Chapter 6

Archiving the Future (Keynote Address)

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I think the whole concept of a keynote speech is a fairly interesting idea. Certainly at this late hour in this whole array of listening to papers and everything, I know you're tired. They've given me this little thing that says, "keynote speaker," and every one of you, I know, have looked at me several times and thought, "Keep it short, Bucko." And then I chose a title that says, "Archiving the future." Well, if you're into words you know that "archive" is a noun and not a verb. But when we finish, it will be a verb, because it is an active process. And I don't know if you noticed or not, but there were at least two times in these meetings when it was used as a verb.

I should start off by saying that a keynote talk should be several things. It should set the tone; it should be entertaining, certainly if people have had alcohol it certainly should be entertaining; and it certainly should be short. I hope that I will be able to do that. This is a really tough talk to give; it's from my former life. I need to bring some ideas together for you and I hope that you will work with me in developing these ideas because I want to talk about where science has gone. I want to talk about some of the good and some of the bad. I hope I don't burden you too much. I'll try to make it all very simplistic and not in any real details, but if you'll work with me on that, then we'll get to the crown jewel and talk about the Guadalupe Mountains, and we will try to keep it short.

I should tell you that all the things we do at Texas Tech we do as a team. There is very little honor and award for individuals. We work together, and there are a lot of people that have done lots of things. Some of the names that I should mention are Clyde Jones, Kelly Allen, Richard Monk, Anton Nekrutenko, and a whole bunch of other people. I'll be showing some slides of individuals and bring them up as we go along. I love working with other people. I got to thinking about this one day. There are only about 10 papers in my life that I've published by myself. I've only done one thing in my life by myself, and I was wishing somebody else was there, so I know I'm a people person.

I first visited the Guadalupe Mountains in 1968. I cannot find my field notes; we're actually in the process of redoing the building and moving things, so I couldn't find my field notes. But, the first time I climbed up to the Bowl I struggled through the whole idea of finding who could give me permission to go up there. We went up to the Bowl and we stretched the net over this [place], and there were a lot of things that happened that day. I was the same age at that time as the Guadalupe Mountains are today; I was 25 years old. At that time, most of you people, a lot of you people are much younger, and you don't understand how that everything hadn't been on TV at that time. Now when you try to be an educator, everything has already been on TV. They've seen desert-mountain bighorns fight; they've seen lions kill; they've seen everything. There is nothing that hasn't been portrayed on TV. We climbed up there, and we got there late in the afternoon, and two bull elk started bugling at each other. They came down out of the hills breaking trees; this was serious fighting. They came down and they locked horns and they put on one of the most magnificent

fights I've ever seen. We were probably about 50 or 60 meters away, and Jim Bull, who is now a professor at the University of Texas at Austin, and I sat there with our mouths open. And there was another little interesting thing about this. There was a little fork-horn that was there with them, and these two big bulls were just knocking the daylights out of each other. This little fork-horn was running around and then it'd leap, then it would run around one side and it'd leap, then it would run around…, and you could just see it saying, "Some day, someday, I'm going to be there and I'm going to be doing this." Of course, they didn't pay any attention to that so they went on about their business. But that was my first. Jan, you asked us to talk about—and that won't be the last time she asks us to talk about—our first experiences or our best experiences in the park.

"Archiving the future"—archive is a noun and it means to hold in trust, so I want to talk about the concept of holding things in trust and where the scientific and the conservation communities associated with this are going. When we published the first *Biological Investigations of the Guadalupe Mountians*, Hugh Genoways and I were very young and we struggled to get this done. I read through it the other day when we reprinted it, or read most of it, and I was pleasantly surprised that there was an awful lot of good work done there. We did the mammal survey, and I want to impress you with where all there are collecting sites. I didn't go to all the collecting sites but I do think we actually earned our spurs for visiting the Guadalupe Mountains. There are a lot of voucher specimens that are in the archives at Texas Tech.

Figures 1-3 are diagrams out of David Schmidly's book, *The Mammals of Texas*, and I want you to look at what this really means about the critical aspect here of this fauna. If you look at the total volume of land that is in these various regions, the post oak savannah, the pineywoods, and then you look over at the extreme right up at the top, the Trans-Pecos of Texas, there are almost 90 species of the mammals that are

