RANGE, PHYSIOLOGY AND NUTRITION - Chairman: Dr. D. Shackleton

T.G. Baumann and D.R. Stevens - Winter habitat preference of bighorn sheep in the Mummy Range, Colorado.

Ray Demarchi: What happened to the other 4/5ths of your mountain bighorn winter sheep range?

Tim Baumann: Loss to development around the resort community of Estes Park - mainly fencing, grazing by livestock, and human disturbance.

Ray Demarchi: Have you thought about forest succession? All the plant species you mentioned are either fire tolerant or fire dependant.

I think you've done an excellent investigation on the habitat factors, and influence and movements of the bighorn, however, you had also better start looking at the fire dependant plant communities.

Tim Baumann: Colorado State University has begun a study of fires; They have done several experimental burns adjacent to the study area.

M.D. Pitt and B.M. Wikeem - Diet preference of California bighorn sheep on native grassland in south-central British Columbia.

Don Eastman: I am interested in your comments about rough fescue. Are there other plants in those timbered areas for which the sheep did not select?

Mike Pitt: There were other plant species in the understory, primarily Blue bunch. None-the-less they selected fescue in those understory areas more than Blue Bunch. Their preference for rough fescue throughout the first three summer months was approximately 10%, and during August it increased to 20%.

Daryll Hebert: Under captive conditions I found that rough fescue stood out as being equal to alpine or sub-alpine at a time when alpine forage was definitely high in quality. It also seemed to be selected over other plant species that were in the earlier phenological stages and probably of higher nutritional quality.

Mike Pitt: I do not think that animals necessarily select for crude protein, because part of that selection is for pallatability or desirability. Big sage brush is high in crude protein but animals do not select it because of the volatile oils. Blue bunch tends to grow in large bunches with old growth in the way and is not as desirable as selecting a plant that has only fresh green material available. In the early spring on the study site they have grazed it to the ground. On the other hand June grass and Sandberg's blue grass both grow with only green material, there is no old growth in the way. It is partly an availability factor and partly a proportion of old growth to new growth.

Randy Bennett: It looked like some of your plants were being strongly selected for and this should change plant species composition within your paddock. How will this effect your results in future years?

Mike Pitt: Certainly the range this spring is much different than it was last spring; many of the browse species are not available. The real changes in their selectivity and diet patterns will occur later in the year, and I expect they will go the blue bunch.

Randy Bennett: Are you trying to regulate the number of animals in the paddock?

Mike Pitt: Yes, we base our carrying capacity primarily on the amount of grass material, biomass, available. If there are too many animals then they lose selectivity and will have to eat whatever is there.

Bill Wishart: Do the sheep leave seed heads alone?

Mike Pitt: Yes, however, just going to seed will not necessarily guarantee survival of the plants. If they are grazed to the ground they are not going to be able to produce enough new carbohydrates to last the winter in terms of root reserves. Blue bunch is a notoriously low seeder, it happens only rarely or infrequently. With this utilization, even having seed heads will not necessarily ensure survival of these plants.

R. Peterson and A. Bottrell - Normal metabolic profiles of lamb and adult California bighorn sheep

Dave Shackleton: I should point out that the melanin cycle is tied up with adrenalin, and of course that has behavioural connotations. Domestic calves with pink palates show quite marked excitability.

Steve Paul: I question the genetic significance of using those values because I think you are ignoring their clinical significance.

Ray Peterson: All age, sex, season, and interaction effects have been removed from these correlations.

We are trying to isolate what fraction of that difference is genetic and what fraction is environmental. We have labeled all the environmental factors we know at this point.

Jim Bailey: Could you explain to me what an inbreeding coefficient of 40% means. How is that calculated?

Ray Peterson: The inbreeding coefficient is, as Fisher defined it, the correlation between the combining gametes. That means 40% of the genes in that population are identical by descent. One can estimate this based on the number of breeding individuals and using probability theory.

Jim Bailey: You paint a very dismal picture about the possibility of inbreeding yet many examples of successful transplants started from rather small numbers of individuals. How do you rationalize that?

Ray Peterson: It surprised me when I heard recently there was, potentially, an inbreeding coefficient of 40% in a group. All I can say is that two things could be happening. First, the transplant was a fairly diverse group so you had a fairly large sample of genes and your inbreeding would be slower than normal. Or second, perhaps a more logical assumption, the tolerance to inbreeding in bighorn sheep is fairly high and levels can reach 40 or 50% while a certain reproductive vigour is still maintained.

Jim Bailey: Are you saying these populations will grow but, because of genetic effects alone, are doomed to fail?

Ray Peterson: Yes. Assuming that you have got enough food and so forth available, it will reach either a genetic limit, in terms of population size, which could be the inbreeding limit, or they will reach their environment limit.

Jim Bailey: If this population has grown and spread and occupied new areas, I wonder when it will come?

Ray Peterson: If you have crossing between populations, i.e., males from adjacent populations contributing, then of course this has a great deal to do with the level of inbreeding. A female does not make a great deal of difference but a male contributes genetically and produces gametes.

Wayne Heimer: Is there an intergradation as well? You suggested that they might be all black, sort of pink, or really pink.

Ray Peterson: I do not know. I saw only one pink tongue and they accused me of drinking too much beer. If we can get gene frequencies this gives us some handle on what sort of heterozygosity exists, particularly if we have a large number of these markers.

Daryll Hebert: Do you know if there is any information relating susceptibility of disease or parasites to the level on inbreeding in any species?

Ray Peterson: Inheritance of susceptibility to diseases is very hard to measure. You can note with inbreeding a decline in vigor and if you wish to extrapolate that it is also an increase in susceptibility to disease.

