ROBERT LEROY BASKIN

Salt Lake City, UT

An Interview by

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Great Salt Lake Oral History Project

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2 of 2

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THIS IS THE SECOND IN A SERIES OF INTERVIEWS WITH ROBERT LEROY BASKIN, ON MAY 15, 2015. THE INTERVIEWER IS BECKY LLOYD. THIS IS THE GREAT SALT LAKE ORAL HISTORY PROJECT, TAPE NO. U-3304.

BBL: This is a second interview with Rob Baskin at his office at the USGS. Today's day is May 15, 2015. This is part of the Great Salt Lake Oral History Project. My name is Becky Lloyd. All right, Rob, last time we left off we were going to launch into the bathymetric studies that you did on the Great Salt Lake.

RLB: Okay. I think we've covered the basics of how I figured out how it could be done. Did we talk about the sugar solution sound velocity?

BBL: Yes.

RLB: So I had this instrument that measured sound velocities in high density fluids. That allowed me to correct for depth because the speed of sound is higher in a higher density fluid than it is in normal waters and normal oceanographic equipment did not take care of that.

Then I went out and found a narrow beam sonar system, a single beam, but it was 2.8 degree. Sonar systems, when they put out a signal, it's focused, and it's focused in a beam. That beam is circular from a source and it sonifies, or uses sound, to look at a particular area at the bottom of the water column. The narrower the beam the more exact your measurement is because you're not picking up things at the edge of the beam that may be sticking up. So I got that and I got the sound adjustment through this sugar solution meter.

I also got a real-time differential global positioning system, which uses a satellite correction to fix the normal global positioning system, or GPS, signal, and correct it for atmospheric issues or various things that the military may be doing to the GPS signal. So I had sub-meter accuracy in my position on the fly. As I moved through the water with the boat, it gave me the actual corrected position. It was a subscription service that I had to purchase, but that way I had position, depth, and the necessary corrections to actually measure the bottom of the Lake.

I also had to come up with some way to put all this stuff together, because these are all separate pieces of equipment, separate systems. So I got a laptop computer and a special PCMCIA card so you could plug multiple devices into the same computer. Then I found a piece of software that would take and write all that information into a file by taking turns basically, asynchronously, so it would write one and then the other so fast that it was only off by a fraction of a second. As slow as I was moving the boat, basically it was the same time. So I had X, Y, and Z at the same time and then I could correct for depth by just stopping every so often in picking a depth measurement and picking sound velocity readings at every meter down the water column so I could correct everything and solve quality-control issues.

But, anyway, initially we had a boat that Dr. Stephens got off of the Mississippi River; it was an old US Army Corps of Engineer riverboat. But it's what's called a cathedral hull, in that if you turn it upside down it looks like a cathedral where it's got two little spires on the side and a larger one in the middle. But it was very stable laterally, so you could walk to one side of the boat and the boat didn't tip sideways. You don't want the boat rocking back and forth because that changes your beam angle, whether it's pointing straight down, or whether it's pointing off into the distance. If it points off into the distance and hits the bottom and gives a reflection back, the beam is longer and it calculates a deeper depth. So you always want that sensor to look straight down. It was a twenty-three foot boat and that's what we used to do the surveying. It had a small cabin on it, so we just put a computer in there with all this other equipment, hooked it up with a small generator running in the back of the boat, and just drove back and forth, six to seven miles an hour. In the south part of the Lake, it took months to collect the data. In the north part of the Lake, we actually lived up there and it was a little bit more efficient. It probably took about a month and a half.

The boat was travelable, so we would just drive out to the Lake, put it in the water, fire up the equipment, make sure everything was operational and go up and start our next line. All the lines were pre-programmed, where we wanted to go, one kilometer spacing all up the Lake, east-west transects with five or six north-south tie lines so we could make sure that we could tie all that data together and that the north-south line depths matched the east-west line depths wherever they crossed. Another quality control check. Every time we did one of those north-south tie lines, I think we had fifty-something east-west transects on the south part of the Lake. So you had fifty different data checks when you completed one of those north-south lines. It was another quality-control feature in case there were problems with beam angles or it was rough. We never really went out there and surveyed when it was that rough.

But conditions were interesting out there sometimes. We only surveyed when we had less than about six inches of chop or swell on the Lake because we couldn't afford a $100,000 unit that corrected for the aspect and the movement of the boat, so we needed to make sure that the Lake was calm. The boat was welded aluminum so in the summertime it got hot. You were in a sweatbox and you were moving slowly. Unless there was a breeze, it got really, really warm. It basically was very long days, twelve-hour days, fourteen-hour days, driving back and forth very slowly with the sun reflecting off the water. We used sunscreen and large hats and etcetera to stay safe and stayed in the cabin as much as possible. You couldn't move around a lot on the boat because you didn't want the boat to be moving at all. Even though it was very stable, you could see, if you went from the back of the boat to the front of the boat, a minor change in the data. So we were very careful not to move around a lot. And it was basically looking ahead to make sure there were no hazards in the water and watching the computer that was programmed with these transects that told me if I was off the planned line or on the planned line, and we just would drive back and forth .

