

BONNIE K. BAXTER, PhD

Salt Lake City, UT

An Interview by

Greg Smoak

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THIS IS AN INTERVIEW WITH BONNIE K. BAXTER ON DECEMBER 9, 2013. THE INTERVIEWER IS GREG SMOAK. THIS IS THE GREAT SALT LAKE ORAL HISTORY PROJECT, TAPE NO. U-3240.

GS: Good morning, it is December 9th, 2013. I'm Greg Smoak and I'm at the office of Dr. Bonnie Baxter of Westminster College and director of the Great Salt Lake Institute. We're here today to continue the Great Salt Lake Oral History Project and I'm so glad you're talking with us today.

BB: Thank you. Happy to be with you.

GS: I'd like to start with a brief bio. Tell us a little bit about yourself, where you're from, how you came to work in the natural sciences, and ultimately we'll get to the lake itself and how you came to work so closely with Great Salt Lake.

BB: My path has brought me across the country. I grew up in North Carolina. I was a person who loved the water, loved ocean, streams in the mountains, any kind of water. But I was fascinated by science from a young age. I knew by the time I was in seventh grade that I wanted to be a biologist and by the time I was in tenth grade I knew I wanted to study molecules and genes and DNA and by the time I was in college I knew I wanted to study DNA structure problems, and by the time I went to grad school at Chapel Hill, I was into how DNA gets damaged and fixed deep inside molecules. So something smaller than cells, certainly smaller than organisms. And then I went to post-doc in Washington State and that sort of changed my personal perspective.

GS: At what institution?

BB: I was at Washington State University in Pullman, in Eastern Washington, which is so close to incredible mountains of Idaho and Montana and not far from the Cascades and I fell in love with backpacking and all the wonderful outdoor opportunities that are

offered in the West that you just don't have in the East. And I knew I couldn't go home. So when I started looking for a job after—post-doctoral research is meant to be additional professional training and not a permanent job, so I was ready to look for a permanent job. I looked intentionally then in the west. And I grew up daughter of a professor at a liberal arts college. I lived in a college town my whole life. I went to a liberal arts college, and that's all I wanted.

GS: So you went to Elon?

BB: I did

GS: And so your father was a professor at Elon.

BB: He was. Yeah, he was. So I was used to small college life. I love being surrounded by people who are experts on minutiae (laughs). I love academics. And I just felt like in science the big research world is so far away from the true academia that is sort of the classic academia where you're connected to students and you think about student learning and those kinds of things. Because researchers in the biomedical field I was coming out of—it never contacts students. They're completely running giant research labs and churning out grad students. And that life was not interesting to me. So I had a passion for training undergraduates in how to do science, and I had a passion for particularly how to get under-represented groups involved in science. Even as a post-doc I had written grants with respect to that. So when I started looking for a job I was looking for a small college in the West. I wasn't really interested in California and all its strange higher-ed institution politics and so that left me with very few institutions in the intermountain West. I applied to a few in Colorado, Washington, and Salt Lake where Westminster College is, the only liberal arts college in Utah. So I ended up such a great fit for the

institution and the institution was such a great fit for me. They were, like a lot of small college fifteen or sixteen years ago when I was coming on board, they were ready for an upgrade.

GS: Yeah this place has changed remarkably since I first moved here in nineteen eighty-seven. It looked very different.

BB: Right. They were ready to start an undergraduate research program. They were ready to infuse this new molecular biology that I was so proficient in into their curriculum. I became chair of the sciences and developed what basically was the basis for this building: a new model of undergraduate research as a way of teaching students how to do science, as opposed to just lecture. So there were a number of great faculty who were here, a couple of them who were experimenting with these methods, say, in physics, but there were also a lot of folks who were on the edge of retirement who weren't really interested in sort of coming along with the new wave. Yeah, we've hired I think fifteen people since I've been here. I've been on most of those search committees. Everyone has brought undergraduate research with them. So anyway, that's how I got here and what my interest was in this place.

GS: So how about the lake. Did you have any kind of developed sense of the Great Salt Lake before you came to Salt Lake City?

BB: Absolutely not. And it's kind of a funny story. As a molecular biologist I don't really care what kind of cells I work in. And that seems kind of silly, but I'm not an organismal biologist who only studies foxes, for example. I study molecules, and we all have them. So it doesn't really matter to me what system I'm in. So I was studying DNA repair in human cells. I was studying how UV light is damaging and how our cells

fix it. And when I decided to work in an undergraduate environment I just felt like human cells were too expensive, too easy to contaminate, and they weren't going to work for undergraduates. So I thought *I've got to find a different model to work in*. And I was doing yoga before I came for my job interview, and this friend of mine in a yoga class said "Oh, you're going for an interview in Salt Lake City?" and I said, "Yeah, I'm really excited about this job, it sounds like a really good fit." And she said "You have to read this book *Refuge*." And she handed me Terry Tempest Williams' book. And I had been in the West for a couple years, I had been reading the Western literature that as a new person in the West you might want to read, the voices, the sense of place that Wendell Berry and, you know, Stegner, all those people. So I'd been reading those texts and enjoying their words but I realized I'd never read a woman writing about the West. And when you read Terry Tempest Williams after reading all those male voices, it's really different. She talks about the scent of the sagebrush and she talks about, I mean, just things that emotionally connect for her. I think that that book, because she parallels the demise of the Bear River Refuge area during the floods, she parallels that with her mother's cancer, it was this emotionally connected story about an ecosystem. And I found it just a brilliant piece of writing. So I'm reading this on the plane while I'm coming to my interview. And I got here and I kept asking everyone, "I want to see Great Salt Lake."