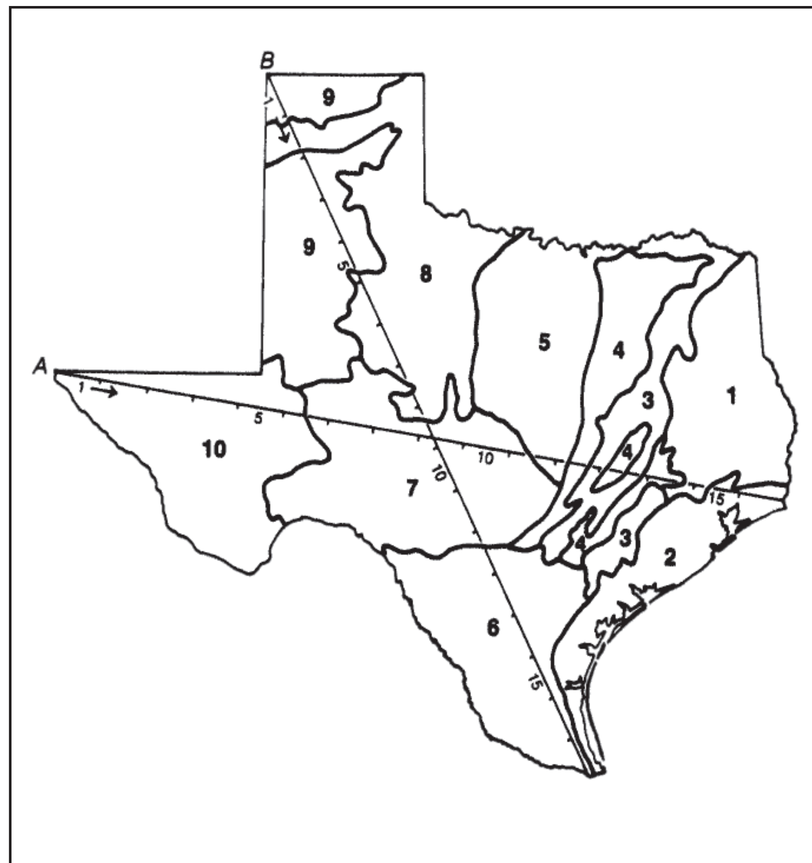

Figure 1. Map of Texas shows major vegetative regions and the location of two transects along which species diversity was analyzed. Transect A stretches from El Paso to Beaumont; Transect B stretches from Dalhart to Brownsville. 1=Pineywoods, 2=Gulf Prairies and Marshes, 3=Post Oak Savannah, 4=Blackland Prairies, 5=Cross Timbers and Prairies, 6=South Texas Plains, 7=Edwards Plateau, 8=Rolling Plains, 9=High Plains, 10=Trans-Pecos, Mountains and Basins. (From *Mammals of Texas* by David J. Schmidly, 1962. Map according to Gould, "Texas Plants: A Checklist and Ecological Summary." Texas Agricultural Experiment Station, MP-585. Used by permission of Texas Parks and Wildlife Press.)

