THE EVOLUTION OF SCIENTIFIC GAME MANAGEMENT

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The field of game management has ancient roots. Hunting, of course, has a long and distinguished history and pre-history across human civilizations, and antecedents of modern game management practices can be found in many ancient societies worldwide. In the Bible, Deuteronomy 22:6 describes a prohibition on the killing or take of female nesting birds. In the sixth century A.D., the Roman emperor Justinian recognized the right of landowners to prevent trespassing on their property for hunting purposes. And the adventurer Marco Polo (c. 1254-1324) notes the presence of a fairly robust game management system in the lands governed by Kublai Khan (reigned 1260-1294), complete with closed seasons on most of the big game species, provision of feed for partridges, quail, and other game birds, and numerous professional gamekeepers whose job it was to prevent poaching and to scatter food for the game birds in winter.

In Europe, game management dates back at least to medieval times when royalty and landowners hired wardens and gamekeepers to combat trespass and the poaching of game species on their lands. Restrictions on hunting and the closure of seasons to hunting were among the earliest management tools applied to game populations. Many of the earliest game laws in Europe were quite strict. For example, at the time of William the Conqueror (reigned 1066-1087), killing one of the king's deer was considered as serious a crime as killing one of the king's subjects. Early game laws in many European countries also severely restricted the hunting of game species and access to game lands to royalty, members of the nobility, and landowners.

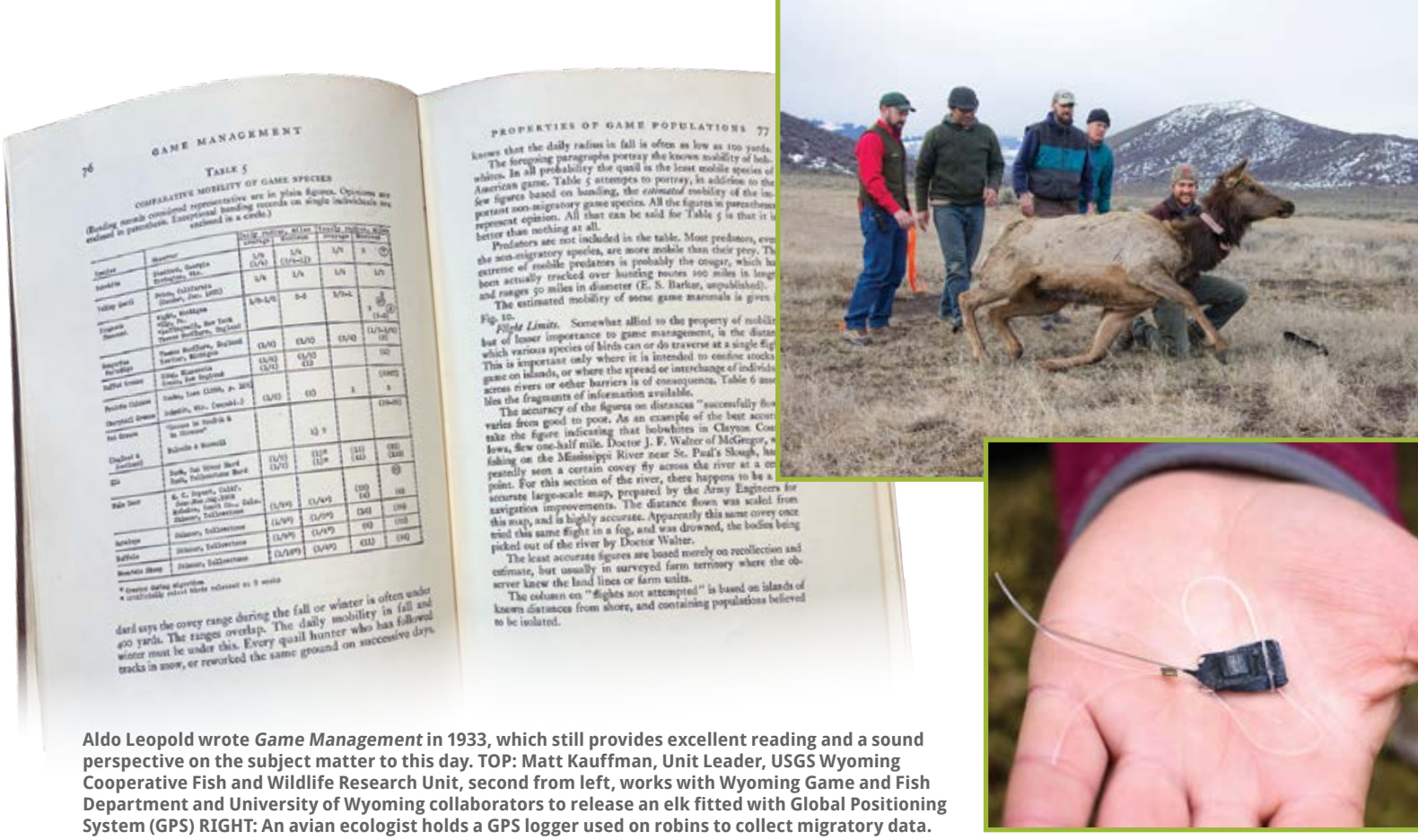
By the onset of the American Revolution in 1776, 12 of the 13 original colonies had enacted some form of harvest restrictions on game species in the United States. In Great Britain, the Game Act of 1831 established closed seasons on game birds and made it lawful to take game species only when in possession of a game license. Resident game licenses were introduced in the United States by New York in 1864 and non-resident licenses by New Jersey in 1864.