GS: Did you not look out the window of the plane? (laughter). That's how most people when they come to Salt Lake City first see the lake is that they look out the window of the plane.

BB: It's true. I was a person who liked to be outside, I wanted to go see this place and explore this place, and no one could tell me how to get there. There's such limited access to this incredibly large lake. And I kept saying "I want to see Great Salt Lake" and people kept saying "No you don't. You don't want to see Great Salt Lake." So my whole interview I'm asking to go see this lake and no one could tell me. So it ended up on my last day I was free and I decided to go find the lake myself. And I did go to the south shore and sort of see the lake and just kind of felt like I was in a different place, a really different place than I had ever been in before. And I went back to Washington, and I—

GS: How different? What do you mean by different? Was it the landscape? Was it the industrial nature of that south end of the lake? The smelter out there?

BB: You know, I think at that time I wasn't thinking that way. I take students out there now for just that perspective. But at that moment I wasn't thinking that way. I actually got out in the water, and the brine feels different. It's slick. I grew up near the ocean and it feels different than going in the ocean. It smells different, it feels different. Once you wade out into it a ways there's no bad smell at all. That's all shoreline bacteria, now I know. I was excited by it. They said they were interested in me so I wrote a research statement for what I might do with undergraduates if I got the job and I sent it to them and it was: I would work on bacteria from Great Salt Lake, because they were living in extreme sunlight. I already knew how to look at organisms that were fixing their DNA from being in extreme sunlight. That's what I'd been doing, shining UV lights on cells and studying them. So I thought, *well, these salt dwelling organisms must be really*

supper interesting in how they fix their DNA. And I looked up in the literature and hardly anyone had studied anything about salt bacteria and DNA repair.

GS: Is there a relationship between the hypersaline water and worse UV damage? Is there any link at all, or is it because the lake gets so many sunny days a year?

BB: I can tell you a whole lot more about that, but there was a study in Canada that showed that UV light penetrates more the more salty the water is. So yes.

GS: Not to derail you there.

BB: So I wrote this research statement. They got really excited. I got here, I got the job, I got here. And they said “So about this Great Salt Lake project,” and I thought, *well, I’m a biochemist, I’ll just call the people who are working with Great Salt Lake microbiology and I’ll get some of the cells they have growing in their labs and I’ll do my molecule thing.* And it turned out that nobody had been doing that. There was nothing (laughs).

And the one paper I found was from nineteen seventy-nine and it was a retired professor from Utah State, and he was a food microbiologist who happened to do some work on Great Salt Lake at the end of his career and then he retired and I called him up and this was before the days of HIPPA and, you know, USU gave me his home number and I called him at home, and he said “I’d love to meet with you and talk to you about it, but every bacteria species that I isolated was in my freezer and got thrown away when I retired, and you know, it was a freezer accident, so there’s nothing.” So I had to start from square one, which means going out into the environment, learning how to sample water, collecting organisms out of the water. This was all stuff I had never been trained in. But the valuable thing about being at a place like Westminster College is there were naturalists here. They don’t exist at big universities anymore. There was a limnologist,

there was an ecologist, these are people who know how to go out in the environment and study water. And I started taking these old guys out with me and they taught me how to work outside. So I was a person who loved the outdoors, but my science was always in the laboratory. And they taught me how to transition to doing the science outside, which has been a remarkable asset when you're working with students if you want to get them excited—to have them outside and then have them bringing that into the lab and this connectedness they get with the environment. So that's how I got to the lake, and that's why I got so deep in the lake, because no one was doing it. Right? And I always say that to be an expert at something you just have to be doing the thing that no one else is doing. And then you're an expert, particularly in academia. So it became my thing. And then Great Salt Lake Institute eventually grew out of that because people needed a resource for doing science and education scholarship at the lake and there was no one.

GS: And when was Great Salt Lake Institute founded?

BB: About five years ago.

GS: And you've been the director from its inception?

