



Bleats and Blats

Official Newsletter of the Desert Bighorn
Council

December 2003



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Hello everyone,

Hopefully this finds you all doing well! In this newsletter, you will find out more about some of your fellow DBC members and the work that they do. Please remember, you are all welcome to participate in these newsletters. If you have a research or management update that you'd like to share, feel free to email me so I can get it into the next newsletter (due out in early spring).

Accounts of your experiences in the field are also welcome. And remember to check out our website at <http://www.desertbighorncouncil.org>

You are welcome to submit information and articles to the website also, and it's a great way to share your bighorn sheep photographs.

Hope to hear from you!

*Esther Rubin
DBC Secretary*

(erubin@sandiegozoo.org)

“MEET THE DBC TECH STAFF”

Here's a chance to learn a little more about our fearless leaders. Who are they and where did they come from??.....

Clay Brewer works as the Bighorn Sheep, Mule Deer, and Pronghorn Antelope Coordinator for the Texas Parks and Wildlife Department. He saw his first desert bighorn sheep in the mid-1960s and says he's been passionate about them ever since. Clay first started working with bighorn sheep in 1995 while serving as Area Manager of Elephant Mountain WMA. He is currently involved in many aspects of bighorn sheep habitat restoration, management, conservation, and research, and serves as the Desert Bighorn Program Coordinator for the state of Texas. He is especially interested in overcoming today's obstacles in restoring bighorn to historic population levels, and restoring historic habitat.

Rick Brigham is now officially retired, after a long career with the Bureau of Land Management in Idaho, Arizona, and Nevada, starting in 1965. Rick first became interested in bighorn sheep when he chose them as a topic for a class assignment in a Big Game Management class at Humboldt State University in the 1960s. He started working with them in the Phoenix BLM district in late 1970. Rick reports that although he is not currently working with desert bighorn sheep, he watches Rocky Mountain bighorn along the Snake River less than 6 miles from his new home in Clarkston, Washington (just across the river from Lewiston, Idaho). Rick continues to be involved with desert bighorn sheep issues through his work with the Desert Bighorn Council, which he joined in 1971. Rick's main interest in bighorn sheep has been habitat management and land use, which represent a major responsibility of the BLM. He is particularly interested in water development for bighorn and other wildlife (see BLM Technical report #397 on Water Development for Wildlife, which Rick was the lead author on). Rick worked closely with sportsmen's groups to raise funds and construct water developments. Rick offers the following words of wisdom to members of the DBC: "Here are some things that have always stood me in good stead, within the BLM, with my co-workers and constituents, and people in general: good communications skills, both writing and speaking; telling the truth--always; you must walk the ground about which you write or make land-use recommendations--(dry-labbing doesn't cut it); recognize your volunteer groups; be very well prepared (equipment/parts) when you go to the field, particularly if you are overseeing a volunteer project; network with your peers and constituents as much as possible; take field notes (because your brain is NOT infallible); recognize that everyone is cut from a slightly different piece of cloth; keep your perspective; give it your best shot, every day, then walk away; it helps to have a sense of humor and be able to laugh, including about yourself. Also, treat people right--the way you would hope to be treated. People will go the extra mile for you if you do."

Joe Cresto is a Wildlife Biologist with the Bureau of Land Management. Joe first became interested in bighorn sheep in the 1950's through hunting stories and articles written by Jack O'Connor, Elmer Keith and others. His initial interest was peaked by the idea of someday getting an opportunity to hunt one of these animals. Joe graduated from New Mexico State University in 1964 (BS in Range Management) and began his BLM career in Fillmore, Utah, in 1966. In 1970 he transferred to Alamosa, Colorado, and worked with the Trickle Mountain bighorn herd. In 1973, he returned to Utah and has remained involved with the state's bighorn programs since that time. Joe works with bighorn management issues on a day-to-day basis through the NEPA process and other land use activities involving the permitting process. He is currently involved in a land exchange that will benefit bighorn, and works on Land Use Plan (Resource Management Plan) revisions where bighorn sheep concerns are a major issue. He is also working with Utah Division of Wildlife and Brigham Young University on a

bighorn sheep disturbance study in the Potash Unit near Moab. Joe has always been an advocate for bighorn sheep and his main involvement has been with land management issues. These include conversion of grazing allotments from domestic sheep to cattle, forage reallocation, habitat delineation and the development of stipulations and mitigation measures that protect bighorn sheep and their habitat.