Further refinements of game management in the United States and Europe during the eighteenth and nineteenth centuries included forms of predator control; the establishment of formal "game lands," parks, forests, and refuges; game population enhancement through captive propagation and restocking; and attempts to control environmental factors related to habitat quality and quantity. However, despite the best intentions in enacting and applying these provisions, many game species continued to decline.

Advances in forestry helped catalyze a scientific revolution in wildlife management in the early twentieth century. In the late nineteenth century, European foresters recognized that certain management practices could help restore forest stands to robust health through the "wise use" and judicious harvest of the existing timber resources, promotion of new growth and forest regeneration in harvested areas, active reforestation when needed, and the implementation of techniques to control erosion and promote overall soil health. By introducing scientific principles and practices, it was possible to improve forest health while at the same time ensuring a continued supply of high-quality harvestable timber from the forest. These and related concepts of what became known as scientific forest management were introduced to the United States through new university programs such as the Yale School of Forestry, which was founded in 1900 through a generous gift from Boone and Crockett Regular Member Gifford Pinchot.

A new generation of biologists, trained in these new perspectives of scientific forest management, realized that many of the same principles could be applied to wildlife management. Wildlife populations could be managed directly to provide a surplus of animals which, in turn, could support harvest by the hunting public on a regular and sustainable basis. New scientific

A hunting scene relief on a quartz tile from the 13th or 14th century.



Aldo Leopold wrote *Game Management* in 1933, which still provides excellent reading and a sound perspective on the subject matter to this day. TOP: Matt Kauffman, Unit Leader, USGS Wyoming Cooperative Fish and Wildlife Research Unit, second from left, works with Wyoming Game and Fish Department and University of Wyoming collaborators to release an elk fitted with Global Positioning System (GPS) RIGHT: An avian ecologist holds a GPS logger used on robins to collect migratory data.

approaches could be used to collect data on population status and trends, evaluate the effectiveness of habitat management activities, and estimate sustainable harvest levels. Even traditional management interventions such as closed seasons and harvest restrictions could now be evaluated using scientific approaches. Key to this new vision was the management of habitat—defined broadly as places for animals to live, obtain food and water, and raise their young—with the recognition that judicious habitat management could directly benefit wildlife species and lead to a surplus of individuals supporting harvest programs. And if these manipulations were set up as scientific experiments, it would be possible for wildlife managers to learn from these experiments and thereby improve their management recommendations in future years.