BB: Yes. We went to our president Dr. Basiss at the time. There were a couple of faculty and I who had been doing little projects on Great Salt Lake for a while with students, but I had started fielding from my office requests from people all over the world who wanted to study algae in Great Salt Lake, or who wanted some sand to study to study this special oolitic sand, or who wanted to know more about brine shrimp, and they would contact me because I was in the literature all over the place for the person who was studying Great Salt Lake and its life and if you weren't studying birds, then call Bonnie. So everyone was calling me, and I was spending a super amount of time hosting people

who were coming in to sample from some other place, connecting people who were working on the lake. “Oh, you’re interested in the stromatolite structures? Joe-Bob is interested in the stromatolites, you guys really ought to talk because your work could really be synergistic.” I’m a big believer in synergy. And that facilitation turns out to be what Great Salt Lake Institute is really super good at, with a legislator or someone in the governor’s office and they ask “Okay, so if someone wanted to grow some algae for biofuel, where would we put the salt ponds?” And I would say something like, “Well, I have a collaboration with one of the salt companies and they already have salt ponds, so could we just have a memorandum of understanding where you could grow your algae in their ponds and that would actually increase solar evaporation which would be great for their product?” I could be the person who could pull those people together for a project, and that turns out to be one of our key roles in this universe of Great Salt Lake is pulling people together to make projects synergistic. So now we’ve gotten involved—we’re Stewards of Spiral Jetty alongside—

GS: I noticed the Dia Art Foundation brochure tacked up there.

BB: Yes. So Dia asked us and the Utah Museum of Natural History to be their triumphant—we call it—partners with the State of Utah to help manage the Spiral Jetty site. So since we’re up there a lot doing biology and chemistry and taking art students and whatever else, we have a lot of presence and we can always call Dia and say “There’s a new sign on the road” or “There’s a sign down on the road” or “The road conditions are bad” or if someone ever vandalized the artwork or anything like that. And Utah Museum of Fine Arts has a great art presence in the community, but they weren’t at that time going onsite to Spiral Jetty so often. So now we run collaborative trips. When Dia

comes out, we all get together and we have these meetings on how can we manage this. Right now we're talking about creating podcasts that you could download and listen to on the drive from Golden Spike out to the Jetty and it was this whole great discussion on if we really wanted to interrupt the experience of someone in their head driving out there. Because we talked about having it specifically timed for the whole trip. And then we talked about well maybe that wasn't a good idea. Because maybe we needed to experience that drive. That was part of what Smithson loved. And maybe we could make that an option. So we have these great discussions.

GS: Let me ask you, this is maybe a little bit off track, but you mentioned Dia and say the road was in bad condition. Do they pay or? Who manages the road because I've driven up there a number of times and I've never really had a problem but I've talked to so many people who say "Wow, the road was so bad I had to turn around," and I can't imagine that but maybe I'm just used to bad roads.

BB: When did you go there?

GS: The last time I was there was Pioneer Day this summer.

BB: Ok so Box Elder County two years ago graded the road. Prior to that time it was a rock field. It was really awful. I mean, boulders that you would have to put your tires on top of to get over and we have a sequence—particularly the last part of that road, we had a special sequence to get in there.

GS: Ok because the last time I was there was probably fifteen years earlier than that. There's a big gap there. But yeah, you could just easily get out there now.

BB: Yeah, now it's much better. They've removed all those boulders and they've graded the road. So Box Elder County is maintaining that. The state owns the lakebed under the Spiral Jetty.

GS: And Dia owns the lease on that, or they are an heir to the lease that Robert Smithson had with the state.

BB: Right. And so we came on as partners when they were renegotiating the terms of that lease, because the state wanted them to have some local people. They don't want distant New Yorkers to be managing an artwork that they never see. So it's been a really interesting process. New people at Dia, it's just been so exciting to see how that organization has changed and how important this artwork is to them. So I guess what I'm trying to say is Great Salt Lake Institute has grown into this breadth of things. We now work with our School of Communications, we work with the Business School, we're writing art grants now, we're hosting a Japanese artist called Motoi who does sand paintings but he does them with salt. He's coming in the spring. So we're all over the place. We're very interdisciplinary. And that wasn't the case in the beginning. Because what we had strength in was science in the beginning. And now we're kind of spread out. So the Spiral Jetty thing, we're actually helping develop curriculum for Utah school kids so they'll know about this incredible piece of art that they live so close to.

GS: We can come back to the Institute later. What I would like you to talk a little bit about is your own research. The actual—we might lose some folks with this if we get overly technical, but what you've found in studying the Lake. Some of the things I'm interested in is do you focus because you want that hypersaline ecosystem on the north

arm, or do you also do comparative studies around the lake with different salinity levels and that kind of stuff, and how your work has progressed.

BB: Yeah, all those things. My interest was in the hypersaline area because I was interested in the damage to cells and how it gets fixed and I thought *well, I need to be in the most extreme place*. Because that's where these organisms dry out. You see salt crystals over there on the floor of my office. Those we will chop up and extract organisms that have been living dried in that salt rock for a long time. I can resuscitate these dried out organisms. So they can desiccate themselves on the shore.

GS: So when you say a long time, approximately how long?

