Scientists make strides toward restoring bighorn sheep in the American West

May 3 2013, by Seth Palmer

Penn State postdoctoral fellow Raina Plowright and Princeton professor Andrew Dobson study the impacts of pneumonia on bighorn sheep. Credit: Peter Hudson

As pneumonia continues to limit recovery of the once nearly extinct bighorn sheep population in the western United States, a research team including scientists from Penn State's Huck Institutes of the Life Sciences has made key discoveries that lead to a better understanding of the disease and how it might be more effectively controlled.

At the beginning of the 19th century, bighorn sheep in the western United States, Canada and northern Mexico numbered an estimated two million or more. But by 1900, only several thousand bighorns remained—a result of extensive sport hunting, encroachment of ranch lands on their habitat, and disease.

Conservation efforts such as a drastic reduction in bighorn-hunting permits, establishment of natural parks and wildlife refuges, and reintroduction programs have stemmed the bighorns' rapid decline. However, disease—particularly pneumonia—continues to be a principal factor limiting the iconic animal's recovery across western North America.

An interdisciplinary research team that includes Huck Institutes Director Peter Hudson and scientists Raina Plowright and Kezia Manlove from the Center for Infectious Disease Dynamics at Penn State has recently published in the journal *PLOS ONE* and in the *Journal of Animal Ecology* several crucial discoveries about the dynamics of pneumonia in bighorn sheep that may help to inform ongoing conservation and management efforts.

Identifying pneumonia's impacts

"Our findings suggest that the impacts of pneumonia on bighorn sheep populations are much worse than previously reported," says Plowright, lead author of the *PLOS ONE* paper. "The initial epidemic can cause high mortality, but subsequently adults—even chronic carriers—survive well, obscuring our detection of the disease. However, an average of 80 percent of the lambs die each year, and some populations continue to lose their lambs for decades, even to the point of extinction. Lamb pneumonia mortality is very difficult to detect, but it may be an explanation for the poor growth rates of many populations across the West."

The team, which also includes scientists from the Idaho Department of Fish and Game, Washington State University, Princeton University, and the U.S. Geological Survey's Northern Rocky Mountain Science Center, conducted this first multidisciplinary study of bighorn sheep pneumonia with support from nearly 20 public agencies, nonprofits, and other organizations. The researchers used the largest extant dataset on the disease, spanning 15 years and 16 interconnected bighorn populations in Washington, Idaho and Oregon.

Researchers have made several crucial discoveries about the dynamics of pneumonia in bighorn sheep. Credit: Tony Bynum

Pneumonia, initially spread to bighorns through contact with domestic sheep, is now endemic to many bighorn populations. Most observed cases die from secondary bacterial infections that mask the identity of the primary pathogen.

"For decades the bighorn sheep research community was stymied by

debate about which pathogen was causing the outbreaks of pneumonia, hence the pathogen's means and pathways of transmission were exceptionally difficult to investigate," Plowright explains. "Only in the last few years, with the availability of new DNA techniques, has the primary pathogen at last been identified as Mycoplasma ovipneumoniae."

Analyzing the data

Analyzing the data for patterns of pneumonia-induced mortality, the researchers identified naïve—previously unexposed—adults and newborn lambs as the most vulnerable groups whose mortality is driving the bighorns' overall population decline. Previously unexposed sheep are at the greatest risk of infection and of dying from a disease, but those that survive develop some immunity to subsequent infections. Mortality among adults rose and fell from year to year, but the lambs were dying at a troubling rate year after year.

Usually a degree of immunity is conferred to the offspring of the surviving individuals—as is the case in domesticated sheep—but the bighorn lambs displayed a striking lack of this inherited, or passive, immunity.

"We hypothesized that previously exposed ewes would protect their lambs from pneumonia through maternal immunity," says Plowright. "Paradoxically, we saw the opposite effect: the higher the maternal exposure to pneumonia, the more likely her lamb was to die. This is in contrast to the protective effect of maternal immunity in domestic sheep, to which M. ovipneumoniae is well adapted. Because of this, the burden of mortality in the bighorn populations we've been studying falls heaviest on the lambs."

Breaking the cycle of disease

As the primary pathogen causing bighorn sheep pneumonia has only recently been identified, an effective vaccine against bighorn sheep pneumonia has not been developed, and so researchers currently in charge of bighorn conservation efforts have focused mainly on translocating healthy bighorns to reestablish herds or boost declining herds' numbers. However, these most recent findings by Plowright and her colleagues suggest that if bighorn sheep are translocated into or near infected populations—as has happened within their study region—such methods may have little or no practical utility.

"Naïve animals translocated into our study area succumbed to pneumonia within a few years of translocation," says Plowright. "Our results show that introducing naïve animals into areas with infected animals is not productive for conservation or recovery."

The researchers' recent discovery of M. ovipneumoniae as the probable primary pathogen causing bighorn sheep pneumonia opens up many more opportunities for these researchers to test their hypotheses in the field and lab, and to identify potential strategies of breaking the cycle of disease.

"In publishing these most recent results, we really are fortunate to have had many years of hard work already done for us by our colleagues who collected much of the data," says Plowright. "In particular, Frances Cassirer, the lead author of the *Journal of Animal Ecology* paper, has spent the past 15 years recording mortality patterns in Hells Canyon bighorn sheep, and Tom Besser led the efforts that resulted in the discovery of M. ovipneumoniae as the probable cause of bighorn sheep pneumonia endemics. We owe Frances and Tom a great debt in all of this, and we'd like to thank them – along with Kathleen Potter, Andy Dobson, and Paul Cross – for their part in making our discoveries

possible."

Provided by Pennsylvania State University