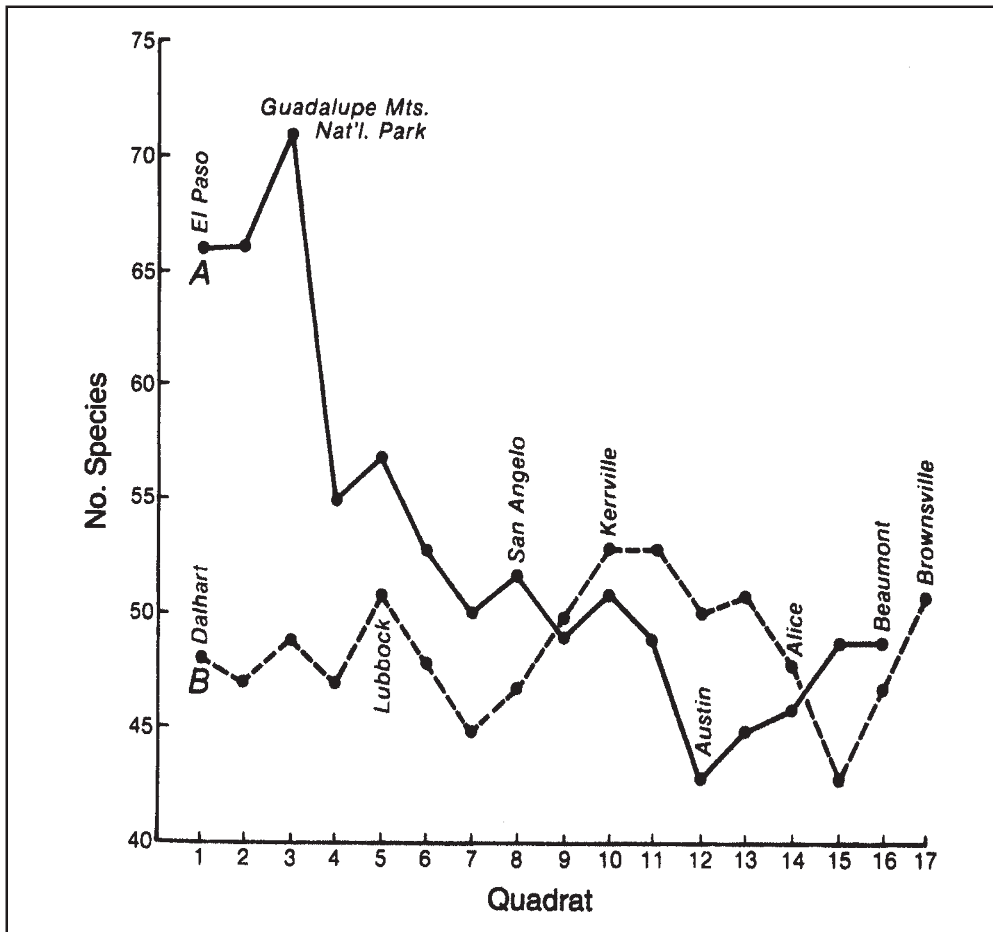

Figure 2. Species diversity plots for the quadrants along the two transects (A and B) shown in Figure 1. (From *Mammals of Texas* by David J. Schmidly. Used by permission of Texas Parks and Wildlife Press.)

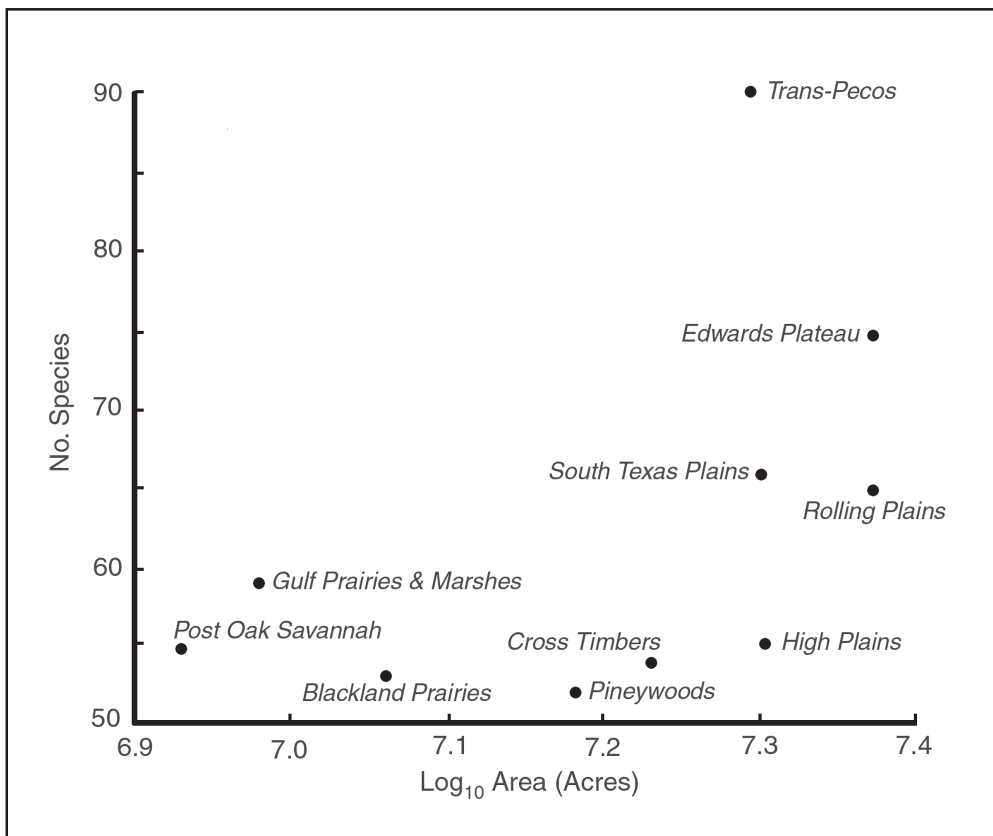

Figure 3. Plot shows the number of species versus the area for each of the vegetative regions of Texas shown in Figure 1. (From *Mammals of Texas* by David J. Schmidly. Used by permission of Texas Parks and Wildlife Press.)

known from Texas, more than half are known from the Trans-Pecos of Texas. The Guadalupe Mountains mammal survey that we did revealed that there are 65 species recorded from the Guadalupe Mountains in the last 150 years, and nine of those have been extirpated. They did not exist at the park at the time that Hugh and I finished our work. I do think prairie dogs should be introduced into Dog Canyon. *Chaetodipus*, a pocket mouse, is a small thing, but it was probably overgrazing that caused this animal to become extinct and we do believe that it doesn't exist here anymore. The wolf has gone, but there is some effort to reintroduce it. The grizzly bear is not going to be back. I doubt we're going to get it back anytime soon. Merriam's elk is an awesome animal. We need to know, "How different was Merriam's elk?" We have elk back here, but they aren't Merriam's elk—that's a biological entity and we really need to know how different that is, and I would certainly like to try to do some of that work sometime. White-tailed deer—I talked to Fred the other day and he does not think it's moved back in. *Antilocapra* was devastated across the whole United States and there are very, very small groups left. Bison—what can I say, bison is making a comeback but the [natural activity of] bison is gone, and *Ovis canadensis*, the desert bighorn. I want you to look at that and think about with me for just a moment what that means for the ecosystem. You're taking nine major [animals out of the ecosystem] with a couple of exceptions. The only animal that doesn't impact the ecosystem in a great fashion is *Chaetodipus*, and it may be really important, too. It has little pouches in its cheeks and carries things around and buries them, and it may really be critical to the survival of certain kinds of ecosystems. So this is a very significant loss, and it's not likely to be fixed anytime soon.

