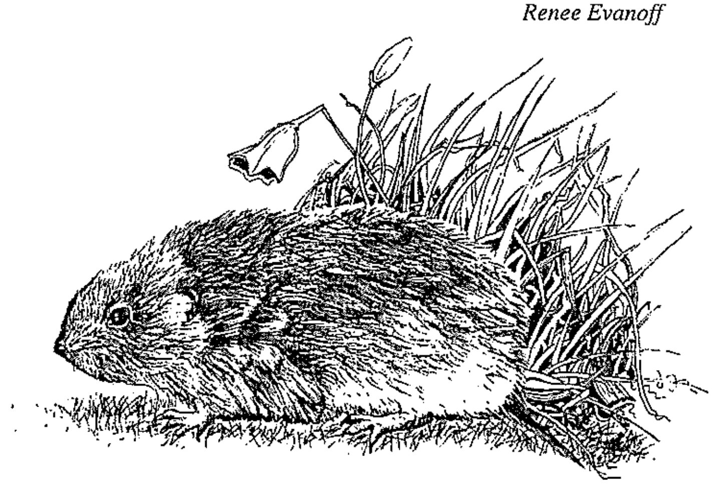
Yellowstone Science Interview:
Elizabeth Barnosky

Renee Evanoff



Confidence in the Past

The practice and potential of wildlife paleoecology in Yellowstone

Until recently, relatively little was known about life in Yellowstone from the end of the last ice age until the arrival of Europeans in the New World. Several studies have been underway in recent years to change that, including Elizabeth Barnosky's paleoecological excavations on Yellowstone's Northern Range. Her first site, now known as Lamar Cave, resulted in an M.S. thesis at Northern Arizona University in 1990. Since then she has continued that work and has added a second site in the Soda Butte drainage. These are the first wildlife-oriented paleoecological studies in the park, and have opened a fascinating window on the region's prehistory. This interview with Liz was conducted in July of 1991, just as she was finishing her excavation of the Soda Butte site. Ed.

Yellowstone Science Caves have a magic that attracts even the layman, but not just any cave will do for your purposes. What kind of things are you looking for when you're trying to find a site that's going to be useful?

Elizabeth Barnosky Deposition and preservation are the two keys. You need a site that has depth, that doesn't just have rock right under it, and that's in a spot that could keep it safe. It's possible to just walk out anywhere and start digging and find some sort of obsidian flake, for example, or some other archeological remains. But a good, useful site is not likely to happen just anywhere, because most places have constant turnover of the top surface of the soil, and you're looking for a place where whatever gets buried stays that way.

Near streams, you look for alluvial deposits, where there have been floods and then the stream has moved and just left its bed covering whatever it covered. Abandoned meanders in a river are perfect places to look. Preservation of animal remains is affected by several factors after they're buried, too. There's soil pH involved, and you don't want a site that's been wet and dry a lot. Now that I know what to look for, I realize how lucky I was; the Lamar Cave turned out to be the perfect little storage unit.

YS But what makes all this possible, all this perfect storage of animal remains, is in fact another animal. I suspect that very few people realize how dependent studies of this sort are on packrats. How do packrats do it? What do they collect? What form do they find it in?

EB Really, I don't know of another way to get this information other than packrats. They are so good at collecting, but there's a lot about packrats that we don't know. The studies that have been done in other parts of the country say that they collect material from within fifty meters of the nest. I don't know why exactly, but they collect a little bit of everything. They collect many forms of vegetation, including sticks and cones. They collect scats, and this is where you get into the mammal remains--from carnivores, raptor pellets, bones, hair from carcasses, and so on. They collect tinfoil and anything that wasn't covered up and nailed down. They collect string I've put around the pit to identify the levels of excavation. They chewed on all my little canvas storage bags.

YS Any theories on why they do it?

