PART 1

LAND AND WILDLIFE MANAGEMENT

ORGANIZATIONS THAT MANAGE ENVIRONMENTAL AND natural resources also aim to protect these resources for a sustainable future. Understanding the relationships between ecosystems and our impacts on them requires a geographic approach. Using the capabilities and tools of GIS, managers can

- monitor species and ecosystems in real time,
- take mobile tools offline for monitoring in remote area,
- capture the extent of management activities,
- measure their impacts through time, and
- use the data to create a conservation plan with spatial analytics.

Prioritize resource protection

Successful land resource protection begins with setting priorities. With GIS, you can

- assess the status of wildlife resources, distribution, threats, and changes,

- compare scenarios against future modeled conditions to target, and
- plan your stewardship activities accordingly.

Track stewardship and restoration activities

Resource protection includes stewarding and restoring our natural resources. With GIS, land and wildlife managers can

- monitor assets and resources in the field,
- keep staff safe while executing management plans, and
- track stewardship over space and time to measure progress and outcomes.

Monitor species and ecosystems

Land and wildlife managers use GIS to

- analyze data from animal collars, cameras, or other sensor networks to remotely monitor species, ecosystems, and environmental variables,
- automatically detect change using imagery and artificial intelligence/machine learning, and
- work in remote areas to efficiently collect observations in the field.

Educate and engage stakeholders

Education and outreach are components of successful land and wildlife management. GIS allows land and wildlife managers to

- scale impacts through volunteer initiatives,
- collaborate with stakeholders to help inform policy decisions, and

- communicate the success of programs and initiatives to stakeholders.

GIS in action

This section will look at real-life stories about how environmental management organizations use GIS to protect and manage natural resources. These stories explore how organizations have used the geographic approach and applied geospatial technology to plan conservation initiatives, understand species and habitats, track management activities, and engage with community scientists and other stakeholders to be part of the solution.

SEEING MULE DEER DECLINE AND CONNECTING THE DOTS FROM ABOVE

Nevada Department of Wildlife

UNLIKE NEVADA'S LAWMAKERS WHO TEMPORARILY descend on Carson City each legislative session before leaving again, a group of mule deer has taken root. It's an increasingly rare sight to see a herd of this size anywhere in the state and across the western United States, and yet these mule deer have chosen the state capital as their year-round home.

The impact of a harsh winter that killed 30 percent of the state's population of mule deer about 20 years ago is still being felt today, said Cody Schroeder, a big game biologist and mule deer specialist at the Nevada Department of Wildlife (NDOW).

Although a series of winter storms raised the Sierra-Nevada snowpack to a 30-year high in early 2023, drought conditions for several preceding years in arid Nevada have not helped the mule deer either, drying out some of the high-quality vegetation that mule deer need. Other threats to mule deer include grazing competition, invasive species, urban encroachment, changing climate, and healthier predators.

To understand the status of the species and to allocate the number of hunting tags to manage herd sizes, NDOW uses helicopters to tally numbers, gender, age, and health of the mule deer. Until recently, the surveys involved logging data on paper while in the air and often not being able to analyze or visualize the data until much later.

"Now, we can see right away where deer are concentrated and where we have conflict areas," Schroeder said.

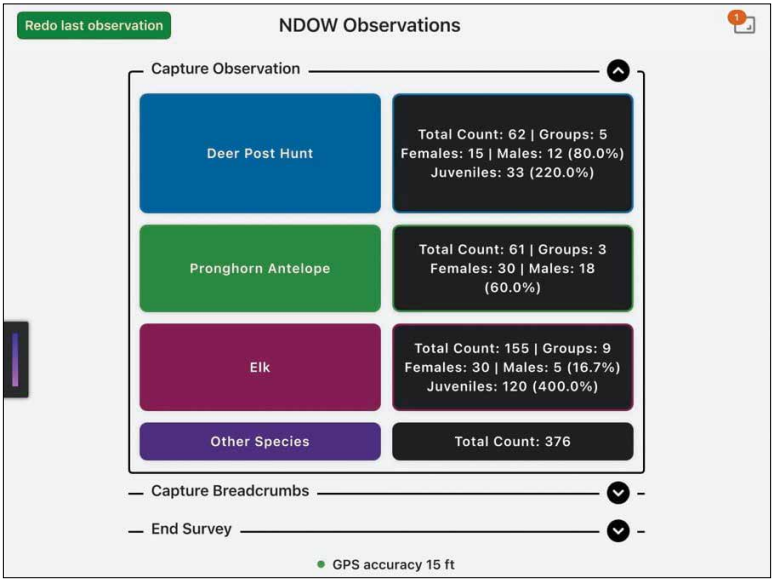
NDOW gathers population details and conducts analysis using GIS technology that allows the agency's biologists to understand

wildlife and ecosystem health. The data supports decisions to address the ongoing mule deer decline.