I want to talk for a minute about some of the changes that have taken place. We archived a lot of voucher specimens from here, and those are available to the scientific community. It's really important that we document what was there. Robert Baker may not be able to correctly identify specimens, and whether or not I did, if we leave a specimen there for these people to look at [we have an invaluable record]. We've looked at some of the other Bailey stuff, and so forth. But it really is important and it's going to become [more so in the future]. I'm going to build a case, but it's only [a] beginning. Our mammal collection at Tech, when I got there had about 5,000 specimens, now it has somewhere around 76,000, representing 20 orders of mammals, 94 families, 478 genera, and almost 1,100 species, and they come from all over the world. But certainly, one of our best representations is from the Guadalupe Mountains. Most of them are in [museum storage] cases, and Tech does have a very real commitment to the museum concept. They have a very real commitment to saving the museum stuff. In fact, there are a lot of collections that are being abandoned, and we're working toward being able to take those abandoned collections and to protect and save them for future scientists because we shouldn't lose sight of the fact that this is our record. These are our baseline data.

Another thing we've done is go to the concept of bar codes. When we go to the field now, we do one of two things. We either punch data into a computer—we don't write on any tags, we simply take a computer or we take one hard copy when it's back and we type from that one hard copy—or we simply download global positioning coordinates, and we take photographs. There's a higher standard now. When we get back, we catalog. We simply push a button and it catalogs all those specimens, and we can catalog a thousand specimens with the push of a button. It prints out all the information that goes on the tag. No longer do you have guys writing in there in ways you can't read. All of that is printed out and goes on the tag in a [legible] fashion. We can print out a field catalog; we can print out a catalog for the museum; we can print out a catalog of all frozen tissues. All of that now is pulled together, and we think it has reduced our error rate tremendously. The young man who did this is on our staff, his name is Richard Monk, and he has

done an outstanding job. We were trying to do bar codes about 10 years ago, but it was just not the right time. All of these things have a time and place. Right now we're just about where Albertson's and United Supermarket are. I don't know whether I ought to feel secure or whether I ought to be asking why we are so far behind. But, basically what we do is, when we make a loan, we now go out and read the bar code and it prints out what goes on the loan sheet. So no longer is there all this tedium and so forth that goes along with it.

We also save frozen tissues. I want to tell you how important all these things are. We've talked tonight already about libraries, and these are absolute libraries. When we collect a mouse or a bat or a grizzly bear, or whatever you can get your hands on, we save those tissues. We literally save liver and heart and kidney and lung and blood and muscle and everything else that we can save. The reason you do that is every one of those is an absolute wealth of information. Every one of those is a library. Every one of those has all the information about the history of life and the DNA code. There are pieces of DNA in there that unite all of life together, us with arche-bacteria. There are pieces of stuff in there that identify every individual as being totally unique, and we can pull that out and read it now; the book is readable. You also can do systematics; you can do toxicology—how much genetic change has been induced by whatever that mouse had in the way of exposure to toxins. You can do forensics. You can tell something about the animal, where it was from. You can tell multiple paternity, whether or not this pregnant female animal had multiple males inseminating the litter. Medicine—There are genes in there that can be pulled out that are going to be used in making trans-genics. There's disease—hantavirus and all the other diseases that we can look at and see whatever. Right now, the problem is that we just don't have the imagination. The technology has gone far enough and soon it's going to go a lot further and those things are going to be absolutely powerful in helping us make management decisions. Agriculture—Genes are going to be brought out for trans-genic things. Recreating history—There are a lot of things from these animals you're going to be able to do, to recreate a lot of events in history. And then all the other things that I haven't managed to think of yet. Maybe somebody will. We keep all these things in liquid nitrogen. We have a facility where we have 10 ultracolds [refrigerators], and there are back-up ultracolds that aren't plugged in [so] if an ultracold goes down [it can be replaced]. Somebody walks through the building every day; somebody deals with it.

The program is a very international program. We work with Ukrainian, Canadian, and Mexican scientists, and most of our work today deals with international issues, not just simple things. Our frozen tissue collection holds tissue from about 26,000 specimens from 16 orders and 61 families. That's a lot of collecting and saving and a lot of people have spent a lot of time doing it. We have things like wooly mammoth. We were able to get something out of an American wooly mammoth up in the Arctic. We've got gorillas and whooping cranes and all other kinds of endangered species and animals from Chernobyl, Texas resources, and all kinds of baseline data.