EB No one is really sure. I think all these little things they do are geared toward protection of their nest. Having talked with packrat researchers, my guess is that when they take these scats and pellets they're collecting smells. What limits the distribution of most small mammals is the vegetation they need, but what limits pack rats isn't so much vegetation type as suitable nesting site. You have to look in the right spots for them, and where you find them doesn't seem to have much to do with the vegetation nearby. It has to do with the quality of their little cave and being near a cliff or a relatively inaccessible spot. It's their nesting sites that matter most to them.

YS So when they collect stuff, they're taking away things that they identify as some competitor's attempt to take over that territory?

EB Maybe. They might also be collecting scents so that if a predator were to come into their cave it would leave because it smelled another predator. That's one guess. Obviously, they're getting food, too. They chew on the bigger bones that they collect, and I've heard them gnawing on antlers when I've been working in the cave. They clip vegetation and bring willows in.

YS How big an object can they haul? They're not going to bring in an elk legbone.

EB No, but they can bring in a coyote legbone.

YS Does that introduce a bias against the biggest animals making it into the cave sample?

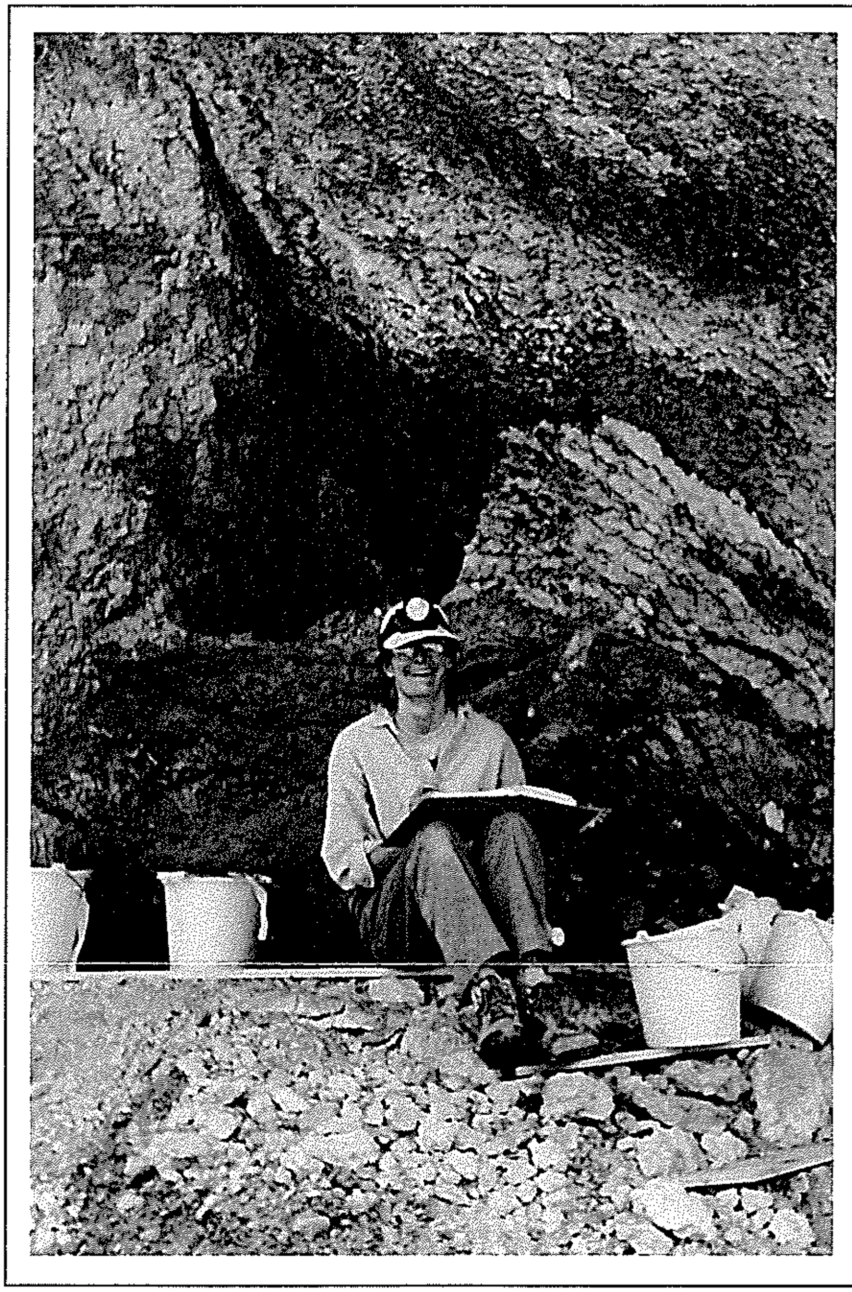
EB Yes, but Lamar Cave has been a carnivore den too, so the carnivores themselves will bring in big leg bones. But even at that, preservation in Lamar Cave has been against the survival of really big bones. One reason is that the big bones last longer as exposed objects. They're harder to cover up. If a coyote wandered into the cave and saw a fifty-year old piece of a femur sticking up through all this duff and organic stuff, he could pick it up and haul it out. A tiny mouse femur, on the other hand, is going to get buried with the first batch of vegetation that is laid on top of it. Plus, the packrats and the carnivores gnaw on the big bones and break them up. And so in Lamar Cave there are lot of big bones, but they're in little pieces.