Mark Jorgensen is the Superintendent of Anza-Borrego Desert State Park, California State Parks. Mark first became interested in bighorn sheep in the early 1960s. He says he was first introduced to the topic of bighorn sheep by an old State Park ranger, who he later worked for and continued to learn a great deal from. In 1967, when nobody else was actively keeping track of the population in the State Park, Mark took it upon himself to learn more about them. After years of hiking around the State Park and observing bighorn sheep, he was hired as a summer seasonal employee to officially study the population for the State Park. Mark then went on to work as a Resource Ecologist for the State Park before being promoted to Superintendent. Mark continues to be involved in the management of desert bighorn sheep as a member of the U.S. Fish and Wildlife Service's Recovery Team for bighorn sheep in the Peninsular Ranges. He is interested and involved in many aspects of bighorn sheep management, primarily habitat restoration, water source recovery, wilderness management, land acquisition, and wildlife corridors and habitat connectivity.

Ray Lee (Tech Staff chair) is the President and CEO of the Foundation for North America Wild Sheep. He first became interested in and began working with wild sheep while participating in a bighorn sheep transplant at Lake Mead in 1983. Ray's work with FNAWS allows him to participate in hands-on management activities such as directing population surveys and conducting translocation projects in Mexico. Ray looks at the Desert Bighorn Council as THE professional organization for researchers and managers working with desert bighorn sheep. He feels that participation in the Council enables one to stay current with wild sheep research and management, and stresses that staying current with the literature and the latest work in one's field makes one a true professional.

Eric Rominger is employed as a bighorn sheep biologist with the New Mexico Department of Game and Fish, in Santa Fe. He first became interested in bighorn sheep when he was working as a back-country ranger in Grand Canyon National Park in 1976. In 1980, he began a M.S. project on the Waterton Canyon bighorn sheep, and graduated from Colorado State University in 1983. He says that these days he works all day, every day, on bighorn sheep, and has done so for the past 8 years. This follows a hiatus of 11 years, during which he conducted research on the Federally Endangered Selkirk woodland caribou population. Eric works primarily on management issues including trapping and transplanting both desert and Rocky Mountain bighorn. Most desert bighorn management issues in New Mexico revolve around the relationship between mountain lions and desert bighorn. Eric's current research includes efforts to better understand the consequences of subsidized lion populations on desert bighorn sheep. He is currently investigating the role of top-down and bottom-up regulatory mechanisms in bighorn sheep populations in New Mexico.

Mara Weisenberger is a Wildlife Biologist with the U.S. Fish and Wildlife Service and works at the San Andres National Wildlife Refuge. Mara first became interested in bighorn sheep while an undergraduate in college, and reports that the more she learned about them the more she wanted to know. She first worked with bighorn sheep in the mid-1980s while working with Dr. Paul Krausman at the University of Arizona. These days, Mara is involved in bighorn sheep management and research. She has been working with White Sands Missile Range and the New Mexico Department of Game and Fish for more than a decade to begin restoring the San Andres mountains bighorn herd. Mara and her colleagues have recently completed research on the status of scabies mites (*Psoroptes* spp.) in this mountain range. They have also been conducting landscape scale prescribed burns on the San Andres

NWR since 1999 in an effort to restore desert bighorn habitat; to date, more than 34,000 acres have been treated. When asked what her primary interests are, Mara responds “It is too difficult to piece out one main area of interest in bighorn sheep. The varied aspects of bighorn conservation are so interconnected not only to bighorn herd viability in itself, but also to how they relate to sympatric ungulates, predators, weather, and habitat conditions, that it is not possible to answer one question without five more questions springing up. The fun is knowing there's always more to learn.”

RESEARCH UPDATES AND NEWS FROM THE FIELD

Find out what others are doing in the field and on research projects! This section could be a regular section in the newsletter, depending on interest and materials submitted. If you have an update to share, just email me! E. Rubin

Update from:

Eric Rominger, New Mexico Department of Game and Fish

Email: Erominger@state.nm.us

NMDGF is just initiating a research project on the potential role of hunter eviscerated offal (HEO) ... can you say gut-piles, as a food subsidy of mountain lions in desert bighorn sheep habitat. Extremely high densities of mountain lions in ranges with extremely low densities of native ungulates appear to defy the Kleiber equation. The role of exotic ungulates, particularly oryx and cattle, in subsidizing lion populations is currently being investigated.