We've done a lot of work at Chernobyl. Chernobyl is a very fascinating place. There is a lot of biology to be learned at Chernobyl, and our question, our research effort there is, "what are the biological consequences of this?" The truth is that [the] Chernobyl [nuclear accident] is not as detrimental to life as is normal human activity where there is no contamination. In other words, we went in, we set up grids, and we found the most radioactive spot. This was the ultimate search. Where is there more radioactivity than anywhere else on the face of the earth? It's actually not at Chernobyl; it's at a place called Chelyabinsk in Russia, Siberia. So we went to this place, and we set out the grids, and there's more life because there is no over-grazing or over-farming, and the habitat is deep and good. There are more mice per trap-night there and

there is no species of mammal missing. If you were to drive through there, you would see more moose and more roe deer and more Russian wild boar and more foxes and rabbits and everything than you would ever see out where normal people live and they farm and they take care of things. We've written a paper, although no one is really happy about publishing it. It's called, "How to create a wildlife preserve: the world's worst nuclear power plant disaster." In reality, we found a hawk's nest on the ground where the Geiger counter was essentially pegged, and they were hatching on the ground, and we cannot find any evidence of radiation that is doing anything that we can detect and show as effect. There are no monsters. The whole ordeal is blown out of proportion. I'm not telling you that it's not bad. I wouldn't want my kid sleeping on the ground over there. I'm just telling you that it's not as bad. If my kid had to sleep on the ground or smoke, I'd probably let him go there before I'd let him smoke cigarettes.

Here is how we use this. Terry Yates is at the University of New Mexico. He's one of my Ph.D. students. When the Four Corners disease came out, there was a big newspaper release of stories saying that this is probably just a military biological warfare agent that's available and has been turned loose and escaped. What we did is, we took all the *Peromyscus maniculatus* we had in his collection and in our collection—his collection is New Mexico—and we sent them off to CDC, and this was all the stuff that was collected long before the Four Corners disease was described. We could show that this was not something from the military. It was a disease that had killed people in the past, but we just didn't have the medical skills to recognize it. It wasn't in the multiple choice answers that physicians have for, "this is what you died with." So they [said the patient] died with a respiratory ailment.

I have this obsession with collecting. I love animals, but people often ask me, "Do you ever feel guilty?" Let me tell you a story about the time I got talked into not keeping something, and I really regretted it. We took a mammalogy field trip to a place that I owned and there were about 1,000 thousand-pound bales of hay, and it had been there for a couple of years. We were taking a tractor and driving up and picking up those bales and shaking those bales and the mice would just rain out! There was *Peromyscus* and all kind of things. This was mammalogy! We were talking today about how these people love their work, and I'm telling you, this was a party! So, everybody is diving under these bales and catching all these mice, and we took several hundred, maybe thousands, and we brought enough back that each mammalogy student could prepare two specimens. I took them over to the collection and the curator, the assistant that I had then, said, "Robert, we've got"—obviously we've got a lot of *P. maniculatus*—"too many *P. maniculatus* already. Why don't you just not save those things?" I struggled with that, and we saved 10. That was before hantavirus showed up. Once when hantavirus showed up, then the question was—nobody [from that collecting trip] got sick—"In breathing all that mouse excrement and hay and everything else, did these people not catch hantavirus because the mice were not carrying the disease or did they not catch it because it is hard to transmit to people?" The answer was very simple. Six of the 10 mice we saved had hantavirus, had active infections. Today, if we took a class out and did that, and somebody got sick, we'd be sued for a billion dollars; and probably appropriately so. But at that time, we didn't know that and mammalogy was an art form. That was meaningful information. I only wish I'd have saved 20, or 30, or 40, or all the ones that were prepared by those students.

We have a contract with Texas Parks and Wildlife that is funded by the state legislature. What we are supposed to do between now and the year 2000, is to visit all the land that is controlled by Texas Parks and Wildlife. We are to collect and present them with a record of what's there—UTM coordinates and photographs of all the taxa—and we're supposed to save these livers, kidneys, hearts, lungs, and everything else and

archive them. The person that's actually doing most of the work is Robert Bradley and he's doing a great job. The other person who is playing a role in all this is Nick Parker. He's always up in the air about something, so I'll have to give him some credit. And, of course, David Schmidly, who we're recycling from Texas A&M. We're certainly glad he's a vice-president at Tech now.