YS You're mostly working with skulls?

EB Teeth. With the larger animals, I identify every single thing I can, because how often do you see a coyote dragging an elk's skull? That's not a part of the elk's body that most carnivores like to drag around, and so teeth of ungulates are not as easily deposited, although there are certainly teeth from large mammals in the cave, including elk, bison, deer, and sheep. We also have a lot of ungulate feet bones and leg bones. I can identify maybe one in twenty of the large mammal bone fragments, maybe even less than that. We count all these shards, and we know they come from large animals, anything from a coyote to a bison, and we often don't know which one. There may be ways to figure that out. There may be some way of looking at the DNA. The stuff in Lamar Cave is so young it's not fossilized.

YS Of course what has gotten a lot of attention in your findings have been the controversial animals, especially elk and wolves. There has been a "common knowledge" perspective for many years that elk and wolves weren't native to Yellowstone, and your study shows otherwise. But that isn't the primary focus for your study. Can you describe your focus?

EB First I'll tell you the reason why elk and wolves aren't my focus. There was no scientific reason for questioning whether or not elk and wolves were present here prehistorically. It's just obvious that it's not a scientifically valid question in terms of pure paleontology. It would never occur to a paleontologist that elk weren't here. Elk are doing fine here now, and there's been no major change that would suggest that suddenly this has become an optimal place for them. When you start looking at extinctions or exclusions of these big mammals, you have to go back 14,000 years to look at a time period that is really different from today, when you might add new large members of fauna



Opposite: the distribution of prairie vole remains in Lamar Cave reveal climate changes over the past 1,500 years. Above: Elizabeth Barnosky at her Soda Butte site.

Analysis of paleontological evidence from a site requires sifting hundreds of bucketloads of soil, layer by layer, through progressively finer screens in search of small fragments of teeth and bone. All material is then bagged and catalogued for later examination.

to the mammalian community, or subtract them. So it's kind of intuitively sensible that they were present. Every time I've tried to incorporate elk or wolves into a presentation to a scientific audience that's not really even aware of the controversy here, they just think I'm wasting my breath. They don't doubt the animals were here.

For paleoecologists, there are much more interesting questions about Lamar Cave. It has an unusual time scale. It's not quite paleontology in some people's eyes because it's so young, and it's not quite biology in other people's eyes because it's so old. Yet it is both. It tells both disciplines a lot that other studies of other ages won't tell them. A paleontological site that is really young like this is fascinating because it tells us about more subtle changes than you could recognize in an older site that lasted over a longer period of time. It tells us a lot more about the perspective of the hundred-year changes that we're used to historically.

Packrats make it exciting too, because it's a short-term time scale, and the packrats still live in there. They run over my back when I'm excavating. They steal my things. I just love that, that they're still there, collecting. When I go back on Monday and look at this new pit, it's going to be covered with vegetation. You can still see it happening. It's just fascinating. It's not like something long dead, an animal that you have to imagine what it looked like and how it moved.