NMDGF, along with other US agencies and NGO's, is cooperating with Mexican biologists in assessing the potential of currently unoccupied mountain ranges. Most ranges are in Chihuahua, Coahuila, and Nuevo Leon, states with historical records of bighorn but none in the wild at this time. This work is being lead by the Mexican NGO Unidos para la Conservacion in cooperation with many government and university cooperators.

Update from:

Alejandro Espinosa, CEMEX, Desert Bighorn Sheep Program Coordinator

Universidad Autonoma de Nuevo León, Doctoral Candidate.

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I work for CEMEX as a coordinator of the desert bighorn sheep program. The program is in cooperation with Unidos Para La Conservacion. The main goal of the program is to restore the desert bighorn sheep in their historical range in northern Mexico.

As a graduate student at the Universidad Autonoma De Nuevo Leon in Mexico, I am working in my thesis which objectives are to evaluate the historical status of the desert bighorn sheep, the habitat condition, and to identify best suitable areas for bighorn sheep in the state of Coahuila, Mexico.

Update from:

Steve Rosenstock, Chasa O'Brien, and Bob Waddell, Research Branch – WMRS, Arizona Game & Fish Department, 2221 W. Greenway Rd., Phoenix, AZ, 85023

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Wildlife Water Development Study: Since July 2002, we have been using remote videography to observe use of a wildlife water on the Kofa National Wildlife Refuge, Arizona. Our objectives are to quantify visitation by desert bighorn sheep and other wildlife and determine how patterns of use vary with time of year, temperature, and other factors. We expect to install similar camera systems at 1 or 2 additional waters used by bighorn sheep, each of which will collect data for at least 3 years. These cameras are part of a 10-year research project on wildlife waters in southwestern Arizona that is a cooperative effort between the Arizona Game and Fish Department, U.S. Army, and U.S. Fish and Wildlife Service. Other project components are examining water quality at natural and human-made water sources, potential for transmission of wildlife diseases, effects of waters on native and non-native insect pollinators, use of waters by bats and migratory birds, and importance of waters to coyotes.

Update from:

Stacey Ostermann, University of California, Davis

Email: sdostermann@ucdavis.edu

I am a graduate student working toward a PhD in Ecology at the University of California, Davis. My research involves investigating the interspecific relationship between desert bighorn sheep and feral horses in cooperation with Anza-Borrego Desert State Park, the UCD Wildlife Health Center, and the San Diego Zoological Society. Using a combination of observations and field manipulations, we tested for direct and indirect interference competition between bighorn sheep and feral horses near water, in Coyote Canyon within Anza-Borrego Desert State Park. Results from this study will be available in 2004.

Update from:

Esther Rubin, Zoological Society of San Diego

Email: erubin@sandiegozoo.org

Since 2001, I have been conducting a field study in the Peninsular Ranges of southern California, primarily in Anza-Borrego Desert State Park. I'm looking at habitat use and behavior of male and female bighorn sheep. My primary objectives are to test several hypotheses about sexual segregation (building on the work done by Dr. Vern Bleich and Dr. Kathreen Ruckstuhl, for example), and to learn more about how bighorn sheep use their habitat. For example, I will look at characteristics of habitat used by female bighorn sheep during different times of the year, and will also explore possible relationships between habitat use and behavior patterns and the seasonal patterns of lion predation that we have observed in this mountain range. For the past 2 years I have monitored 24 bighorn sheep that were collared with Televilt GPS collars. While the collars collected locational data, I collected data on behavior and forage availability/quality. The collars recently dropped off the study animal as planned (the drop-off mechanisms worked!!). As I approach the data-analysis phase of my study, I'm working on understanding and addressing potential biases in the ability of GPS collars to acquire locations (such as biases due to habitat characteristics), and may be doing some collar testing in the field. If any of you are dealing with similar issues or have addressed them, I would be very interested in talking with you.