The south part of the Lake was fairly uneventful. Everything looked like it was supposed to. The water was greenish in color. When we hit the end of the line, when the bottom of the skegs, which are the fins on the bottom of boat engines, when you felt the boat start to vibrate a little bit in really shallow water, you knew it was time to turn because that meant that you were going to run aground fairly soon. So we took the engines up a little bit—we had hydraulic lifters on the engines—took the engines up a little bit and made our turn and went up to the next line. Just before we reached the next transect start, we'd make the turn so we ended up right on that transect and then head back in the other direction. So we just zigzagged back and forth up the Lake until we got it done.

BBL: Who were you traveling with?

RLB: Generally, for the south part of the work, it was myself and David Allen, who was a technician here, since retired, and an occasional student. We liked to train students and get them exposed to various different aspects of work and how data are collected, etcetera. So we would take students out there. We'd just show them how everything worked and let them drive the boat and freak them out because we'd put them in charge and say, "Okay, stay on the line." And boats steer from the rear, they don't steer from the front, they steer from the rear. So it's like backing up a car when you're facing the back of the car. So if they've never done it before it's very strange to them. It didn't matter if we drifted off the transect a little bit because the data was still there. We were still collecting data no matter where we went because the system, once I got it started, it would generally run all day with no problems. So we'd put students in there and say, "Okay, stay on the line." They'd overcorrect and they'd steer in the wrong direction, things like that. They'd think that they were committing the biggest crime in the world by drifting ten meters off the line. We'd sit there and laugh and say, "Oh no! Oh, oh! It's ruined! We've got to start all over!" Things like that. But it didn't matter to us because we still got the bathymetric data that we needed if it wasn't right on some arbitrarily collected line. So we would tease them, "Oh, look at this. Are you drunk today?" Or whatever. But they learned—eventually they learned—that the objective was to keep good quality control and make sure that the data were being collected and not to move around the boat. We'd teach them what they needed to do to collect good data and it wasn't a big deal.

They would learn how to drive the boat and all the safety issues. We always had redundant systems because the saltwater would eat up everything. So we always had two motors. We always had two operators out there, two people. Two fire extinguishers. Two radios. Two GPSs. Everything, so if something went bad we could repair it right then and there. But the students always enjoyed going out.

We got caught in a few storms, even to the point when coming back one day, we had a storm come up, well, we got caught in a water spout out on the west side of the Lake. We just threw out—we always have two anchors—so we had an anchor out on both the bow and the stern of the boat and we just sat there and let the engines idle, just anchored it as the winds whipped around us. We were just riding it out. We always have our PFDs, or personal flotation devices—lifejackets—on when we're out there. So we just rode that one out.

I remember coming back once, we got caught coming to the south harbor and the wind started kicking up, so we shut down the equipment. By the time we got close to the harbor, we had waves actually breaking over the top of the boat. That's probably five feet above the regular water surface. It was pretty amazing. I was worried that they were going to smash the window out of the front of the boat, because it was a rather flat surface. The waves were hitting almost directly, but it didn't.

BBL: I've heard of the Tooele Twisters.

RLB: Yes, I know them well.

BBL: An afternoon storm kicks up.

RLB: Yeah, it comes around the point there at the north end of the Oquirrhs. Oh, yeah. I was out sailing once and we got caught in one of those. We had to reef the sail and everything like in a minute it was so bad.

BBL: It comes up pretty quickly, from what I understand.

RLB: Yes. But that was probably a Tooele Twister when we were in there with the boat because it was just horrible, horrible conditions. We got through it with no problems, but it stopped us from surveying.

BBL: That's probably pretty scary being out in the middle of that, isn't it?

RLB: Oh, I've seen as bad. Pyramid Lake, we got in a condition there that was pretty amazing. But we've got a welded hull aluminum boat with positive flotation, two engines, self-bailing deck. If water gets in it, it runs out the back. Two 12-volt batteries to run the engine so if one battery goes bad, you've got another backup. We have a battery in the cabin for the equipment. We've got generators, we've got lifejackets on, we've got throwable life jackets, we've got dual everything. So it's just a matter of will the boat survive and as long as I paid attention and pointed it into the waves at a twenty- to thirty-degree angle and did all that, did what I was supposed to do, there was not really any concern that we were going to sink. It's just we weren't able to collect any data; that's what we were there for.

BBL: So you were as prepared as you could be and then just took what came.

RLB: Yes, that's all I can do.

BBL: So would you look at a week and say let's plan to go out Tuesday, Wednesday, Thursday, weather dependent.

RLB: Yes.

BBL: Then you'd go or maybe you'd wake up that day and say, "Oh, we can't go. The conditions aren't good."

RLB: Yes, that's exactly how we did it. It's all opportunistic; when the conditions were right and we didn't have other things we had to do, travel or meetings or all the standard office sort of activities that sometimes overruled the data collection, but generally we tried to make sure that we did office-related stuff on those bad weather days and we were actually out on the water collecting data on good weather days. But, yeah, if the weather was good, we'd go.

But we had occasional engine problems. You're dealing with hyper saline water, so the engines would give us fits every so often. We'd have to take them in and get them cleaned out. Things like that.

BBL: You never got stranded, though, where you had to be towed?

RLB: No, actually not on this project. We ran aground, but the boat that we had modified, the design, I had them put what are called doublers on the keel and chines of the boat. I had them also increase the hull thickness to a quarter of an inch of marine aluminum. So you had a half an inch of aluminum on the keel, which is the part that goes down the center of the boat, and the chines are for those two kind of outrigger sides of the boat, those pontoon-type edges of the boat, had doublers on those, too, so if you ran aground, chances are that that's what would hit first. And because we were going so slow, *kuuuuuwwww*, you'd slow down and then, okay, you'd put the engines in reverse or whatever and bring them up a little bit and you'd come right off of it. But we never got stuck, stuck where there was any problem.