YS You mean like studying dinosaurs.

EB Right. That's a different area of fascination. Lamar Cave shows us a process that is still going on. It's really easy for me to imagine 2,000 years.

After the winter of 1988-1989, there were two winter-killed elk carcasses within a hundred meters of the cave. That summer, two packrat nests in Lamar Cave were made out of elk hair. You can watch the carcasses fade, you can watch the skeletons start to stand out, and you can watch the bones accumulate in the cave. You can see it all still happening.

YS Half the fun of your "detective work" in sorting out what has gone on around Lamar Cave the past couple thousand years must be in trying to sort out how the material got into the cave. Tell me about taphonomic bias.

EB This is a big question for paleontologists. How do you do a valid census of what lives in an area today? There are so many biases in small-mammal trapping. Some small mammals love the trap, some of them are trap shy. Some of them are only trapped at certain times. Some are nocturnal, some are diurnal. How do you capture everything that uses this little system? How long do you have to stand there to watch a grizzly bear go by? I think that Lamar Cave, with its packrats and carnivores gathering bones, does a better job of collecting a representative sample than we can. If you're out there and you're in abundance, you're going to get eaten. And if you get eaten around Lamar Cave, you're going to get put into Lamar Cave.

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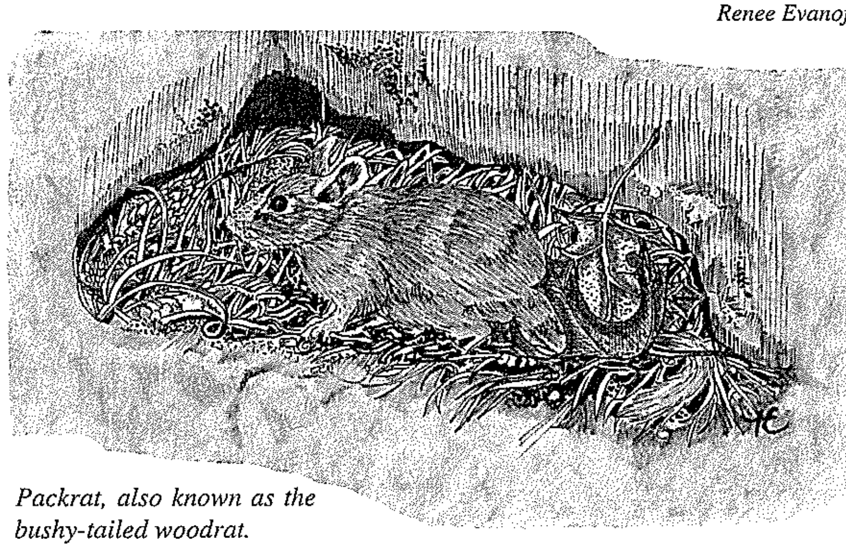