Update from:

Mara Weisenberger, USFWS, San Andres National Wildlife Refuge

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With the first rut winding down following a historic augmentation of desert bighorn sheep from the Kofa National Wildlife Refuge, Arizona and Red Rock Wildlife Area, New Mexico, the San Andres Mountains desert bighorn sheep herd is doing well. This long awaited transplant was an interagency effort between the U.S. Fish and Wildlife Service Kofa and San Andres National Wildlife Refuges, Arizona Game and Fish Department, Arizona Desert Bighorn Sheep Society, White Sands Missile Range, New Mexico Chapter of FNAWS, and the New Mexico Department of Game and Fish (NMDGF).

We currently have a total of 63 bighorn roaming the San Andres mountains to include 21 rams, 27 ewes, and 15 lambs. Twenty lambs were known to have been born initially, with 15 observed with ewes until early Fall. Of the 63 bighorn, we have 43 active VHF radiocollars working to aid in monitoring movements and determining causes of mortality. Of those 43 radiocollars, there are also four with remote satellite capabilities.

Since the November 2002 transplants, 12 bighorn have died (falls = 8%, predation = 42%, undetermined natural causes = 50%). Comparatively, radiocollared bighorn mortalities (n=77) on the San Andres National Wildlife Refuge since 1980 are as follows: capture related = 3%, disease = 8%, determined natural causes (i.e., lambing, old age) = 13%, undetermined natural causes= 28%, and predation = 48%.

Most of the bighorn have remained within 8 miles of the release site, with a few wondering farther north. Prior to the November 2002 transplant, we had three rams that have traveled south, across Highway 70, into the Organ Mountains. These three sentinel rams have not moved back into the San Andres mountains and remain in the Organs, often approaching Highway 70, but not crossing. This is a four lane highway bordered with barbed wire fencing on both sides. We are cooperating with the State Highway Department and NMDGF in evaluating possible locations for effective wildlife crossing areas along a nine mile stretch. The construction of wildlife crossings would facilitate safer movements of wildlife between the Organ and San Andres mountains.

There is also one ram that moved up to the Oscura mountains during the 2002 rut, and remains alone up there. Many of the bighorn observations during the past year have been in habitat we burned as part of our prescribed burn program. To date, more than 34,000 acres have been successfully treated on the San Andres National Wildlife Refuge in past prescribed burns intended to improve desert bighorn sheep habitat conditions.

Refuge staff were also fortunate to be able to participate in an October 2003 desert bighorn sheep transplant on the Navajo Reservation in southeastern Utah. Nike and Dave Stevens coordinated a bighorn transplant in which the animals had to be flown to the remote release site on the San Juan river. Our transport crates, designed specifically for bighorn sheep, were carried by helicopter to the bottom of the canyon. Thanks to the Navajo Department of Fish and Wildlife, Bureau of Land Management, and Stevens Wildlife Consulting for a great learning and cooperative experience.

As we close in on the first year post-release, we are happy to report a successful step in the effort to restore the San Andres desert bighorn sheep population.

RECENT LITERATURE **RELATED TO BIGHORN SHEEP** *(citations and abstracts)*

Blanchard, P., M. Festa-Bianchet, J. M. Gaillard, and J. T. Jorgensen. 2003. A test of long-term fecal nitrogen monitoring to evaluate nutritional status in bighorn sheep. *JOURNAL OF WILDLIFE MANAGEMENT* 67(3):477-484.

We analyzed 23 years of monitoring data from a bighorn sheep (*Ovis canadensis*) population to determine whether fecal nitrogen (FN), expected to reflect diet quality, can be used to track population nutritional status over the long term. We considered 3 measures of FN: its maximum value each spring (FN peak), the date of the peak, and the area under the curve relating julian date to summer FN (FN-total). We first determined the sources of variation in these 3 measures. Population density had a strong negative effect on FN-total while summer precipitation was positively related to FN-total, suggesting that diet quality declined with increasing density and improved with precipitation. Most sheep were recaptured every year, allowing us to assess FN as an indicator of nutritional condition by examining the relationships between summer mass gain and both FN peak and FN-total. The value of FN peak was not related to summer mass gain for any sex-age class, but FN-total was positively related to summer mass gain of nonlactating females and yearling females. Our results suggest that FN can be used as an index of forage quality over several years. Over several years, FN also reflects aspects of bighorn sheep body growth and is correlated with changes in density that may ultimately affect population performance. Short-term monitoring of FN, however, may not provide much useful information.