A new field of science—known variously as game management or wildlife management—quickly arose to meet the needs of this new brand of wildlife managers. Many Boone and Crockett Club members played significant roles in the early development of this new science. Our illustrious co-founder, President Theodore Roosevelt, eloquently expressed the importance of science as a tool for discharging public responsibility for the management of game species. Member Aldo Leopold wrote the first textbook for this new field, 1933's *Game Management*, which still provides excellent reading and a sound perspective on the subject matter to this day. Honorary Life Member Jay "Ding" Darling pioneered the university-based research and training programs that became today's Cooperative Fish and Wildlife Research Units and also worked to establish separate research stations and centers under the auspices of the federal government, such as the Patuxent Wildlife Research Center in Laurel, Maryland.

With this framework firmly in place, wildlife science grew rapidly throughout much of the twentieth century. Wildlife programs were added at colleges and universities, and the Cooperative Fish and Wildlife Research Unit Program grew from an original 9 to the current 43 Units in 41 states.

Wildlife scientists rapidly adopted new advances in other fields of science for wildlife management purposes. Many developments in statistical biology and ecological science found ready applications in the nascent field of wildlife management. Following World War II, developments in radio communications and the ongoing miniaturization of electronics made it possible for wildlife biologists to use radio collars and microtransmitters to track wildlife species. Initially applied to big game species, radio transmitters are now regularly used to study movement patterns of animals as small as hummingbirds and bats.

Advances in satellite technology have also made it possible to study animal distributions and movement patterns more precisely than ever before. The availability of high-resolution satellite imagery of the earth's surface from the Landsat series of satellites and others has led directly to the development of sophisticated maps of vegetation, land cover, and animal species distribution, such as those produced through the federal and state GAP Analysis programs. And the Global Positioning System (GPS) satellite network is widely used by hunters, anglers, and many others who enjoy the great outdoors, in addition to the wildlife biologists and scientists who find GPS signals essential for their work in studying wildlife.

Advances in computing power and computer technologies have also driven major advances in wildlife science. In the earliest days, computers filled entire rooms and could be used to solve simple equations related to

wildlife population dynamics. The development of increasingly sophisticated and smaller computing devices—workstations, personal computers, laptops, and smartphones—has revolutionized the ability of biologists to collect, analyze, and share data, as well as communicate research findings to key audiences. Smartphones today provide more computing power than the giant computers of the past. And citizen science apps such as eBird and iNaturalist provide opportunities for hunters, anglers, and other outdoors enthusiasts to contribute in meaningful ways to wildlife science.

The discovery of DNA and the development of increasingly sophisticated DNA extraction and analysis methods are technologies that are finding increasing application in wildlife management and conservation. Developments in these fields are so rapid that what was considered cutting-edge just a few years ago is now regarded as routine. Whole genome extraction and analysis is becoming a routine laboratory activity, and we are only just beginning to understand the potential value of these techniques for wildlife science and management. The possibilities we understand are exciting. For instance, genomic analysis makes it possible for wildlife biologists to study population structure and identify past bottlenecks in population size, all from a relatively small number of DNA samples, sometimes even a single individual.

The growth in scientific wildlife management during the twentieth century coincided with some of the greatest accomplishments in the management of wildlife species by humans. We need only look to the recovery of migratory waterfowl species, whitetail deer, beaver, turkey, black bear, and many other taxa whose populations had been decimated in the nineteenth and early twentieth centuries by uncontrolled and/or unsustainable harvest. For many of these species, the use of scientific information and scientific principles contributed in meaningful ways to their recovery. But we cannot afford to rest on our laurels. Wildlife today continues to face significant challenges, including invasive species, disease, increased rates of habitat loss, illegal harvest, and changes in weather and climate. The good news is that wildlife scientists are actively studying these areas and identifying possible management interventions that could reduce or ameliorate the effects of these threats and stressors on wildlife. Wildlife science has an important role in helping wildlife managers understand the challenges ahead and ensuring a future for all humanity, which includes robust and healthy wildlife populations. ■

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