BB: Well, that's a really big question, because (laughs) the cover of the journal that's framed right there is an article from a two hundred and fifty million year old salt deposit where we tried to resuscitate organisms. We didn't find organisms but we found DNA and cellulose, so biological molecules that can only come from biology, existing in the environment in salt pockets for two hundred fifty million years. So we know molecules can last that long. Those are the oldest visualized molecules on the face of the planet that were made by biology, so we have that honor right now for publishing that study.

GS: And were they collected here in Great Salt Lake?

BB: These were collected in a salt mine in New Mexico that's underground. So there were studies on some of the old salt mines that were showing that organisms could live a really long time in salt. So the salt crystals that we've studied at Great Salt Lake of course aren't that old because the salt then, is on the surface. So you'll have these salt crystals get produced and then they'll get dissolved in the lake. So I had some that were about ten years old and we were able to get plenty of organisms out of them. So what I

was saying was these organisms live in extreme conditions. They dry out, they have high sunlight, so a lot of radiation they're dealing with, high levels of salt. Human cells could not survive. What happens is the water inside your cells rushes out to try to dilute everything that's outside so all your cells would shrivel up which is what happens to your skin if you are out in the lake for a long time. Of course skin cells just slough off so that's not a big deal. But to a microorganism, they're surrounded by all this salt so they've got to have a way to deal with that, and I just thought the north end was the most fascinating place I'd ever seen. So when I finally find my way sixteen years ago to Spiral Jetty, that was a place we decided to sample. There were no signs, there was barely internet at that time, so we found online a list of steps on how to get there, in Western tradition, which involved counting cattle guards and turning right at the pink trailer, which is now gone. And now there are little signs that say "Turn here." So it kind of takes away from the experience, but it was really just incredible. I first tried to approach the north arm from Ogden and ended up on Hill Air Force Base property with black helicopters—

GS: Yes, they don't like that.

BB: And a truck full of students, so I was really nervous (laughs). So just looking at a map didn't seem to get me access to the north arm. And at that time of course Spiral Jetty was underwater so nobody was going out there. But I found the pink water that people talked about and I sampled it and we grew organisms out of it and what we do a lot of times is we genetically identify the organisms that are present there at that time. And that had never been done. And we can say how related those organisms are to organisms that have been found elsewhere. So microbes that live in the Dead Sea, sometimes we find organisms in Great Salt Lake that are really close cousins to microbes

that are in the Dead Sea. And you think, *how is that?* These are geographically very disparate, but the earth has some secrets that we don't know about yet. And it might be birds that fly from salt pond to salt pond or it might be seven forty-sevens. It might be salt that we ship around the world, right?

GS: Well excuse my ignorance being a non-scientist, but what about parallel evolution? Just similar environments?

BB: It's mathematically impossible in this case. The interesting thing about DNA work is because you're dealing with four nucleotides, you basically have codes that become mathematical. And you can calculate the probability of, really you're talking about a hundred million base pairs. A code of a hundred million digits compared with another code of a hundred million digits, and the possibility of those evolving separately to have the same sequence where everything is in alignment would be ridiculous odds.

GS: So these are identical?

BB: Mostly. With some changes, but mostly. So that's shocking. My students in my genetics class actually isolate new organisms out of the lake every semester. They find relationships with microbes that are living in salt lakes in Australia or the Dead Sea, or ponds where they make salt in Spain or Argentina. And it's so, just mind blowing to think about similar genetics of microbes all over the world.

GS: So you mentioned a couple of ideas. But what are your best guesses? What explains that?

BB: Well, somehow they had a common ancestor who could've been delivered to both places. And so the "somehow" is the part we don't know. But I think for me, watching the birds on the lake, these birds migrate. They have salt in their feathers, saltwater on

their feet. A milliliter of saltwater might have a hundred thousand microbes in it. And then they take it to some salt pond at Monterey Bay, well, they deliver those microbes there. They go down to Mexico, they take them there. And then you've got other birds that transfer them from one place to the other. So I point to birds as a vehicle of carrying microbes around the world.

GS: That makes perfect sense. And like I said I interviewed Don Paul and he talked about the projects, the migration patterns, and the new projects that link these saline lakes in Mexico, in Canada, in the United States.

BB: The "Linking" projects. Yes, amazing. So I think that you have to look at the whole ecosystem, and that's what laboratory biochemists never do because you're just looking at the one molecule in the lab and you're not thinking more broadly. It has been such an expansive experience to take that very myopic molecular biology, biochemistry work that I did and expand it into such a system to where you're studying ecology at the same time you're studying genes. I love that. So a lot of what I do now is I go to different spots in the lake. I isolate DNA from water, from stromatolites, from salt crystals, and I ask what organisms are present at that spot. And we create these pictures of microbial communities that are in one place or another and look at how different they are. I have one study where we followed the water around Spiral Jetty over a period of four years. So we looked at the changing communities, changing with the weather and with elevation, and—so that's a lot of what I do. I get into a lot of side projects. I'm just really interested in what microbes are where and what they're doing in the lake. We've had a grant recently on mercury methylation in the lake. And that's all done by microbes. So knowing who's there, who are the culprits, what are they doing to make the mercury

more toxic or to make it less toxic. That's all microbial activity. So knowing who's there is kind of important for asking these bigger questions.