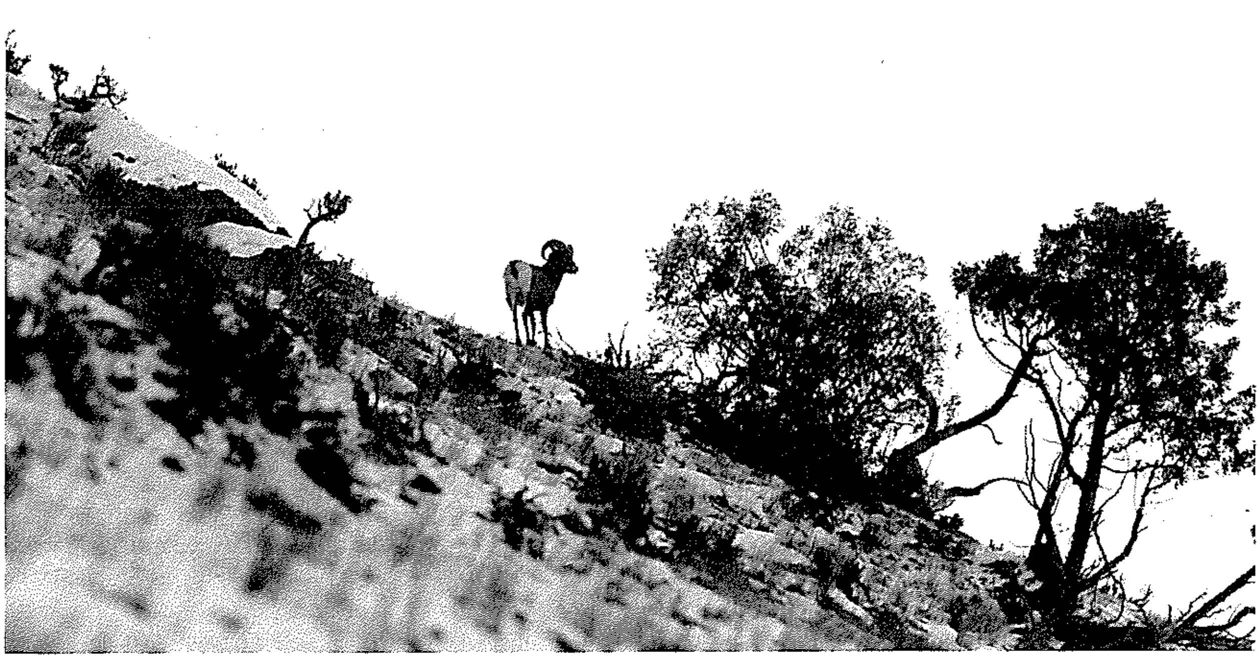
Packrat, also known as the bushy-tailed woodrat.

Taphonomy is the study of what happens to an animal after it dies until it's uncovered by someone, so the taphonomic bias is really important. At Lamar Cave, we're lucky because there are not a lot of things that happened to the remains after the animal died. Maybe it was preyed upon, or maybe it just died of starvation or freezing or whatever, then the bones were brought in to the cave by a packrat or a coyote or a wolf. Then the only thing that happened to it was that the packrats gnawed on it or a coyote broke it up or chewed on it. Maybe a fire came in and burnt it. Then it got buried by the periodic layering of sediments on the cave floor, and nothing else happened to it. So there's not a lot of disturbance, what is called bioturbation in this case, once it's finally buried in Lamar Cave.

But taphonomic bias is complex. Let's say that packrats range 100 meters from their nest. Does that mean that all these things that we find in the cave were collected within 100 meters? No. How far are coyotes and hawks and owls going to range to get the food that will make up their scats? Raptors can range pretty far. They produce pellets about every 24 hours, and so the pellets reflect where they've gone in a day.

My conclusion in my thesis was that practically everything I find in the cave came from within something like five miles of it. Three miles is about the daily home range size of a coyote, you know, kind of zigzagging and walking all around. Certainly raptors can fly great straight-line distances, but in watching the raptors out in the Lamar Valley, which is so big and wide, I saw that they tend to swoop down and capture something and then perch. Ravens and some of the hawks will sit on those big glacial boulders and isolated Douglas-firs.

I don't really know how far they all go, but there aren't extraneous animals



represented in Lamar Cave material to suggest that these bones are coming from any great distance like 50 miles away.