Boyce, W. M., C. S. O'Brien, and E. S. Rubin. 2003. Response of bighorn sheep (*Ovis canadensis*) to feral honey bees (*Apis mellifera*) at water. *SOUTHWESTERN NATURALIST* 48(1):81-84.

We used remote cinematography to evaluate the interactions between feral honey bees (*Apis mellifera*) and desert bighorn sheep (*Ovis canadensis*) at an artificial water source (guzzler) in Anza-Borrego Desert State Park in southern California from July through September 1995. Honey bees, determined by molecular analysis to be non-Africanized (i.e., not *A. m. scutellata*), were present at the guzzler collecting water from dawn to dusk whenever bighorn sheep were videotaped. Bighorn sheep exhibited behavioral responses (violent head shaking, rapid withdrawal from the water source, and temporary refusal to drink) to honey bees during 62% (66 of 107) of their visits to the guzzler. Bighorn sheep spent significantly ($P < 0.001$) more time at the guzzler when their visits were interrupted by honey bees than when they were not interrupted. We concluded that honey bees altered the behavior of bighorn sheep and that honey bees and bighorn sheep were competing for water resources at the guzzler.

Eleraky, N. Z., S. A. Kania, J. F. Evermann, and L. N. D. Potgieter. 2003. Comparison of targeting F and G protein genes to detect bovine and ovine respiratory syncytial viruses. *JOURNAL OF VETERINARY DIAGNOSTIC INVESTIGATION* 15(3):277-280.

In this study, 2 reverse transcriptase-polymerase chain reaction (RT-PCR) assays were developed and compared for simultaneous detection of bovine and ovine respiratory syncytial viruses (RSVs). One assay was based on a set of primers, which amplified a 426-bp fragment of either bovine or ovine RSV F gene (RT-PCR F). The F products could be distinguished by EcoRI or BstYI restriction endonuclease cleavage. In the other assay, a set of primers amplified a 542-bp fragment of either ovine or bovine RSV G gene (RT-PCR G). EcoO1091 and RsaI restriction enzymes were used to differentiate between the ovine and bovine PCR-G products. Sequencing of the PCR products confirmed the fidelity of both assays. The 2 assays were evaluated using 18 bovine RSV isolates, 1 ovine RSV, 1 bighorn sheep RSV isolate, 1 caprine RSV isolate, 2 human RSV isolates, and several other viruses associated with bovine respiratory tract disease. RT-PCR G may be more sensitive in detecting viral RNA. Because the target sequence of the F gene is more conserved than that of the G gene, RT-PCR F followed by the appropriate restriction enzyme cleavage may be superior to RT-PCR G to discriminate between the 2 ruminant RSV subgroups. This assay should prove useful for determining the relative contribution of ovine and bovine RSV to the pathogenesis of bovine respiratory tract disease.

Festa-Bianchet, M., J. M. Gaillard, and S. D. Cote. 2003. Variable age structure and apparent density dependence in survival of adult ungulates. *JOURNAL OF ANIMAL ECOLOGY* 72(4):640-649.

1. Large herbivores have strongly age-structured populations. Because recruitment often decreases as population density increases, in unexploited populations the proportion of older adults may increase with density. Because survival

senescence is typical of ungulates, ignoring density-dependent changes in age structure could lead to apparent density-dependence in adult survival.² To test for density dependence in adult survival, we used data from three populations that underwent considerable changes in density. Bighorn sheep (*Ovis canadensis*) on Ram Mountain, Alberta, ranged from 94 to 232, mountain goats (*Oreamnos americanus*) on Caw Ridge, Alberta, varied from 81 to 147, and estimates of roe deer (*Capreolus capreolus*) older than 1 year at Chize, France, ranged from 157 to 569.³ We used recent developments of capture-mark-recapture modelling to assess the response of adult survival to changes in density when age structure was and was not taken into account.⁴ Survival rates were 10-15% higher during the prime-age stage than during the senescent stage for all sex-species combinations. When adults were pooled into a single age class there was an apparent negative effect of density on female survival in bighorns and roe deer, and negative trends for female mountain goats, male roe deer and male bighorn sheep. When age class was taken into account, there were no significant effects of density on adult survival. Except for male mountain goats, the strength of density dependence was lower when age was taken into account.⁵ In ungulate populations, age structure is an important determinant of adult survival. Most reports of density dependence in adult survival may have been confounded by changes in age structure.