GS: So another side project that I noted from your CV is you've worked with Division of Wildlife Resources on the Great Salt Lake Ecosystems Project. And could you tell us a little bit about that and how DWR might apply your work or how you've consulted with them?

BB: Yes. So they have several meetings a year. They receive funding from the brine shrimp industry, and so one of their primary objectives is to bring a research database back to the brine shrimp industry. So they're very *Artemia*-based, *Artemia* being the brine shrimp. And their interest in microbes would be, *how are those algae populations or bacterial populations affecting the brine shrimp population?*

So I'm on their technical advisory group. We meet several times a year. There will be brine shrimp industry representatives at these meetings. There will be other state agency representatives at those meetings. And sometimes there are other academic scientists who come. And we talk through the projects that have been funded, they'll present data on those projects, then we talk through about why you might be seeing a decrease in brine shrimp cyst production this year versus last year. If the green algae is down in population in the lake could that be impacting the population of adult brine shrimp? And maybe it's impacting the adults but not the cysts they produce. So they like to get a bunch of scientists in a room to kind of go through the semantics of those models and see what might be affecting what. And come we come up with a predictor for is it going to be a good harvest year or a bad harvest year? And DWR, the Great Salt Lake Ecosystem Project, like I said they're funded by the brine shrimp industry but they also

have to make the call of, “Hey, you can’t harvest this year,” or “The harvest is going to be short because the population is low.” So they like to follow the algal populations and keep counts on that because that’s food for the brine shrimp, and then they like to follow the adults versus the cysts in the lake when they start producing these cysts. And the cysts are what are collected by the brine shrimp industry, so that’s what they’re primarily interested in. But all the factors that go into that start in the spring, even though their harvest doesn’t really happen until October or November. So it’s been really interesting for me, again, connecting microbes to the larger picture of the food chain. And I think the expertise that I supply then is mostly just sort of asking scientific questions about the models they’re producing, but also the expertise on this lower level of the food chain.

GS: So when we started this I asked you about your developed sense of the lake, and you said it seemed like such a strange place at first visit. Could you tell me a little bit about how your perception of the lake, the landscape, the ecosystem, how it’s changed over this lengthy period of really close interaction?

BB: Yeah, very interesting. You know, I’m out there a lot, and what’s fun is that, let’s just say the Spiral Jetty site, the north arm. Every time I go there I see something new. And I mean, I go there probably six to ten times a year. Every single time I see something new. Last year the lake volume went up and I think the pressure of the water started pushing the petroleum up out of the seeps up there. I have never before in the sixteen years I’ve been going up there, seen this much tar, like it’s very heavy molecular petroleum. It’s like asphalt. We could hardly get to Spiral Jetty without getting it all over our shoes. I stopped taking my dog there.

GS: Really, right there on the shore by the Jetty?

BB: Yes. And usually over by the oil jetty you would go there if you wanted to collect some of those seeps, because we were looking at microbes that degrade that asphalt for a while, so we were collecting over there. But never before had I seen it there. I stopped taking my dog because she would get it in her fur. I had my kids wear different shoes (laughs). So that was different. So every time I go there's something new, there's something different. If the conditions have been just right and a wind whips up it's like a bubble bath out there because the lipids from the microbes are released into the water from them getting blown around and dying, I guess, and it turns into, like, soap suds. It literally, it was like...here's a picture. I can't show that to the reader, but... That's all foam. That actually was out at Antelope Island. But usually you see much more of that up at the north arm. And they'll blow around like tumble weeds if it's windy. And I've seen it from the air. It's amazing. So I've been up with DWR on pelican counts. That's another experience.

GS: Did you go out to Gunnison Island?

BB: I didn't get to go to the island. Jaimi's been out there, our coordinator, a number of times. I would love to go. I've been invited on days that I had to be out of town. But seeing those pelicans from the air when you're doing counts—amazing! The north arm to me has so many secrets to offer. I've kayaked from Lakeside into the north arm and I've been into—you can drop a boat into the Little Valley boat harbor. I've been in there. There's a West Rozel oil field which is around from Rozel Point, right?

GS: Yeah, up northwest of the Jetty.