BBL: Right. Did you have any other equipment issues that came up, particularly with your measuring equipment? Did you have any problems with those as you went along?

RLB: Not really. It was sometimes tricky to set up the communications because I was using standard, what are called the NMEA sentences, National Marine Electronics Association, to have the equipment talk to each other. We did corrode out the display on my first computer due to the salt water, I guess just the mist or whatever. We never got the computers wet, but the contact between the display and the computer itself, the wiring harness, ended up corroding, so the screen went dead. It could still record data; you just couldn't see what you were typing in the computer. When we pulled it apart to see if we could fix it, there was corrosion all over the rest of the laptop. So we lost a laptop doing that work and had to buy another one.

But there were always maintenance issues in terms of electrical contacts. Everything had to be sprayed with a clear lacquer to keep things from corroding. The fuel gauge corroded away, so we didn't know how much fuel we had for a while until I took the deck plate off and went down there and pulled it apart and cleaned everything and put the contacts back together and then coated it with liquid rubber tape, just a rubber compound.

We'd have the engines tuned up once a year or so just because things would corrode. We've had spark plugs that would gap against the next spark plug wire. We had spark plug wires burn through the sheathing on the spark plugs, so we'd have to replace spark plug wires and things like that that were salt-associated, because you're constantly churning up saltwater and if you get caught out there in a heavy wind or whatever, the boat would be just covered with saltwater. Launching, recovering the boat out of the water, the engine would be going full bore because we had the power on the trailers frequently because of the launch conditions. We had to actually run the boat onto the trailer rather than just park it on and pull it out. So we'd actually power it onto the trailer. But that's just normal operations. Those are the sorts of things that happen out there on the Lake. It's just you have to be aware of the conditions and get off the Lake before it becomes too dangerous.

BBL: Right. About what years was this happening?

RLB: That was back at 2005 or 2006, perhaps, for the south part of the Lake.

BBL: Then the next year for the north?

RLB: Well, we had the contract. Once I figured out that we could use this sugar solution and how to survey the first part of the Lake, I made the map of the south part of the Lake. The State, that was funded by…I'll have to look it up. It was the Great Salt Lake Ecosystem Project, perhaps. Or perhaps Utah Water Rights. We have a program that's called Cooperative Funding for scientific investigations that benefit both a cooperator and the federal government—we have to have some vested interest on the federal government side for a project, for us to cooperate with someone in this sort of capacity. For projects that meet that criteria, we'll supply forty percent of the cost of the project to actually collect the data and do all the work. So we got the first project, the bathymetric map, because if you're studying the Lake, anything you do, if you want to do a model for nutrient dynamics or circulation or whatever, you have to start with the basic physical properties of the Lake. How deep is it? Where is it deep? How does it change? How does the depth change? Where is the water? And you can't do that without having a good bathymetry. That's what the bathymetry defines, the shape and the physical characteristics of the Lake. So you have to start with that. So we had been in discussions with the State. And once I figured out how to do that, to correct for the sound velocity issue, the State funded the south part of the Lake. Then the State Division of Forestry, Fire and State Lands that owns the bed of Great Salt Lake, once they saw that map they said, "Well, go do the north part." Well that was, "Sure, I can do the north part." Turned out to be a little bit more exciting than doing the south.

BBL: So that would have been the next year, 2007?

RLB: Yeah, 2006, 2007. Yeah, it followed fairly soon afterward. As soon as they saw that map, the first one, they said, "Oh, yeah. Let's do that one."

BBL: So tell us about the north part.

RLB: Well, the north was a little bit more interesting. Number one, it's hard to get there. If we tried to live here in Salt Lake—most people live locally—and drive the boat around, it's about a three to three-and-a-half hour drive to go up to Corinne and go to the north end of the Promontory Mountains. We go south, then, along Promontory Mountains out to Promontory Point and then around to the west side and then launch at Little Valley boat harbor. It would have taken us most of the day to do that and we can't leave this boat with all this equipment sitting out because there's risk of theft, and if things were stolen, then we're down and we can't collect data anyway. So we have to protect the boat somehow.

So our only other option was to cross the salt ponds where Compass Minerals operates on the northeast part of the Lake. Even though they allow us fairly easy access to cross those ponds, when they're harvesting salt, when they're working on their dikes or whatever, it's a problem for them and for us to be pulling a boat across this really rough dike that's one lane wide and they've got semi-trucks that are going down there. So that was not an easy solution either.

So the other solution was, well, a couple others. We could have either gotten a hotel up on the east side of the Lake and driven across every day, or we could just live out there. So I opted for the live out there because if the conditions were good, we wanted to get on the Lake and get the data collected. The expense of a hotel for two people for a month and a half, it just didn't seem feasible to spend that kind of money when I could go out and spend a thousand dollars on a few tents and the gear we needed to live out there. I put a fuel tank in the back of a pickup truck and we burned about a half a tank a day, maybe a little bit more on the boat, so every three days or so we'd bring the boat and the truck with the fuel tank back across to the closest gas station, fill everything back up, get food supplies and head back out to the Lake and live there for three or four days. As we burned up the fuel, as soon as we ran out of fuel from both the boat and the tank on the truck, we'd have to drive back in and restock.