Kamler, J. F., R. M. Lee, J. C. deVos, W. B. Ballard, and H. A. Whitlaw. 2003. Mortalities from climbing accidents of translocated bighorn sheep in Arizona. *SOUTHWESTERN NATURALIST* 48(1):145-147.

Desert bighorn sheep (*Ovis canadensis*) are known for their climbing skills in rugged and steep terrain. Occasionally sheep die from climbing accidents. Between 1979 and 1995, the Arizona Game and Fish Department reintroduced desert bighorn sheep to areas within their historic distribution: northwest, southwest, southeast, and central Arizona. Because at least half of reintroduced sheep (n = 412) were fitted with radiocollars and monitored monthly, we documented mortalities by climbing accidents. None of 54 mortalities in the southeastern region and 53 mortalities in the southwestern region was identified as climbing accidents. However, climbing accidents caused 5 of 42 sheep mortalities in the northwestern region and 4 out of 54 mortalities in the central region. Most climbing accidents (7 out of 9) happened <9 months after sheep were translocated. Our data suggest that translocated desert bighorn sheep can be vulnerable to climbing accidents due to lack of familiarity with local terrain. Differential vulnerability between regions might be related to differences in substrate, ruggedness of terrain, or both at release sites. Additionally, sheep translocated from less rugged terrain might be more likely to fall in new areas than sheep translocated from more rugged terrain.

McNeil, H. J., P. E. Shewen, R. Y. C. Lo, J. A. Conlon, and M. W. Miller. Novel protease produced by a *Pasteurella trehalosi* serotype 10 isolate from a pneumonic bighorn sheep: characteristics and potential relevance to protection. *VETERINARY MICROBIOLOGY* 93(2):145-152.

A strain of *Pasteurella trehalosi* serotype 10, E-CO-100, isolated from a bighorn sheep that had succumbed to pneumonic pasteurellosis during an epizootic, was compared to well-characterized strains of *P. trehalosi* serotype 10 and *Mannheimia haemolytica* serotype 1. The gene for leukotoxin A (*lktA*) from E-CO-100 was sequenced and found to be identical on an amino acid basis to a published sequence for *lktA* from *P. trehalosi* serotype 10. However; the toxic activity in culture supernatant measured over time for E-CO-100 was quite different from reference strains. Typically, the ability of the supernatant to lyse target cells increases over time corresponding to the logarithmic growth of the organism, peaks at mid to late phase, then declines gradually. Supernatant from E-CO-100 exhibited a sharp decline in toxicity after mid-logarithmic growth to undetectable levels. Investigation of this anomaly using a commercial kit with a porcine gelatin/bovine albumin substrate matrix revealed high protease activity in the supernatant of this strain compared to another *P. trehalosi* serotype 10 and to a *M. haemolytica* serotype 1. Protease activity was also visualized using gelatin based zymogram gels. This protease was not substrate specific as it was shown to degrade leukotoxin. Activity was neutralized by bighorn sera in a titratable manner. There was an association between the ability to neutralize protease and low pneumonic lung scores in bighorn sheep experimentally challenged with Ego-100 ($r = 0.5$, $P = 0.1$). This previously unidentified protease may be an important protective antigen in vaccines designed to prevent pneumonic pasteurellosis resulting from *P. trehalosi* in bighorn sheep.

Mooring, M. S., T. A. Fitzpatrick, J. E. Benjamin, I. C. Fraser, T. T. Nishihira, D. D. Reisig, and E. M. Rominger. 2003. Sexual segregation in desert bighorn sheep (*Ovis canadensis mexicana*). *BEHAVIOUR* 140:183-207.