BB: Yep. So all that area I've had access to in different ways, with different people. But here's what makes it different. It's not just that the ecosystem presents this different

image every time you go. There's something new to explore, something new to see. Some new smell. Some new insect that I've never seen before up there. Formations of pelicans that blow you away. There's something every single time. But here's what makes it really special is that every time I go, I go with a different collection of people. Many scientists seem to only spend time with scientists and I really like to broaden my horizons. So I've been up there with people who write poetry, I've been up there with people outside of my field like geologists. I haven't been with Terry Tempest Williams yet (laughs), but I have hosted her on campus. I've been with Dia. Last year I got to go with Nancy Holt, who is the artist who did *Sun Tunnels*, and the widow of the artist who did *The Spiral Jetty*. We got to take her up there and that was an amazing experience. That night the sun set over the Jetty and the most spectacular clouds and lights I've ever seen up there. I have amazing pictures from that night. And she sat there, and it was as if Robert Smithson was dancing in the sky for her. It was the coolest thing. So I have the experience of being out there with different people who have different perspectives. And if you listen, every single person has some different connection to the lake. And that is a magical place to go, because the artwork is there with the science that we study. And it impacts people, and I think that's what that piece of work was supposed to do.

So I love that site because it's so rich. It's so rich scientifically, and from an art perspective, and from a humanities perspective. There's just so much to get out of that place. So that's just one site on the lake I can tell you about.

GS: Yeah that's actually one of my boiler-plate questions for these interviews is to ask people about their favorite places on the lake, and you might have answered that, but are

there other favorite places? And you don't have to reveal the exact location if you don't want to.

BB: No, I love Black Rock. I love where industry meets nature. Up on the wall you'll see a Savage stereoscope picture that I framed that came from a box of great American West photographs, and it's a woman and her two kids who are playing on the shore of Black Rock, and up above you can see Block Rock, in the distance as these boaters are going to go all the way around Black Rock. Well, the water line is way past Black Rock now, that's up by the road, that's up by the highway. So you can see, when you have something like Black Rock you know that native people probably used it as a landmark. You know that people on the Hastings Trail probably used it as a landmark. You know that that rock has stood for centuries as some marker for lake level. I just think it's such an interesting place. So I go out there. It's a great entry point for paddleboards and boats. And it's a great place to watch birds. My son likes to look for meteorites out there. I interface with that place a lot, plus it's close, it's local, it's easy to get to. So that's a fun place to me, and I like to think about it through history.

GS: Now you said you'd kayaked out from Lakeside, tell me about that a little bit.

BB: Oh, Lakeside's an interesting place (laughs).

GS: It is. It's not easy to get to and I don't know if Union Pacific really likes you out there very much.

BB: Well and you have to go through bombing areas, you know, through the Hill Air Force Base area, so you have to get permission to pass through there. So once you get there you feel like you've accomplished something. It's a point to get on the causeway, which you can actually drive a little way on the causeway. So if I want to do a quick

sample of north arm and south arm water at a similar GPS location, that's a great place to go. But you can put a boat in right there. I went out there once to look for current stromatolites that are calcium carbonate deposits on the bottom of the lake. We have these in the oceans as well and no one's really studied the ones in Great Salt Lake and I find them interesting. They're rocks that are made by biology. So my geologist husband thinks that I shouldn't be studying rocks. So I say, "Well, you got your rocks in my biology, so I get to talk about them." I went out there because there were a lot of these stromatolite structures that were reported in the literature in the seventies when the lake level was down (late sixties, early seventies). When the lake level was low people were talking about these structures. So I thought, *I wonder if I can find them*. And there's all these vestiges of them out there on the water now. These big tufa mounds that were created by the organisms of the lake at some time, but now they're out of the water, so I went out there on a geology expedition and we just boated out a little ways looking for these structures. So I was doing science. But we have paddleboards—and these were kayaks that this person had—but now we have paddleboards that we bought on a grant because they're sampling instrumentation.

GS: The stand on top ones?

BB: Yes. They're wonderful on the lake, because they're big and flat and you can put science equipment on them and a couple students and send 'em out, and it's flat water so it's really easy to stand up on them. We love to take students out on those with a bunch of equipment and sample and try to find out what's going on in the lake. So they're doing science, they're having fun, getting exercise.

GS: So besides *Spiral Jetty* or Lakeside, what are some of the other places you use a lot for your student trips?

BB: I have a passion for Antelope Island. I love that place. There are a lot of stromatolite structures west of the slips there where the boats are, so that shoreline, no one ever goes to that particular shoreline except for us, I think. But I'm really interested in that area because it's a lot of these living rocks, essentially. So I have brought out international geobiology students from a course that is taught through Colorado School of Mines in the last two years in a row, and we've looked at these stromatolite structures out there. Lady Finger point is that sort of first little parking area off to your right as you drive onto the island. And that is an area where Jaimi and I, with Great Salt Lake Institute, working with school kids—we love to take fourth graders out to that spot. It's a short walk to the beach. We set up stations for experimentation that they can rotate through, they have easy access to the water, there are bathrooms, there's a little parking lot, it's really a simple place. That's where the spiders are crazy fun. I mean thousands and thousands of spiders. Which, Great Salt Lake Institute has really gotten into the spiders recently because one of our faculty members, Dr. Black, has discovered that the mercury levels and the spiders in the same species are sevenfold higher at Antelope Island, at Great Salt Lake, than at Utah Lake. Same species. So they're eating brine flies here, not there, and these brine flies are pupating on the bottom of the lake where the mercury gets sequestered. So the spiders have become really interesting and we participated in Antelope Island's spider festival. We co-hosted with them this last year.