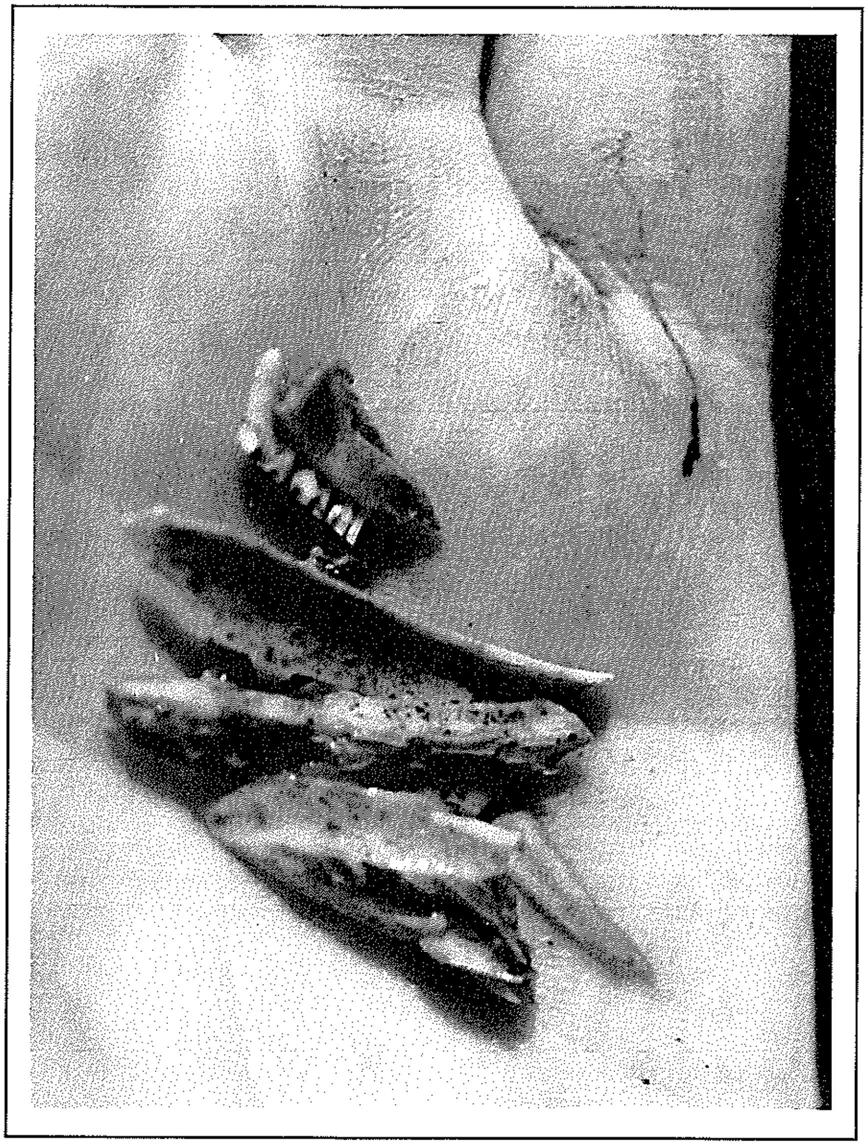
YS So perhaps the big question is, how much paleoecology can tell us? How does it radiate out from the bones you find to a portrait of what Yellowstone was like? Yellowstone is currently hosting several paleontological projects, including Cathy Whitlock's (*University of Oregon--Ed.*) studies of the pollen record in lakes and Grant Meyer's (*University of New Mexico*) dating of the fire record in alluvial deposits. It appears that you and your scientific colleagues are writing a whole new prehistoric biography of the region.

EB One thing you have to remember when you look at the records of the past is that they don't answer your questions exactly the way you want them answered. For example, the small mammals indirectly answer questions about the climate because there are direct effects of climate on animals. Usually, something like climate affects the vegetation first, and then the effect appears in the animals. But the process of understanding what happened by analyzing animal remains is still very interpretive.

For example, in the remains in Lamar Cave, there is a time period that appears to have been effectively drier, but I can't say for sure that it didn't rain just as much then. Maybe the amount of rain was the same but the average temperature was higher so that the moisture got used up faster, giving the effect of it being drier.

In some cases there is no way to answer questions like that with just the mammal evidence. But when you combine different paleo studies, you come closer to being able to answer those questions better. Interdisciplinary studies approach similar questions but from different angles.

Grant is finding periods of change that relate exactly to at least two time periods at Lamar Cave, one being the effectively drier period, and one the effectively wetter period. All this evidence makes you realize how broad-ranging the effects of a climatic change may be. Even if it's significant enough so that there's just a little more grass out there, what does that mean for the ecosystem? That's what Cathy's pollen studies can get at.



