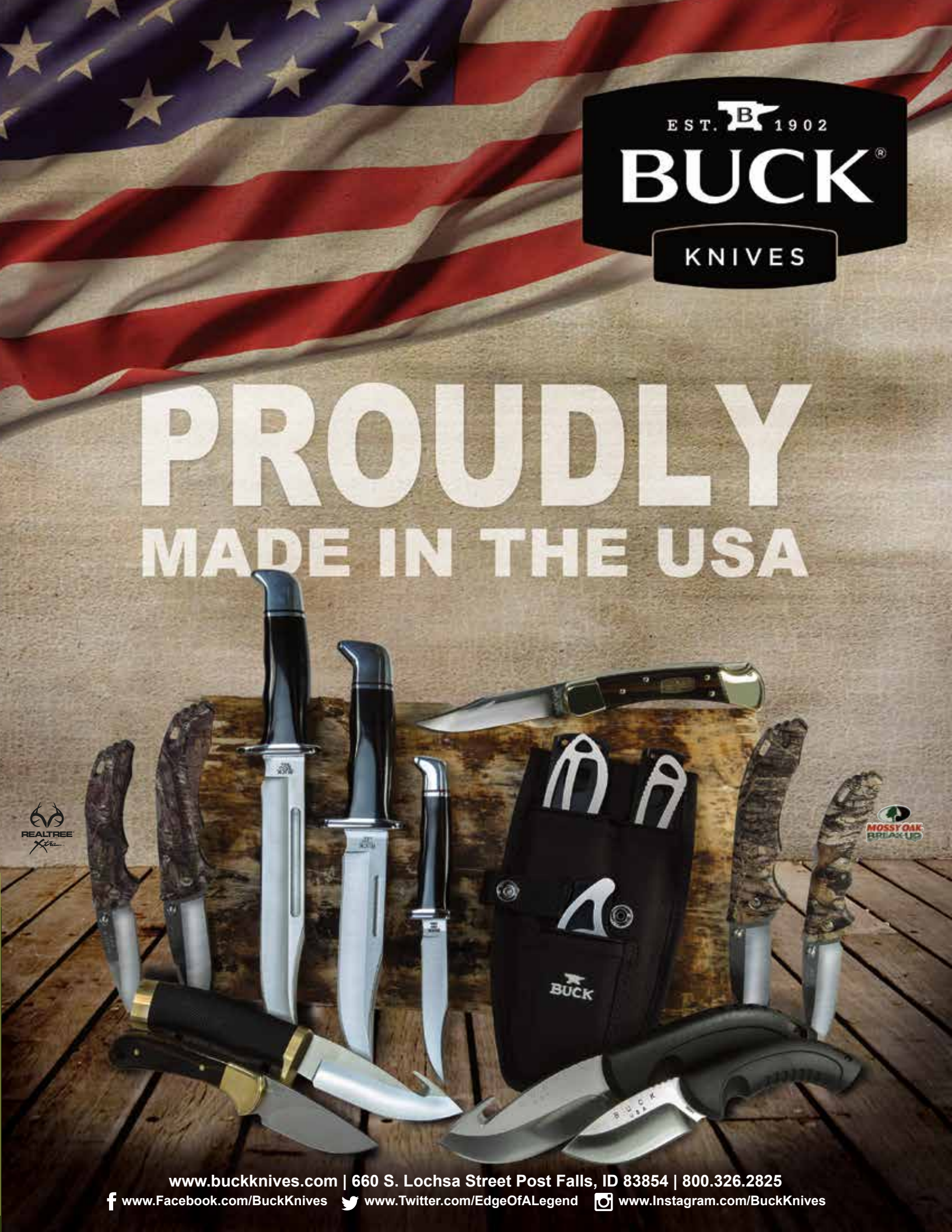
An understanding that apex predators can, and do, dramatically influence harvestable surpluses of big game is essential for wildlife managers. Some states have an overabundance of big game. However, some western states like New Mexico have many fewer deer today than just 20 years ago. A proactive predator control program has been used to recover endangered desert bighorn sheep and to attempt to recover low-density mule deer herds. Wildlife managers in Alaska have long recognized the influence of wolf and bear predation and wildlife management actions to reduce predator populations have increased moose and caribou harvest in many areas. Other western state agencies are also implementing predator control to stop the decline of big game numbers.

Wolves and grizzlies were intentionally eliminated throughout much of their historical range in western North America. Few will argue that apex predators should be eliminated from ecosystems. But high levels of predation should not be allowed to threaten the viability of any species. Boone and Crockett Professional Member Dr. Valerius Geist encapsulated the issue when he wrote: "Letting predators run down game herds will indirectly weaken the framework of wildlife conservation. Together with the other opponents of public wildlife such as game farming and the anti-hunting and animal rights movement, this may succeed in destroying the greatest environmental success of the past century—the return of American wildlife."

The late Aldo Leopold, a Professional Member of the Boone and Crockett Club, felt that hunting was essential for societal well-being. In his insightful essay "Goose Music" he recognized that "We have not yet learned to express the value of wildlife in terms of social welfare," referring to the ability to get away from society's pressures and hunt. Professor Leopold went on to point out that "the love of hunting is almost a physiological characteristic" and that, "the destruction of wildlife removed the incentive for days afield".

For me, after wearing out nearly 25 pairs of high-dollar hiking boots, the take-home message from these Boone and Crockett Professional Members and other renowned wildlife biologists is that harvest levels of predators must be managed as appropriately as we manage harvest levels of ungulate species. To fail to retain current hunters and to lose future hunters because there is more action in a video game would be a travesty. We must not forget that a cornerstone of North American conservation is the funding base provided by the hunter-conservationist. ■

LEFT: This ram, scoring 188-2/8 points, was taken by Russell A. Young in Hidalgo County, New Mexico. RIGHT: Regular Member Kyle C. Krause harvested this desert sheep this last September while hunting in the Peloncillo Mountains, in New Mexico.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