We lived out on Little Valley Harbor, on the west side of Promontory Point, and it was generally myself and Jane Turner, who was a student who used to work here. She was one of the best, most conscientious students—I cycle through a lot of students and have over my career—that I had. She had done some support for Grand Canyon river running groups and had been their cook and their camp manager and that sort of thing as people went down the river. So I thought there's no way I'm going to be able to take care of the boat, and collect the data, and come in just as it's getting dark and cook and process data and fuel and do everything. So I thought, well, who can I get to go out there and camp in the middle of nowhere and Jane was the perfect choice. I went out and looked for people with those sort of characteristics and Jane was one of the people that applied.

BBL: Were there a number of people who were interested in doing that?

RLB: There were people who were interested in doing that, but no one…many of the applications we get are—I can't say many—some of the applications we get are from people that just put their resume in for everything, whether they're qualified or not.

BBL: They need a job.

RLB: Yeah. We look at everybody that is qualified and we have to go through every single application. Sometimes it's pretty onerous to go through every single one of them and say, okay, this is what we advertised for and we write those needs based upon what we actually need. And we write up the application, the form that they need to fill out, based upon those needs. Sometimes we get people with just a couple of them; sometimes we get people with none of those needs; sometimes we get people with all those needs. Getting someone who has that kind of experience is rare, but Jane had that kind of experience. She could handle both the technical aspects to help me run the equipment, process data, very sharp. She also could take care of…knowing myself, I'd go out there and eat cold ham sandwiches for every meal, just buy five pounds of ham and five loaves of bread and I'd stay out there for a week and that would be it. But I knew that was not going to work. We needed two people that we could just separate the duties and I would take care of getting the boat taken care of or whatever, and processing data, while she did other things and we took turns cooking and stuff like that. But I needed somebody I could trust to do a good job and to…I don't know how to say this. I needed somebody that I didn't have to worry about, kind of a proven asset that if something was going wrong or if for some reason I was knocked unconscious out there on the Lake or whatever that I knew that person could be responsible and take care of that. Jane fit the bill. There were some other people that I know now that could do the same thing, but at the time, knowing what we needed to do and the hazards out there, which there are many from rattlesnakes to mice and rats in the food supplies, things like that, it kind of had to be someone that could handle it. So we went out, we looked for people with those sort of skills and actually Jane was the only one that applied that had those skills. So we just hired her on a temporary basis, I think it was for six months or something like that, because she was a student and we could just pretty much reinstate her at the time because she had worked here previously. Anyway, I went to Kirkham's and bought a bunch of camping gear. Salvaged what I could from our warehouse in terms of other equipment and went out there and set up camp.

There were lots of problems out there. The water's pink—actually, the water's not pink; the cyanobacteria in the water are pink**.** Launching was very difficult because the ramp was unimproved at that time, so we sometimes had to hook up two vehicles and a winch to get the boat out of the water. The water's so salty that you actually have salt that forms in the exhaust ports of engines, closes up the engines like someone stuck a potato in the tailpipe of your car. There'd be so much back pressure that the car wouldn't work, the engine wouldn't work, and it would eventually stall. And that happened out there frequently. So every couple of weeks, every week, perhaps, I had a mechanic come out and drop the lower units off of the engines and I would separate the engine part from the drive shaft part and chip out this salty mix, well, it was a mix of salt and carbon and engine oil and everything else that was coming out of the exhaust ports and it would actually form rock inside the engine there. So we'd have to drop the lower units and chip that out. It was very strange.

BBL: And you had anticipated that in advance? You knew that was going to be an issue?

RLB: Yeah, I had thought that was going to be a problem. We'd run it and one of the engines would start losing power, *oh, yeah, it's happening*. So he would come out on a regular basis to try to prevent that from reoccurring, because we didn't want to get stuck out there. The water density's so high, it's very dangerous.

BBL: And not an easy rescue if you get stuck.

RLB: No rescue. You're hours away from anybody else even putting a boat on the water, let alone being able to maneuver out there and come to get you. So we spent, I think it took us about a month and a half, or two months of time living out there, driving back and forth, just like the south, to collect the data. But it was gorgeous. You had no evidence of any man-caused anything. So it was like the Lake that man was never around, except for the causeway. There was this big line across there and every so often you'd see this train just come out of the water because you were so far away from the west edge of the Lake that you couldn't see the causeway over there, but you could see this train coming slowly climbing out of the water onto the tracks. The sunsets were incredible because you're looking across this pink water towards mountains that are far in the distance, and with dust getting stirred up in Nevada, it just was amazing. It was really nice. Two or three times we had a storm come through and actually flatten every single one of our tents. These were wind-proof, they were staked down, but these storms would come through and just flatten everything. I remember many a night standing up in the middle of the night holding onto the tent to support it so it wouldn't blow over. We had a separate tent that we would eat in. To keep the mice and rats out, everything was in plastic containers, things like that, to prevent the mice and the rats from getting to the food.

BBL: Were the rats and mice a problem? Were they there?

RLB: Oh, they were there. I think they were pack rats. They weren't the normal, like, city rats.

BBL: But because you had everything packaged up okay, you didn't have problems with them?

RLB: No, but we saw them. They were around. But, you know, it's just what you deal with out there.