One or several factors could explain sexual segregation, in which males and females of polygynous, sexually dimorphic species form separate herds during most of the year. Bighorn sheep (*Ovis canadensis*) are polygynous ungulates that exhibit extreme sexual dimorphism and segregate into ram and ewe herds outside of the rutting season. Four major hypotheses for sexual segregation were tested in a population of desert bighorn (*O. c. mexicana*) at the Red Rock Wildlife Area, New Mexico, from 1999-2001. We collected data on the size, composition, and location of ram and ewe groups during the summer period of segregation. Activity budgets were recorded for males in ram herds and females in ewe herds, and foraging selectivity was measured for males and females in mixed groups during early rut. Habitat was

evaluated by measuring forage availability, ruggedness, and visibility at sites utilized by ram and ewe groups. Ram herds utilized areas with more available forage compared with ewe sites, while ewe groups preferred more rugged terrain than that used by ram groups. Ewe groups occurred much closer to free water sources than did ram groups. Bighorns in ram and ewe groups did not differ in foraging time or selectivity, nor did time spent moving, reclining, or ruminating differ between the sexes as predicted by the 'activity budget hypothesis'. The results support the predictions of the 'reproductive strategy-predation risk hypothesis', which proposes that males seek more abundant forage in order to build up body condition needed to maximize mating success (even if exposing themselves to greater predation risk), while females choose rugged terrain that minimizes predation risk to themselves and their offspring (even if sacrificing forage abundance). Female bighorns chose sites that provided access to water, also predicted by the 'reproductive strategy-predation risk hypothesis', indicating that lactation-related water requirements may constrain the movements of ewe groups and contribute to patterns of sexual segregation in desert bighorn.

Reale, D. and M. Festa-Bianchet. 2003. Predator-induced natural selection on temperament in bighorn ewes. *ANIMAL BEHAVIOUR* 65:463-470.

Temperament traits in animals may have important fitness consequences, but have received little attention from ecologists or evolutionary biologists. A few studies have linked variation in temperament with fitness, but none has measured selection on temperament traits. We estimated the strength of selection on female boldness and docility on bighorn sheep ewes, *Ovis canadensis*. The Ram Mountain population experienced little predation pressure during the first 25 years of study, then 2 years (1997 and 1998) of frequent predation by cougars, *Puma concolor*, during which adult ewe mortality almost tripled over the long-term average, to 27% a year. During years of high predation, we found moderate selection favouring bold ewes, and age-specific selection on docility. Old ewes appeared more vulnerable to predation than young ewes. In contrast, no evidence of selection on temperament traits was observed during 2 years of low predation (1996 and 1999). These results suggest predator-induced selection favouring bold and nondocile ewes. Leadership was highly correlated with age and may increase the risk of predator encounter. Leadership alone, however, could not explain the higher vulnerability of old ewes to predation. Cougar predation on bighorn sheep occurs sporadically and unpredictably, probably because individual cougars often are prey specialists. Cougar predation may have limited microevolutionary effects on temperament in bighorn sheep, because it mostly affects ewes near the end of their reproductive life span and because of potential countervailing selection on boldness and docility.

Rosas-Rosas, O. C., R. Valdez, L. C. Bender, and D. Daniel. 2003. Food habits of pumas in northwestern Sonora, Mexico. *WILDLIFE SOCIETY BULLETIN* 31(2):528-535.

It is questionable whether food-habits studies of pumas conducted in the southwestern United States can be extrapolated to northwestern Mexico, because of differences in management, distribution, and abundance of wildlife. We determined food habits of pumas (*Puma concolor*) in the Sonoran Desert of northwestern Sonora, Mexico. Based on studies in the western United States, we hypothesized that desert mule deer (*Odocoileus hemionus*) were the major food source of pumas in Sonoran Desert habitats of Mexico. The study area supports populations of desert mule deer, white-tailed deer (*Odocoileus virginianus*), lagomorphs (*Lepus* spp. and *Sylvilagus audubonii*), collared peccary (*Pecari tajacu*), and the largest population (similar to 300 individuals) of desert bighorn sheep (*Ovis canadensis*) in Sonora. Based on pugmark characteristics, we recorded 3 different adult resident pumas in approximately 90 km². We analyzed 60 puma fecal samples collected September 1996–November 1998. Primary prey items based on frequency of occurrence and estimated biomass consumed were desert bighorn sheep (40% and 45%, respectively), lagomorphs (33%, 19%), deer (17%, 17%), and collared peccary (15%, 11%). The high percentage of desert bighorn sheep in puma diets may be due to high abundance relative to mule deer, which declined in number during our study. No differences were found in puma diets between seasons ($\chi^2(2)=2.4526, P=0.2934$). Fluctuations in mule deer populations in northwestern Sonora may influence prey selection by pumas.