A palmful of paleontological clues, small bones and fragments (including an unidentified rodent jaw with a few teeth), freshly screened from the Lamar Cave site in northern Yellowstone.

YS The public conception of how changes happen is perhaps subconsciously based on their own life span. To most people, their life span meets their definition of a long time. But the hard lesson here in Yellowstone is that European Americans have only been active here for less than two centuries, and we've only got written records for a little more than a century, and that's not enough to tell us much about how these systems work. It just seems like that's hard for people to grasp.

EB Having a longer-term perspective of the past is really essential. When I hear someone say that the winters were a lot harsher when their grandparents were alive, and they had a lot more snow, or even if they say that things have changed a lot in the past ten years, it makes me realize that we don't have any idea where we're going. People are always trying to find some kind of order in the world so that they feel confident about the future. My confidence comes from just seeing what happened in the past.

YS So, what can the small mammals at your two sites tell you about change in the past?

EB I used the small mammal bones to look at how the relative abundance of these small mammals changed. In the Lamar Cave, it's so interesting because it's so easy to see, and because it relates so directly to how the animals live.

The ground squirrels, the ones that make the kamikaze dashes across the road in front of our cars, prefer to live in grasslands, and they like to be able to see. The reason they like to be able to see is that their social organization is such that that's how they protect themselves. They have a watchdog who is always whistling at you when you come too close; they depend on that social organization to protect their community. They burrow underground to escape from predators.

Voles, on the other hand, don't live in those tightly knit social communities. They need dense grasslands because they build grass-lined runways that hide them from predators. So if you suddenly put voles in very open grasslands, they're exposed and they run all over looking for cover because that's how they protect themselves. They live above ground and they don't have burrows like the ground squirrels do.

And so, even without looking at what these two species eat, just looking at their habitat preferences based on protecting themselves from predation, it's clear they thrive best in different microhabitats. The bones in Lamar Cave tell us that 1,000 years ago there were a lot more ground squirrels relative to the vole, and 1,500 years ago voles were more common than ground squirrels. Based on what we know about the habitat preferences of the two species, I concluded that 1,500 years ago it was wetter and 1,000 years ago it was drier.

There are still other questions, though; I'd like to understand a little bit more about how specific the various small mammals are to the habitat. Some of them aren't at all. Deer mice don't care where they are.

YS Is your new site aimed at helping you do that?

EB It is. My new site is in a different macrohabitat, in a forest. That's going to tell me about the big scale, of why are they different or if they're different. And so far I think they certainly are. But then within those two sites, small-mammal grids incorporate lots of different microhabitats. Both Lamar Cave and the new Soda Butte site have small mammal trapping studies going on.

YS The effect of those studies will be to give you a current check on how things are going for the small mammals, right?

EB Yes, there are many small habitats nearby, and so there are different scales in the study of this site from the Lamar Cave site.

This brought up some interesting questions. Is the Soda Butte site going to give us a different set of animals, that is a different assortment, in the forest around it than in the sagebrush-grasslands around Lamar Cave, several miles away? It's an important test of the precision of the study of paleoecology in Yellowstone.

YS Well? How does it look so far?

EB From the first go-round, the two sites have very different percentages of animals. We hardly had any rabbits or hares at Lamar Cave, but virtually every level at Soda Butte has rabbits and hares and pikas. It looks like the remains in the cave really are representing the areas and habitats nearby.

In paleontology it's easy to assume that what you find in a site is what was common in the region around it. But here in Yellowstone we have two sites less than 20 miles apart, probably about the same age. And yet they tell us very different things about what animals lived here. The sites really do tell you what was in the site's locality, rather than in the larger region.

The findings at Lamar Cave have been reported in Elizabeth Hadly's M.S. thesis, "Late Holocene Mammalian Fauna of Lamar Cave and its Implications for Ecosystem Dynamics in Yellowstone National Park, Wyoming," Northern Arizona University, 1990.