BBL: Part of the camping experience.

RLB: Yeah. And there was a rancher out there that ran sheep, so while we were out there during part of it, *baaah, baaah, baaah*. You'd hear sheep in the morning waking you up. We saw rattlesnakes on the dirt road going out there.

BBL: Never any in your tent?

RLB: Never any in the tent.

BBL: So once you went out there, did you just stay? Did you ever say, "Let's take a weekend and go back home to Salt Lake"?

RLB: We did do that whenever the weather turned bad.

BBL: For a prolonged period of time.

RLB: For a day or two, yeah, until the weather, if it was stormy there was no use us being out there. And the boat we would leave out there unless we brought it back to get it refueled or whatever, but we'd leave the boat out there because there were two different gates that people had to get past, and then miles of, if they walked past the gates, it's miles of walking out to the middle of nowhere. And the rancher was there occasionally checking on the sheep. So it was a fairly secure area. So, yeah, if the weather was bad, there was no use us just sitting there because in order to get power we'd have to run a generator to charge the computers, etcetera, so we just came back into town.

BBL: I see. But basically you were out there pretty much full time.

RLB: Yeah, it was a lot of time. My wife was going, "Oh, man, you're gone a lot." "It's okay, honey. All you have to do is call." But, of course, out there there was no cell coverage. So we had to, if there were any problems or whatever, we actually had to drive five miles to get a weak cell phone signal to call in and say everything's fine. I tried to call in every so often. I didn't call in once for like five days because the weather was great and we were busy and my wife got worried, called my boss, "Have you heard from them yet?" He said, "Yeah, he's okay."

BBL: No news is good news.

RLB: Yeah, no news is good news. But it was a very strange environment because you'd spend hours looking ahead in front of the boat, making sure there weren't any floating logs or pilings or anything there. You'd be keeping your eye on your depth finder to make sure your depth readings were good and the GPS navigation computer to make sure you were along transects. So you're constantly looking everywhere and you get used to the water being pink because you were looking at the water most of the time. You'd look up and the sky would be bright blue. You knew something was wrong, but you couldn't figure out what it was because you were so used to the pink water, you couldn't identify that the water color was pink and that was what was wrong because that was what was natural after a while. So you know that the sky was supposed to be blue and the water was supposed to be pink, but it didn't match with my many, many years of operating on a bunch of other lakes that are blue-green water. So you'd just kind of get confused or just kind of, *mmmm, something's not right.* And you'd start checking to see if the engines were running okay, the water temperature's good, the equipment's running. *Mmmm. Okay, well, we'll just keep going*. But I remember that happening a number of times, because it's just, you know, if everybody around you was green, eventually you'd get used to it and a green person walking down the street wouldn't be an issue, but something still wouldn't quite be right. That's what it was like out there, something just wasn't right, and it was because the water was pink and you just got used to it.

So we just did the same thing we did in the south arm: drive back and forth. A lot more boat maintenance, a lot more issues, many more issues with salt coating everything, big salt crystals. In some of the northern parts of the Lake, we limped on barely operating motors, because after sometimes two or three days of really long days, the motors would be clogged up and we'd have to call on Shawn, "Come on out here." But luckily, the mechanic lived up in Syracuse, so it was a couple of hours for him to get out there. The greatest mechanic in the world. Just amazing. He would make house calls and drive out there and fix the engines and we'd go out again. Of course, we had to pay for him to do that, but we were saving up money not staying in a motel, roughing it, as it were. Then the project could afford to pay him to come out there to fix it.

BBL: You said there were some storms that came through that knocked down your tents. Out on the Lake, did you get caught on the Lake sometimes in storms?

RLB: We only got caught out on the north end a couple of times, but we made it back in. I remember one time the engine started to clog up when we were way at the extreme north end of the Lake. So I turned off one engine to keep it from basically shutting down and came back slowly on the other engine. Then it would start to have problems, so I'd turn that one off, lower down the other engine and use it until it really started to clog. Then I lost, like I said, that one engine, started limping back on the other one, but by then it was like one o'clock in the morning. There's a very narrow channel that you have to find to get back into the harbor. We had the transects planned out, but I forgot to program in entrance or exit to that narrow channel. Of course, at night, the water is all the same color, you can't see very far. There are no lights marking where it is. So we spent probably an hour just coming up to the fault, because we watched the depth finder and there's a pretty prominent drop off where the fault is and you can see all of a sudden the depth start to get really shallow, then we'd turn and go back out and go down another hundred meters or whatever, and point it back towards the…so we'd zigzag in until we finally got close enough where we could see a piling that we knew was close to the end of the harbor and finally found the entrance and came back in. It's part of the game. We collected data as much, as long as we could out there while the conditions were good. But it was, like I said, a very strange environment.

Because we were out there camping, we would use these solar bags, which are basically plastic bags, really thick plastic, that have a black liner on one side and a clear liner on the other. We'd put them on the deck of the boat filled with water, so eventually in the afternoon that water would heat up from the solar heating, and we had two big bags out there, and that's how we got hot water to take showers. So we would take showers during the day as we were surveying because we had hot water and when you're operating the boat, you're looking in one direction, so the other person would be in the back there showering as we were driving along. As long as we kept the shower in the center of the boat, the moving around didn't bother the quality of the data at all. So that's where our hot water came from.

We had to bring all of our water, also. There's no fresh water source out there.