Ruckstuhl, K. E., M. Festa-Bianchet, and J. T. Jorgensen. 2003. Bite rates in Rocky Mountain bighorn sheep (*Ovis canadensis*): effects of season, age, sex and reproductive status. *BEHAVIORAL ECOLOGY AND SOCIOBIOLOGY* 54(2):167-173.

We investigated the effects of vegetation biomass, crude protein content of consumed forage, age, sex and reproductive status on bite rates in Rocky Mountain bighorn sheep. We expected higher bite rates and vigilance in lactating females with young and higher bite rates in young growing individuals, than in non-reproducing females or rams. Lactating ewes had higher bite rates than yeld ewes and than subadult or adult rams. Subadult rams had higher bite rates than adult rams or yeld ewes. On recently burned grassland in spring, however, rams had a higher bite rate than adult females, while the contrary was true on control plots and on the burned plots in autumn. Bite rates declined for both ewes and rams from April to September and varied from year to year. While rams of different ages had significantly different bite rates, there was no effect of age on bite rates for ewes. There was no correlation between bite rates and available total biomass or biomass of live vegetation, or the numbers of steps taken while foraging for either ewes or rams. Adult rams had a lower vigilance rate than adult ewes, and vigilance decreased with increasing bite rates for all sheep. Bite rates in bighorn sheep vary greatly according to age, season and vegetation structure. An increase in bite

rates during the forage growing season may compensate for higher energy demands during lactation and growth. There is a potential trade-off between foraging and vigilance as vigilance decreased with increasing bite rates.

Toigo, C. and J. M. Gaillard. 2003. Causes of sex-biased adult survival in ungulates: sexual size dimorphism, mating tactic or environment harshness? *OIKOS* 101(2):376-384.

Using both a conventional and a phylogenetic approach, we tested whether sexual size dimorphism, mating tactic and environmental conditions influenced the between sex differences in adult survival among 26 populations of polygynous ungulates. As a general rule, male survival was both lower and more variable among species than female survival. Whatever the method we used, sexual size dimorphism had no direct influence on male-biased mortality. In food-limited environments, the survival of males relative to that of females was lower than in good environments, suggesting a cost of large size for males facing harsh conditions. On the other hand, the survival of males relative to that of females tended to increase with sexual size dimorphism in good environments, indicating that large size may be profitable for males facing favourable conditions. Lastly, we found that the between-sex differences in adult survival did not vary with sexual size dimorphism in harem-holding or tending species, but tended to increase with sexual size dimorphism in territorial species. Our analyses indicate that sexual size dimorphism does not lead directly to a decrease in male survival compared to that of females. Thus, environmental conditions rather than the species considered could shape between-sex differences in adult survival observed in ungulate populations.

Weiser, G. C., W. J. DeLong, J. L. Paz, B. Shafi, W. J. Price, and A. C. S. Ward. 2003. Characterization of *Pasteurella multocida* associated with pneumonia in bighorn sheep. *JOURNAL OF WILDLIFE DISEASES* 39(3):536-544.

Pasteurella multocida is a highly diverse group of bacteria recognized as important pathogens. Although *P. multocida* is not ordinarily associated with disease in Rocky Mountain bighorn sheep (*Ovis canadensis canadensis*), numerous isolates were cultured in high numbers from free-ranging bighorn sheep in the Hells Canyon area of Idaho, Washington, and Oregon (USA) during the winter of 1995-96. Animals captured in Hells Canyon and held in captivity, and their offspring, also harbored *P. multocida*. Biochemical utilization tests on 90 isolates identified three subspecies: *P. multocida multocida* a (n=54); *P. multocida multocida* b (n=13); and *P. multocida gallicida* (n=15); and a non-specified biotype, U-6 (n=8). Genomic DNA digestion with restriction endonuclease Hha I separated the isolates into 62 unique restriction fragment length polymorphism profiles. Capsular type A was predominant (72% of isolates). Only one isolate type, which may have been transmitted from a feral goat, was capsular type D, possessed the structural gene, *toxA*, for dermonecrotxin detected by polymerase chain reaction, and produced toxin as determined by monoclonal antibody immunoblot. In conclusion, bighorn sheep in this study carried diverse types of generally non-toxicogenic *P. multocida* associated with epizootic pneumonia.

Hope you all have a safe and happy holiday season!!