The kind of data we're pulling together gives you a new view. This is something that Kelly Allen did. Today, Nick Parker was pointing out how the habitat is very restricted for *Peromyscus truei* in the Panhandle, and they live on the very steep sides of the canyons there. But more importantly, the Guadalupe Mountains animals, habitat-wise, are absolutely different than the animals up there. Now what that usually means is that you don't have the same species. So what we need to do, we need to pick up on these kinds of things, and probably when it's all said and done, *Peromyscus truei* in the Texas Panhandle will not be recognized as the same species. This is the kind of thing you get from Texas GAP and from doing those kind of animal associations with habitat, but we can test it; we can work on that.

We are committed to putting all the material that we can on the World Wide Web to deal with students. I have an 11-year- old son, and he's a computer nerd. I try to break his arms and everything whenever he goes in there, but so far I haven't been able to keep him away from it. When he was eight-years old, I picked him up from school one day and I asked, "Bobby, do you have any homework?" And he said, "Yes, sir, I do." And I asked him, "Well, what is it?" And he said, "I'm supposed to compare and contrast the public policy and positions of Bill Clinton and Newt Gingrich." And I said, "Just where are you going to find that?" And he said, "Oh, I'll just get it off the Web." So I thought, "I'll just go watch," and I did. My son went in there and he started clicking through this thing, and he started pulling all these things up that Newt Gingrich had said and that Bill Clinton had said. He started highlighting and pasting, and when he walked out of there he had a one-page statement on each of those and would be able to articulate it. I thought, "Holy cow!" We're missing something here. If that kid can go do that, we need to figure out, to get those children using, studying biology, and looking at all the agendas that we have.

The problem is that no longer are the students, the young people, involved outdoors. They're living in cities; there's more and more urbanization, and there's less and less opportunity to interact with nature. We need to fix it so they can interact with nature and they can see the Guadalupe Mountains and all of these things. So, we are about this [work]. We've set about to fix all this. We have *The Mammals of Texas* on the Web, on our home page, and so does Texas Parks and Wildlife. We work with them and when we get one of those things finished we put it on [the Web]. They actually own the copyright, so we have to play on their team, so I won't sound too magnanimous.

One of the things that's going to be exciting is that David Schmidly has looked at every [mammal] specimen that has been collected from the State of Texas, in any museum, anywhere. He said, "I didn't get them all right, I'm sure, but I got most of them right." I would bet money that, absolutely, he got most of them right. Some of the things that are at the Smithsonian, from that 1880 to 1905 (or 1903) biological survey of the State of Texas, are about 1,500 photographs that were made around 1900. Some of them were made by A. H. Howe, and you mammalogists know who that is. Unfortunately, we [at Tech] only have six that are from the Guadalupe Mountains, from Upper Dog Canyon, but there may be a substantial number more. Our plan is to have this so that everybody in the State of Texas can simply go on [the Web] and they can interface them by going to any county, or wherever they are, click on that, and have a list of all the photographs, then be able to pull them up. We hope to be able to go back and get as close as we can to UTM coordinates and other ways to let people be able to look at them. This is part of our

history, and having that available, I think, will entertain a lot of people, a lot of ranchers, a lot of naturalists, and a lot of children as well.

One of the things that always worries me is I'm always saying, "Why are we doing this? Who called this meeting? What's the goal here? Where are we trying to get from this point?" I think one of the goals is to get scientists to communicate with each other to make information available. One of the goals is to communicate and have successful communication.

This is what Larry Henderson wrote in the introduction, "…preservation of outstanding ecological, scenic, cultural and other natural values in a place of untrammeled wilderness…." I've edited the beginning and the end of that [statement], but that's a very honorable goal and a very specific goal. That's out of the foreword to the second printing of *Biological Investigations in the Guadalupe Mountains National Park, Texas*. We need to conserve resources. We have just heard from the National Parks Conservation Association how that's really important. We need to avoid unnatural change. And am I uncovering a fight here, because there are people who say, "What is natural?" and the deconstructionists, humans, are just a part of it. I probably would like to take on that group a little bit, because I think that while it is true that the guys with spears and the guys with bows and arrows and perhaps even with rifles played a real role in selection and forcing ecosystems to go, I think the bottom line is that the problem that we are facing today is a different level and a different magnitude. It may still be natural, if you want to just call humans a part of the ecosystem, or whatever.

The other real big issue here is "What is change?" The human mind is an amazing thing. I can go to the women's basketball game playing UT-Austin, and I can thank the referees for the worst they ever were, and every call went against Tech. Everybody who's sitting over on that burnt orange side feels exactly the same way, except every call went against the UT ladies. We're both honest; we both saw the plays. I think it was E. O. Wilson who said that the human brain is made for survival; it's not made for accuracy in science and all that stuff. Here's the problem. What this means is that we have to back off. We have to learn how to work with ranchers. We've got to learn how to work with economic developers. We've got to learn how to work with all these people, and we've got to understand that how they see it is different than how we see it, and we've got to listen. We've got to build, and that's really critical, because we've got to understand that the human brain and the perception of change are different for everybody that sees it.