BBL: So that would be part of the provisioning that you would have every three days or whatever.

RLB: Yeah. We had these two, probably thirty gallon, thirty-five gallon plastic containers that we would fill up with the hose and that would be our drinking water and washing water and cooking water and everything else that we'd haul out there. And that would also be our engine rinse water, because when you came back in off the Lake, there was another hour, probably, of maintenance, cleaning everything out, backing up the data, and then we had to rinse the engines out with fresh water to try to remove some of the salt that we had accumulated during the day in the engines. It didn't work very well for the salt that was being deposited at the end of the engine exhaust, because that had been coated with hydrocarbons from the engine and carbon, etcetera. So it was really hard to dissolve that. In fact we couldn't dissolve that; we had to chip it out, but stuff that was actually inside of the engine, we had to flush both the engines out and rinse down the boat, so we'd go through that water. It lasted us probably four or five days, something like that.

BBL: Wow. Just all the advance planning and anticipating all the needs that you had would be a lot.

RLB: Yeah, it was a lot of thought put into the entire process. But I'd been working on the Lake, the south part of the Lake for many years, for ten or fifteen years by then, so I knew a lot of the problems, a lot of the issues, how the boat would handle in different conditions, the issues with the high density water, the boat floats higher, so it becomes a little bit more unstable in turns, things like that. Because of the design of the hull, you can actually turn the boat and the rear of the boat will skip sideways. If you're going really fast, it will skip sideways across the water, so you can do these power turns where you can, the front of the boat is not stationary, it's still moving through the water, but the boat's rotating on itself. It's actually fairly dangerous, because if you hit a wave or something like that, it would stop that motion and possibly flip the boat over, so it's not done regularly.

I'm also a motorboat operator instructor and teach classes in motorboat operation and safety for the USGS. That's one of the things, using this boat, I had them bring it up on plane and had them go fast enough and make a sharp enough turn where it starts to skid and it scares people because it's unstable.

BBL: And you can feel that.

RLB: Yeah, you can feel that. So I had them just take it to that point, *if you feel anything like this, you're going too fast*, just to experience it, so they can get a little experience on what the extremes are.

Anyway, just to give you an example of what the water was like out there, it was one of those days where it was really hot, really hot. Went in the cabin. Jane's studying for her GREs. I'm asking her questions. I have a full sheet I read off of, you know, what is the opposite of some strange word that you'd never use in your life. She'd have to spout it back at me because she was studying out there, because once everything got going, whoever was in control of the boat just had to keep it on the transect or very close and just make sure all the equipment was running, the data was coming in and logging. I had it set up so if one of the systems failed, it showed a little red square around that system, otherwise it was green, so when you'd see the red square it was, *oh, we lost communications*. We'd have to stop, circle back around to a point where we had data and then start again, which didn't happen very often.

But it was really hot. Most people, and I'm fairly sure of the "most" on this, have never been in the Great Salt Lake, probably half the population or more of Salt Lake City has never been to the Lake. But Jane wanted to go swimming. I said, "Sure, go ahead." So she stripped down to her skivvies and dove over the side of the boat—I was there with my PFD on in case there were any problems; we were in the middle of the Lake—and her feet never went below the water. Diving into the water, the buoyant effect of the saltwater was so high that she would dive in and she just pretty much came almost straight back out of the water because it's that buoyant. It was like, *what*? She was floating, but you could tell it wasn't right. It's another one of those moments where it's like *something's wrong here*, because when she tried to swim, her body was not in the water, her body wasn't low enough in the water to actually be real because of the buoyancy. She tried to dive under the water and she couldn't get under the water. It's close to saturation, sodium chloride saturation, which is about 27.5%. If you took one meter of water and evaporated the water from North Salt Lake, you'd have 2.7 decimeters of solid salt in the bottom of that. So almost a third of the water in the north part of the Lake is salt. So that's how dense it is. So when you're driving a boat through it, if you hit a wave or whatever, it wants to stop the boat. It's not like the ocean or a freshwater lake where you can cut through the wave fairly easily. It's a high density fluid compared to regular fresh water.

But it was just the strangest thing, getting in that water. I've not dove into it, but I've swam in it before.

BBL: In the north?

RLB: In the north part, yeah.

BBL: Because I was thinking that must have been painful, wasn't it, for her to dive into that?

RLB: No. She had to keep her eyes closed and I don't know if I sprayed them off with fresh water or gave her some fresh water to rinse her face off with just after she got in there. Yeah, it stings your eyes. I dove in the south part of the Lake and if it gets in your eyes, it's pretty painful.

BBL: No kidding. That's intense. I've been in the south water, but I can't imagine being in the north with that much salt, that dense. I admire her for doing that (laughs). Was that the only time she did it?

RLB: Yeah, that was the only time she did it (laughs).

BBL: I have this picture in my mind of her diving in and then just bobbing up like a cork.

RLB: Yeah, just came right back out. Her feet never went under the water. Then, of course, she flattened out as soon as she came up, but it was very strange.

But, anyway, we would drive back and forth. We would study for her GREs.

BBL: How did you pass the time? You must have become very well acquainted talking about everything.

RLB: We did. We mainly studied for her test.

BBL: Did she do well on that test? You don't have to answer that.

RLB: Oh, she just got her PhD in some, I don't know the exact…she's studying the effect of certain types of dust on lung tissue at the University of Colorado. So she's done extremely well. Very, very smart woman.