GS: And what species of spider is it?

BB: Um, it's mostly these orb weavers. There are a number of species, but I don't do whole organisms. Jaimi could tell you more about spiders. But yeah, it's orb weavers, a particular species that's dominant out there. And this is another great Great Salt Lake Institute story because it illustrates to me what our purpose is. We had this new young chemist, I guess he's an environmental chemist, who came to work for the chemistry department here. He'd been studying mercury in aquatic systems, so I thought, *this is my new best friend, I love this guy*. And Jaimi, our coordinator, went right to Dr. Black and said "There are these spiders and there's tons of them and they're eating brine flies and can you take this new instrument that we bought for you and can you crush them up and see anything about the mercury?" So our staff member who's the coordinator for Great Salt Lake Institute actually suggested this project to a new faculty member, and he's taken off with it. So he discovers this, and I call the non-game avian coordinator for Division of Wildlife Resources, the person who studies birds you don't hunt. And I said "I got to know what's eating the spiders. There's like thirty thousand spiders on Lady Finger Point. What's eating them?" And he said, "Oh, birds just don't like these spiders. They're not good bird food, so I don't think there's anything eating them and that's why the population is so big." And I said, "You know, nature doesn't do that. Nature doesn't produce something that's a huge carbon source and have nothing that's going to eat it. That makes no sense to me." And he argued with me and said, "No, no, we have no data on anything. Nobody's feeding them to their young," and it just was a puzzle. So this mercury study in spiders made the newspaper, we got a big grant, and the *Salt Lake Trib* wanted to do sort of a focus story, and they said, "Well, do you have a cool research project that we could talk about and not just have the article be on you getting the grant,

but we'll talk about some of the work you're doing?" And I said "That's fantastic, you got to talk to Dr. Frank Black and Jaimi Butler about the spider project, and we'll have the students come who are studying it and it will be just such a fun story to do in the paper." So I got interviewed for a piece of that, and I said this thing about how I was told there were no bird species who were eating the spiders but I didn't buy it. This ran in the paper and that week I got an email from a guy who said "We have to talk."

GS: "I know the birds!"

BB: (laughs) So we had a clandestine meeting. And it turns out that Ron Dudley is a photographer who shoots birds out at Antelope Island, almost exclusively, he's out there shooting amazing photographs of birds, and he runs a blog. And he presented to us pictures of shrikes eating these spiders. If we didn't have Great Salt Lake Institute where we could connect all these kinds of resources—you know, I think it's a different way of solving scientific problems. You're not just isolated. You've got the coordinator for the Institute who's leading a lot of education efforts and stuff, shaking the new chemist, saying "You've got to take this on! You've got to study spiders!" And then we've got interaction with the newspaper and now we're actually interacting, we invite this photographer to our mercury meetings, so we've got this photographer who's involved, we've got the Antelope Island Rangers who's involved. Now they're running a spider festival totally based on this work that we have going on, and meanwhile, how many students have been trained on this project in the last three years? It's been really fun. So that's the kind of infiltrating networking we want to do. And—there are a couple ground rules for Great Salt Lake Institute. One of them is, interactions are synergistic. If someone says, "Hey, I want to work on this special species of algae in the lake," and we

know someone else is working on it, we'll connect those people, as opposed to saying "No, you can't work on it, because this guy has the territory already," which is traditional in science. It's a very territorial, paternalistic structure, science. We have a really different model where we network people. We believe that these interactions only lead to good things and if they don't, then we're there to pick up the pieces. And the other rule is that we have to remain non-biased. We have relationships with salt companies and with brine shrimp companies and with the state and with nonprofit organizations like Friends of Great Salt Lake. So we have to manage all those relationships, therefore we can't get involved in a lawsuit or petition or we can't do our job to facilitate those discussions if we do that.

GS: Building on that statement, as a scientist, what do you see as the future of Great Salt Lake? And this is an oral history, not a prediction, but what do you see as the crucial issues out there right now?

BB: Water.

GS: Aha. Most people have said that. Tell me about that.

BB: Well, you know, water in the West is a giant issue and, coming from the East where it's a nonissue, it's really quite different. We had several years of drought on Great Salt Lake and then when the snow started coming we drew up models and anticipated a certain rise in the lake and we didn't see it, and the next year we didn't see it. And then finally last year we saw a rise in the lake. And we think that some of the water that's upstream needed to go to fill reservoirs before the water eventually got to the lake. So the lake is the last stopping point for water, and as development happens more and more then that water gets sucked away before it gets to the lake. So it is natural for a terminal

lake to rise and fall. And that's not disturbing. That's just a natural part of being a terminal lake. But I would find it hard to believe that we would ever see floods like the eighties again given the development that has occurred since that time. I would welcome that, I think it would be interesting to follow this lake through those kinds of cycles. But I think that water is an issue. Now, what's the impact if the lake dries up, or pieces of the lake dry up? What's the impact? Well, there's certainly an impact on industry. Brine shrimp industry would hate it, the mineral extraction industry would love it, because you've got a giant evaporative pond out there. So you bring in saltier water to your ponds. So it would impact industries in different ways. Gunnison Island, if a land bridge is created to Gunnison Island those pelicans will go away because—

GS: The predators will get there.