Here's the thing that really frightens me. There are 5.6 billion people on the face of the earth right now. There'll be 6.0 billion by the year 2000, and I don't know where this is going to end. But you know what? I have followed this for 25 years, and so far we have been very accurate in predicting how many people there are. We might be able to stop some of this. But the problem here is, go back to Chernobyl. At Chernobyl, we have a unique situation where those people are trying to survive, plowing the ground behind their house, growing their radishes and their cucumbers and their small wheat fields. In just the fact that they are trying to survive, they are destroying biodiversity at a level greater than what is the ultimate fear of all humans, and that's being exposed to radiation! We're doing that. We've got NAFTA [the North America Free Trade Agreement] down here. That's going to produce a lot of pollution in here. I think we need to archive—here we go with the verb again—we need to obtain samples from this mountain range to know how much pollution is in various birds and mammals and everything else that's out here so we have baseline data to know what's happening. What do we have to change, that kind of stuff.

This is a recent statement by E. O. Wilson, "To raise the rest of the world to the level of the United States in amount of food and amount of resources, using present-day technology, would require the natural resources of two more plan-

ets Earth." We are the very chosen people on Earth right now. This whole deal with Earth's population, I feel just like this. I was walking through a museum the other day, and I thought, "That guy must feel boxed in." I don't know what the solution to it is. I hope there are some people here smarter than I am or whatever.

Donald Dayton talked to us and he pointed out that a few years ago a major problem was, that getting the Guadalupes the magnitude of care that they needed required getting everybody together. I believe his words were, "We've got scientists crawling all over those mountains and they don't even know the other one is there." That's one of the reasons we held that symposium in 1975. I applaud this symposium, because this is doing the same thing. It's getting people to talk to each other; it's bringing new students in. We need that.

The magnitude of data that's out there is just overpowering. There's a whole new field developing. It's called bioinformatics. This is the definition that we dragged out of some home page: "systematic development and application of computing systems and computational solution techniques, analyzing data obtained by experienced modeling, database search and instrumentation regarding biological abstracts." Is that pedantic, or what? Basically, I think it says that we are using models to calculate values and to sort through the data. I decided with Nick Parker that we needed to redo this definition, so I think this is what we're talking about in bioinformatics: "the delivery of all these powerful data sets and its synthesis, and an understanding that they can interpret to decision makers and potential users, including the general public." That's our responsibility as scientists. Now, I agree that there are things that shouldn't be given out to the general public. There is sensitive data. But I think that this is where interpretation of research data needs to go. Bioinformatics is the hottest field in America, according to some of the magazines.

Here's a little breakdown on it. In 1995, the word first appears on the World Wide Web, and then in 1998 we are getting about 500 hits. There are symposia now on bioinformatics and all this kind of stuff, so it is a very rapidly developing field. Let me tell you where most of the application lies. Most of it lies in genomics. We now are sequencing; we are reading the DNA of everybody and his dog; yeast, bacteria, humans, cotton, everything you can think of. We're in there busily reading all of this stuff. An example is from a paper that we published, and it is a bat study. Bats have about 2.7 billion base pairs. That's a lot. What we wanted to know is, can we go in and find the piece of DNA that is unique to this bat that we took it from? Can we find a piece of DNA that identifies the species *Microtus waterhousii*? Can we find a piece of DNA that identifies the genus *Microtus*? Can we identify the family that it's in? Can we identify the suborder of bats? Can we identify the order? Can we go into these 2.7 billion base pairs and find them? So we made a library, which means what we did was we took this bat, isolated its DNA, cut its DNA up into 35,000 base pair pieces. That's still quite a bit of DNA. We put it in a vector, something that we could grow it in, *E. coli*. We grew it all up and then we did a bunch of scanning. This is the result of this thing. We actually were able to find 17 clones that identified *Microtus*, we identified 10 clones that identified Phyllostomidae and seven that identified the family, and 44 that identified Microchiroptera, and then we tested it to see if it would work. We took all the Noctillianoidea and put them all on there and saw that they all had that, and identified other things as well. So—we were trying to see—can we cheap and dirty pull out a piece of DNA that does that? The reason you want to do that is because you might want to identify a taxon, but you also might want to know, is this a mule deer? Is this a deer? Is it an elk? So if you pull out and go through this kind of method, you can have probes that tell you. If you've got a piece of meat or something, you can go through and see where these are. You can use it in forensics, you can use it in

taxonomy, and you can use it in a whole bunch of things. We were very successful.