BBL: Then when you were out on the Lake, looking ahead trying to avoid whatever was out there or just tracking where you were going, did you tend to get highway hypnosis?

RLB: A little bit, yeah. You just kind of, that's your field of view and that's it. You look around. But you're always listening for changes in engine pitch because if the engines start having problems, the first thing you notice is that the sound of the engines change. There was always this *mmmmmmmmmmmmmmmm* [varies pitch]. As soon as you hear that pitch change, *uh-oh, there's an issue here*. So you're always listening for that. You're feeling for strange boat movement. If all of a sudden you feel a little tick on the boat or something, you may have hit something, there may be something that you ran aground, but you generally avoid that sort of stuff because you're looking at your speed, you're looking at the depth, you're looking at a graphical representation of the depth, you're looking at the data coming in to make sure that the numbers from the digital feed from the depth finder are coming in. You're making sure that everything's green and everything's still good. You're looking ahead into the water to look for logs or any navigation hazards. You're looking over at the depth finder because I recorded analog data on a paper tape at the same time I recorded the digital data to make sure that if for some reason something happened and we lost the digital data, I can go back and at least retrace what I collected from the analog data. We can put that paper tape on a digitizing board and register the minimum and maximum and sit there and digitize that, if I needed to as a backup, because going back out at some later date to resurvey a little section of the line just was not financially responsible and it would have been difficult, very difficult.

BBL: Did you ever end up having to do that, use the analog data?

RLB: No. But the analog data showed some things that the digital data didn't. If there was an issue with the digital data and you got spurious reflections, you'll get the, in some places, you could actually see the difference between a deeper high density brine layer than in the shallower less dense brine. So there's a high density brine layer, especially in the north, because Compass Minerals has operation ponds on the west side of the north side of the Lake. What they do is they pre-treat or pre-evaporate water out there to close to saturation for potassium chloride. They evaporate some of the water out there, then they pump that into the Behrens Trench, which is basically a ditch that was dug underneath the Great Salt Lake and it runs from the west side of the Lake to the east side of the Lake. It's just an open ditch, but it's on the bottom of the Lake. They pump this high density brine into that ditch and it flows down the ditch underwater to the east side of the Lake where they have big intakes and they suck out that high density brine out of there and bring it over to the east side of the Lake, the northeast corner, to finish it, to finish the evaporation process. But if they have problems with their pump system or there's a failure in the canal that's down there, a slope failure and it clogs up a little bit, some of that high density brine will start to build up in the bottom of the Lake because it will rise above the level of the canal. It will fill up the canal and overflow into the bottom of the Lake. Well, that high density brine has a density difference strong enough that we can see that with the depth finder. The digital part of the depth finder doesn't want to see that; it wants to take the deepest part of the Lake, the deepest reading it gets. So you'll be going along and you'll have a bunch of 5.8 meters and then all of a sudden you'll go up to 4.3, 4.3, 5.8, 5.8, 5.8, 5.8, 4.3, 4.3, 4.3, etcetera. So the digital data will have these spurious elevations that there's no way—well there is a way, but it's highly unlikely—that you'll have a meter vertical difference within a third of a meter distance horizontally, and then drop right down. It would be like you had a bunch of two-by-fours stuck in the bottom of the mud, or at the bottom of the Lake. It's not going to happen. But you can tell that on the analog data. You can see that there's kind of a little ghost reflection that's flat, relatively flat, that is hanging over top of the main trace of the bottom of the Lake. That would tell you that these spurious reflections are a result of that high density brine layer that's sitting down there. So then you know why, which was a big concern when you get these weird reflections in the water column. Why are they there? What's causing them? Are they air bubbles? Are they the deep brine layer? Is it the debris that's partially submerged? Is it a telephone pole? Is it an old boat that sunk out there? You just don't know. But the analog would give you information that helps you figure out why you're getting these readings on the digital data.

Of course, then once we collected all that data, we had to process it. There were 12.7 million points, I think, total, that we collected and split up between the north and south part of the Lake. That's X, Y, Z, and when you have to go through all of those data and get rid of all these spurious reflections and correct them all for sound velocities, from the periodic sound velocity measurements that you make, then go through and try to contour them.

BBL: Okay. We'll come back to that in a second. I want to go back and ask a few more questions. Did you find any shipwrecks or any treasures or any really interesting things?

RLB: Lots of treasure (laughs)! No, unfortunately, using a single beam system, all you'd see is if you ran into, not literally ran into something, but crossed over top of something, you would see this spike. Or going across the Behrens Trench, all of a sudden you'd see this big U-shaped hole in the bottom of the Lake and it would flatten back out. When they built the Behrens Trench, they used a dragline to dig that out and they'd put the spoils off a little ways to the north for most of that. So you go across there and you see all of a sudden the bottom would get bumpy. You go, *what*? Of course, we couldn't see the bottom. So we didn't know what it was, but that was the bathymetry, that was the data, that's what it looked like there. So when you try to contour that, when you've got these little bumps, you might hit them on one line, but you wouldn't see them again on the next line. So all of a sudden your contours would get all messed up, but because you didn't see them on one and you saw them on the other, you'd know it was just a local problem, or an issue. You could go through and, because we were just doing the general bathymetry of the Lake, we couldn't get down to, even though the system could get down to one centimeter, I contoured at a half a foot. The State wanted it in feet, the map in feet, so I contoured on a half a foot. A lot of those small variations just disappeared because of rounding, the interval.