Confronting changing conditions

Advancements in the way NDOW conducts aerial surveys allow for real-time analysis of populations and conditions as NDOW seeks to balance the mule deer's precarious position.

Cody McKee, a biometrician and elk and moose specialist at NDOW, has been working on streamlining data collection, management, and analysis for several years. He was tasked with gathering historical aerial survey data from spreadsheets and filing cabinets and realized that NDOW needed to modernize its workflow for greater efficiency.

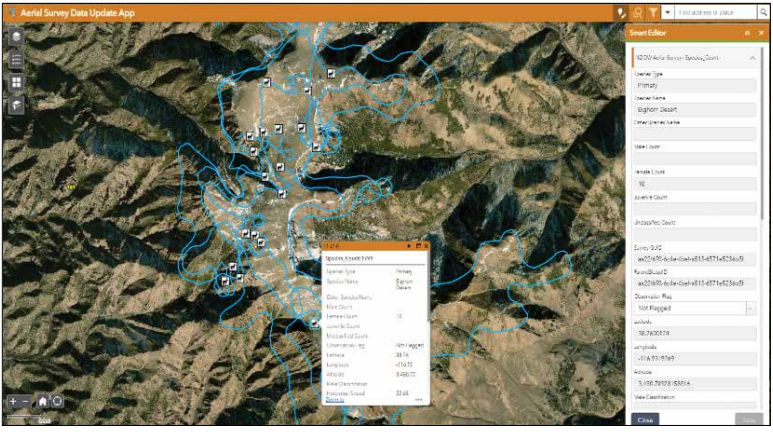


A simple big-button form eases input in the challenging data-entry environment of a moving helicopter.

Previously, biologists would take notes and jot GPS points while in the helicopter, and then back in the office they would spend a lot of time typing data into spreadsheets and then merging data and fixing transcriptions errors. NDOW estimates that biologists were spending half the time they spent in flights to get the data usable, so if they spent 1,500 hours flying, it would take an added 750 hours to analyze the data.

"Helicopters are an important part of what we do, for that bird's-eye view of the landscape that gives our biologists a holistic perspective," he said. "It's also a dangerous part of our job, and at least for me, the question 'Is this the last time I get into this ship?' is always in the back of my mind. We need to be sure that we are making the most of our time in the air."

McKee contacted Esri to match the capabilities of ArcGIS® Survey123 and ArcGIS QuickCapture to create one app on one device for the aerial surveying task and save the time it once took to look down instead of forward, where hazards lie. The group



The data of each survey pass is displayed easily on a map alongside the path the helicopter took and what was observed.

worked through iterations to greatly improve what had been a paper-based process, using buttons rather than entry fields to standardize observations.

Using ArcGIS, notes and photos are tagged with position and data goes right to a shared database. The time saved on processing data gives biologists a chance to reflect and study the data to see trends.

For mule deer, and other species, the data supports queries about the cause of decline.

"We used GIS to map the overlap between where mule deer and feral horses are and their preferred habitat," Schroeder said. "We're also looking at other things that are impacting them, such as invasive grass, the drought, and where mountain lions cluster and have kills."

The cheatgrass problem

One of the most vexing problems that Nevada land managers face is the growing impact of cheatgrass (*Bromus tectorum*), a type of grass that consumes water from native vegetation, and that sprouted in large areas where big fires have burned sagebrush habitat.

"Southern Oregon, southern Idaho, and Utah have had a big problem with cheatgrass, but Nevada has had a cheatgrass invasion," Schroeder said.

In winter, mule deer rely on brush sticking up out of the snow. When cheatgrass is present, native shrubs aren't, so deer have nothing to eat.

The grass flourishes in Nevada's lower arid elevations, where it has altered ecosystems.

"We've documented how cheatgrass changes the natural fire frequencies from 100-to-300-year cycles down to 3-to-5-year cycles," Schroeder said. "It used to be that fires in our ranges were rare, but now they burn over and over."

A dashboard view provides details about the current status of survey efforts and the running total of wildlife counted.

Feral horses multiply, squeezing out other species

More than 80 percent of the land in Nevada is public, and much of it is managed by the Bureau of Land Management (BLM), which is responsible for herd management of burros and feral horses. BLM sets the appropriate management level of herds and works to keep populations down, noting that an appropriate number in Nevada would be 12,811 total. However, it estimates there were 41,853 horses and 4,717 burros as of March 2022 statewide.

Schroeder teamed with David Stoner from Utah State University and other researchers on a paper about the impact of feral horses on other big-game species.

The research involved the spatial analysis of the range of different species such as mule deer, bighorn sheep, elk, and pronghorn antelope overlapped with the range of feral horses. The paper noted that expanding populations of feral horses are a concern for all species.

Researchers are using GIS to study how feral horses impact waterholes during drought and on land with little to no vegetation, and what species are displaced and where.