I think also one thing we need to do is to remember economics and the role that economics can play. Now economics can't solve everything, but we've got to remember that economics are really important. I will give you one real easy example. The two countries in Africa that have more elephants than they can stand are the two that prevent hunting. And I know that the people who want to save the elephants are also the people who don't want any hunting of elephants and don't want any sale of ivory and don't want this stuff. But in Zimbabwe, I believe the figures are something like this. They sell an elephant permit for $12,000 and they have sold something like 20,000 permits. The person who bought the permit has to get there and they've got to hire a guide and do whatever. As a result, the country has built schools, they've built hospitals and they've built everything else with this money, and you know what their problem is right now? At this moment, they have more elephants than the environment can handle. And in those countries that don't permit any hunting, people are poaching, trying to get a few pittances for whatever. The goal is to save the elephant, and this is the way that economically we can do that. Now I think they ought to just jack the price up higher to get more money for elephants and all that.

Another problem I think is pointed out by E. O. Wilson in his latest book called *Consilience*. You'll find he defined the word as, "the interlocking of causal explanation to cross disciplines." We do need to really back off and really look at the big picture. We need to not lose sight of the fact that—I know the most important thing to me is to protect my bats and my rats but in reality—the overall pattern is absolutely important. Natural science is moving away from the search for fundamental laws and elemental truths and reduction approaches toward highly organized systems.

This is the sixth of seven weekends in a row that I have been away from home going to meetings, and I went to the Texas genetics meetings not long ago, and I sat in on this meeting. So I'm sitting there listening to these people, and they are sequencing genes from the human genome. Now, there are 100,000 genes in the human genome, give or take 5,000 or something, and so they sequence these things and then they look at the promoter. You've got to have something to turn a gene on, and you've got to have something to turn it off. I'm sitting here and this guy's up there talking about the gene for cartilage. Well, you know, you've got cartilage here, and you've got cartilage in all the bones, and you've got to know when to turn it on and make cartilage. You don't want to make cartilage in your eyeballs, you want to make it where you need cartilage. You've got to know how to turn all that stuff on and everything. So this guy's going through it and he sequenced the whole gene, and he sequenced the promoter region, which tells it when to turn on. He has found four protein binding sites in this promoter region. He went over each one of them. He says, "Well this one's used when you develop cartilage; and the precursor for bone, this one binds here; and when you need to do this, this one binds in the ear and the nasal septum; and when you do this...." So he has gone through and he has worked all of this out. Wow! Right? I don't know whether I can stand listening to 100,000 genes or not, you know? I mean, what we have done is we have sequenced less than 7,000 genes. We have 93,000 more to go. I had attention span deficit syndrome long before it was a disorder, and I just wanted to scream and run out of the building. I'm sure it's absolutely important. I'm sure it's perfect, incredible, but you know, God help me, how many of those can I listen to and work with.

What I think I've tried to do is tell you, "Boy! There are a lot of powerful methods out there." There are computers and there are all kinds of things that we can use to address problems like biodiversity in the mountains, to document pollution in the fauna, to ecotoxicology, to capture

genes, to do things like go to Chernobyl. Chernobyl has created a stressful environment. The mice that live there probably have genes that, if we can pull them out and use them, we probably can put them in cattle and every other thing and make a better cow that can live on a more stressful environment. We probably can get the plants there and get stuff that cotton can grow where there is more soil with salts and all kinds of things. I mean, everything is the good news and the bad news; you've just got to figure out what the good news and the bad news is. But this is the diamond in it. That's what it's about.

I remember a day when we were doing our survey in the mountains over on the west side, and I was trying to figure out where the limits of woodrats, *Neotoma mexicana* and *Neotoma albigula,* were. I had this idea that if we could figure out where that boundary was, and we could watch the stress on the system, maybe this would be a bioindicator of environmental stress and change, and we could follow this distribution, which one comes right up to the other. The west side is huge, you know. I mean, I was wandering around over there—you can only haul so many traps so long—so in the middle of this after a while I got to looking at these cacti, and I decided I didn't really care much about woodrats. I climbed that mountain all day long and I looked at probably a thousand of these cacti over there, and I got to looking at symmetry and everything else, and that actually was one of the finest days of my life. Then I saw the truth, went back, and started to set traps again.

The Guadalupe Mountains are an archive. Archive means to hold in trust. The Guadalupe Mountains are held in trust by the government and by us. You're the movers and the shakers. We are all a major part of this. What a diamond this lady is. What cake, icing and cake, this lady is. I think we need to not lose sight of the fact that we are in a position where we can impact this, and we need to dedicate ourselves to excellent science. We need to dedicate ourselves to biodiversity and ethics in behavior that will lead to and protect this. We need to dedicate ourselves to trying to spend the money because money is always going to be tight. There is never going to be enough that we can squander any. We need to make sure we spend it correctly and we need to go in with the same philosophy that we have heard so many times here, with the enthusiasm and the love and the pleasure that we get from the lady that is the Guadalupe Mountains. I hope all of this weaves together eventually so that we can do a better job, and I hope the Guadalupe Mountains are there for my children and my grandchildren and for all the other people that can appreciate those aesthetics.