Ian Robertson: Are you in a position to say what sort of sampling of a wild herd is going to be necessary to establish inbreeding?

Ray Peterson: I do not think so at this point.

Anonymous: You speculated that in some of these transplants it may take several human generations for us to see a real decline in sheep populations. Can you project for a transplant of one productive male and five females, two or three of which are closely related.

Ray Peterson: If you assume the females are not related to the males then the coefficient relationship between the progeny is .25 - half

sibs; there is no inbreeding at that point. Coefficient of inbreeding at the next level would be about .0625. By the third generation inbreeding will be on the order of about .25 if you close the herd at that point; 25%. Now, that is relative to when you started. Any inbreeding that you had to start with is added on top of that.

Anonymous: It might be possible to have reproductive depression within 10 or 15 years with a small plant?

Ray Peterson: I should think so. It depends on the tolerance of the species.

Anonymous: Is this mechanism for reproductive depression the exposing of homozygous recessive deleterious genes?

Ray Peterson: Yes, quite often. But when you are talking about the genetics of natural populations you are really dealing with it on a level of the tolerance of that species, and the rate of inbreeding expected under given conditions.

Bob Jamieson: Did you look at the managment implications of the research you are doing?

Ray Peterson: I think it will affect management decisions through the selection of the areas from which you selct animals for transplants. It is unlikely that a manager will see an increase in the lamb crop by importing rams or a die-off if inbreeding continues. It is important to determine the level of inbreeding they can attain and still reproduce adequately.

Bob Jamieson: That is only half of it. We have also to know what is the potential for these populations to keep that gene transfer going.

Ray Peterson: The other side of the coin is what rate of inbreeding is consistent with normal reproductive habits.

A. Bottrell, B. Gordy and R. Peterson - Comparisons of chromosome and blood constituents of Rocky Mountain and California bighorn and Dall and Stone thinhorn sheep

Wayne Heimer: I am interested in knowing what the chances are that what you saw in the bighorn might be an abnormality or an artifact, and what are the opportunities for error in a situation like this?

Al Bottrell: There are a lot of opportunities for error, and for determining it . I counted about 200 spreads and in 150 of them they showed the karyotype that I presented there. In other counts the number was less because they spread out and you lose some. That number ---150 out of 200--- is just too high a number, it can not be an artifact.

D.M. Hebert - Blood chemistry as an indicator of nutritional condition in bighorn sheep

Ross Eccles: If the body proteins catabolized during the winter, were they used as an energy source for the animals or were your feed values high enough in caloric value to satisfy them?

Daryll Hebert: I am sure they were being used for energy, and I think that is one reason why that digestible protein/digestible energy variable was relatable to blood urea-nitrogen. I was not making the type of measurements that would indicate how much was being metabolized as an energy source. The energy values that I was measuring were declining, but the gross energy component in the plants remained reasonably high, even during the winter, though that does not mean very much of it was available to the animals.

R.W. Chappel and R.J. Hudson - Prediction of energy expenditures by Rocky Mountain bighorn sheep

Jim Bailey: Could you give me a break-off point on how many miles per hour the wind speed was?

Bob Hudson: The highest wind speed tested was 10-12 m.p.h.

Ross Eccles: Were your coefficients additive? If the animal is subjected to minus 20 degrees and on a certain plan of nutrition, could you just add those?

Bob Hudson: Yes, that is the idea. This M.C.A. is a lot like multiple regression. The only difference is that, instead of using continous variables, they are broken down into discreet catagories which makes it easier for people to evaluate these things in the field. You simply sum them all up.

Rick Ellis: Could it explain things like large population die-offs?

Bob Hudson: I would say no. I would say nutritional factors affecting forage intake from ewe studies would appear to be the really critical thing.

Daryll Hebert: I found that when we had our animals down to about minus 20°F. for two and three week periods there was some attempt to respond with increased food intake, but the quality did not seem to be adequate to allow them to do it. What is the effect on an animal which cannot really respond to alow quality winter diet?

Bob Hudson: This could have serious consequences. Animals pushed into very poor body conditions because of forage quality may not be able to cope with the conditions to which we exposed these ones.

Daryll Hebert: I mentioned the same thing with blood-urea nitrogen: The time period that they spend at any one of these levels over the winter is going to be very important too, not just the fact that they reached it.

As another field technique, how useful do you think things like rectal temperature would be in measuring the time they reached a low level? The pattern that Al (Bottrell) and I found with rectal temperature corresponds with your energy finding.

Bob Hudson: I cannot really comment on that because we did not take consistent measurements throughout. In response to thermal environment, we looked at how it changed as we dropped environmental temperature, but not on a seasonal basis.

Daryll Hebert: Were there attempts to increase feed intake on the quality of diet you were giving them, after you had the animals at various levels at minus 21°(F), minus 30°(F)?

Bob Hudson: In his thesis, Randy (Chappell) had seasonal changes in food intake that showed the normal kind of cycle. I do not think he extracted how intake on any specific day might effect it. From elk studies it is quite clear that they do.

Wayne Heimer: How cold is a cold day on a Bighorn sheep range? Lower than minus 20°(F)?

Bob Hudson: Yes, quite often. Wind speeds are often higher, but associated with warmer temperatures.

Wayne Heimer: From your seasonal data it looks like November to February was the lowest. I am quite concerned about the idea that this energy expenditure during rut could be draining enough that rams may burn themselves out in a short time. Does that relate at all to that hypothesis?

Bob Hudson: We had wondered about this because we expected that rutting rams would have a very high metabolic rate but they did not.