BB: They will get there. The foxes, the coyotes will get there and that's what's so cool about that island is it's predator-free. So that could impact special places like that. I think it's the second largest North American white pelican colony in the nation, and that's a pretty critical place. I think that with the mercury problems, selenium problems, heavy metal problems, that a terminal lake can have because it's the end of everything and it holds all of the memories of anything that's ever encountered it, I think that if you create dry salt dust that then blows around the valley in those winds we get that's probably not good for human health. So I think drying up the lake is probably not a good idea. And I think upstream us humans don't see it that way. Bodies of water that don't have fish don't fall under particular legislation that's set up to protect bodies of water. So terminal lakes are excluded from pieces of legislation, say, the Clean Water Act. So we, in this state, have had to push to develop standards for this very special system, because

they don't exist. If you're not governed by fisheries then they don't exist. So those are some of my concerns. I think the heavy metal problems are even a bigger deal if even the lake starts to dry up.

GS: Well are there other things you'd like to talk about? It's been a pretty wide ranging conversation.

BB: Yes, it has. I hope I haven't been too tangential.

GS: Not at all. That's the kind of thing I really want to capture with these interviews are people's lived experience, and their individual experience. Every interview is going to be different and it's often that sometimes what feels like a tangent are some of the best stories. So are there other things though that you anticipated perhaps that I'd ask?

BB: Well, you know, my work on the lake has been scientific but I also have to say maybe there is just something I'd add, that I think it's been an incredible place for my children. I think kids growing up experiencing their local ecosystem is rather critical. I talk about all these things I've done on the lake, but my kids have done them too. I took my son who's newly in high school out with three of his buddies this summer to camp at Spiral Jetty and they didn't get out of the water. They floated in the lake. (GS laughs) And I kept wondering...I take students up there who go out in the water all the time and I've been out there, but not for hours. And I kept thinking *is this good for their skin?* *What is this going to do?* (laughs)

GS: So your kids were born in Utah, right? So maybe sad, maybe not, I think they might be among the minority of Utahns who actually have went out and got in the lake. Small minority.

BB: Yeah, that's my point. At Westminster there are more students who come from out of state than in state now, but for a long time that wasn't true. I had a lot of in-state students and I would say "How many of you have been to Great Salt Lake," and just a couple hands would go up, and usually it was because they went on a school trip to Antelope Island. It wasn't because they had been immersed in this place that they felt special. But you know, we've seen bobcats at Antelope Island. We've floated around Spiral Jetty before we could see it. And we've paddle boarded out of the marina and around and I think it's just a cool place. I think kids have to interact with their environment. So I love to take little kids out there. When I take fourth graders out there they have no fear. They don't worry about the smell, they put on the rubber boots and they walk in the lake and they could care less if they get their pants wet or they get salt or dirt on them. And that's the way everybody ought to be because to know something is to experience it. John Muir wrote a piece that my friend Ty Harrison who is an ecologist that worked here, retired now, he shared with me, and I've read it to students out loud. But it's about—when John Muir visited Great Salt Lake, he talks about just stripping his clothes off and running in the water and the foam and the salt and the cold water and the feeling of the strange sand under his feet. It's a beautiful piece of writing that just is filled with such energy. And I think that that's the way everybody needs to experience this lake, whether they're a scientist, whether they're writing about it, whether they're just driving through and they think well they ought to see it. Jaimi and I talked some people into this. They were on their honeymoon and they were just stopping by I-80 on their way to California. We were at the marina for some reason and we saw this couple of kids and they were asking about the lake and we were educating them and then we

convinced them that they had to go in the lake. So they striped their clothes off, went in their underwear and experienced Great Salt Lake (laughs). And they'll never forget it.

It's not just driving by and passing.

GS: Yeah I spent a year once teaching at the University of Minnesota and when I moved back to Utah, this was back in 2001, several of the professors of the history department there came out to Salt Lake for this world history conference, and that's what they wanted to do. So they called me up and I said okay, so I took them to Antelope Island over to the west side, and here are these middle-aged Minnesotans walking out...and that's the thing, you don't see as many native Utahns wanting to get in the lake. It's the visitors who come here and have a sense of fascination about the lake.

BB: Particularly it's the Europeans, disgusted that we don't have spas along the shore.

GS: We once did. We once had many. Yes.

BB: I think the rising and falling lake level makes that not economically sustainable.

But very interesting. That would be my advice to anyone: just get in it. Enjoy it.

Experience it. It's different every time.

GS: Well, thank you so much for the interview.

BB: Thank you Greg. So nice to talk to you.

END OF INTERVIEW