But we do have all of those data still and it's down to little tiny changes. Some of those changes were, you could see bioherms and various other structures on the bottom of the Lake. I thought I saw, and in some cases going back and looking at some side scans, sonar data that I have, that there were some unusual objects, perfectly round things that looked like they may have been tires, things like that. So there are some objects down there that I don't know what they are, but it's not, it was not pertinent to the bathymetry.

And using that technology, I couldn't see if there was a F-16 lying on the bottom of the Lake or whatever. All I would see is basically a profile across whatever, a piece of a wing or something like that, and it didn't show up on the next line, didn't show up on the next line, and the task was to get a natural bathymetry of the Lake, so those little things never showed up in the final product.

BBL: I'm guessing while you were out in the Lake, on the north part, you didn't ever run into other people.

RLB: The landowner.

BBL: Aside from the shore, while you were out on the Lake proper.

RLB: No, no. No one else was out there.

BBL: Did you ever have a sense of being freaked out, like *I am so remote, this is so far away*?

RLB: No. Never. Always redundant systems. Towards the last half of that effort, we did have a satellite phone and we used it once because we had a software issue. Because of government security, only the systems administrator or people at headquarters can modify the software on our computers and so there was a problem with the software and we had to reinstall it. I'm out there in the middle of the Lake and the weather's good and it's like, *Ah*! But I don't have permission to go in there and even just reinstall the software that I'm using to collect the data with. So I had to call the system administrator and he had to then give me the secret password to that particular computer, because the computers all have administrator passwords that are unique to those computers. So he had to give me that password so I could reinstall the software. But then he had to come in and change stuff here so I couldn't use that administrator password, except for that particular thing. Oh! It just, you know, it's crazy and that was the only time, really, that he's given me one of those passwords because that gives me access to put on anything on that computer, including evil things, which, of course, I would never do. But it's one of those security things that the USGS says you don't administer your own computers; that's someone with a higher security clearance. Anyway, it took us like eight telephone calls to keep the connection open long enough to get enough information to get everything reinstalled and operational.

BBL: So maybe a different question along that same line is did you ever, when you were out there and so remote and alone, did you ever have a moment where you thought, *this is so cool, to be alone and so remote and so far away*?

RLB: Oh, frequently. Yeah. But I was never alone out there; there was always someone else on the boat.

BBL: Sure.

RLB: I'm not sure on the north arm if anyone else came out with us on the boat, except for myself and Jane.

BBL: Any students or anybody.

RLB: Yeah, because it was just so remote and it was a pain for anybody else to get there. I would have to come back into shore and get them, across the salt flats, unless I wanted to drive that three-and-a-half hours around. But, thankfully, Compass was nice enough to let us cross their ponds. But, I don't think anybody except myself and Jane actually collected data on the north part of the Lake. But, yeah, it was like, *oh, this is incredible, this is amazing*, because I remember one time the sun was setting and we were just coming in and there was a train coming across the railroad causeway and the sun was just going down. So there was a bright orange orb there in the west, but the train was reflecting all of the sunlight that was glancing off of the Lake and off of the sun, so it looked like there was this train that was on fire that was coming across the causeway. I actually have a picture of it somewhere. It was this bright orange, it looked like, because of the shimmering effect that you get off of the Lake, it looked like the train was actually on fire coming out of this lake. It was really cool because you see this train—you can't see it, of course—on the west side of the Lake, but you see it slowly rising out of the water and it's on fire, it looks like it's on fire, and it slowly comes into view and passes close to you eventually. It was just amazing.

I remember there are lots of organics dissolved in the Lake and you may have seen foam out there on the Lake. You get these big piles of foam. Well, in the north it's even worse. There are piles of foam that were larger than our boat, that are just gigantic, huge foam piles ten feet tall and hundreds of feet long, after storms, immediately after storms. The wind would be blowing and these giant foam blocks and balls would be rolling across the railroad tracks and blowing up into the sky and falling all over. It was just incredible. We drove the boat through a couple of them. We were out there in the middle of the Lake, when we know there's nothing out there, but immediately after storms if it got calm, because the water's really dense and the water will calm down and flatten out very quickly, we'd go out there, but there'd be these big, huge piles of foam still going around. They'd have some brine shrimp cysts in them, the little tiny brown things, and they'd have salt crystals everywhere. So when they dry, you'd have these little salt patterns all over the boat. Of course, we had to wash the windshield and everything else off as soon as we did that a couple of times. But that was probably the extent of our fun out there. That was just a strange experience. We'd scoop it up in our hands and look at it and play with it, look at it with magnifying glasses and things like that. But just these giant blocks of, like you'd see in a sink if you put too much dish detergent in and just let it run. These huge gooey piles of foam.

BBL: I didn't know that.

RLB: Yeah, it's amazing. Then when the Lake was perfectly calm, you'd get reflections of the mountains and everything in the background and it would be like a mirror, but it would be tinted pink because you see blue water reflecting a nice blue sky, but here you get the water reflecting kind of a pinkish hue to everything. Being out there at night or if it's slightly foggy, you can't tell the difference between the water and the sky. They kind of have the same grayish color. So you don't know where the horizon is, you're just going along blind. That's why you have a differential real-time global positioning system, so you know where you are on the Lake. I had an image of the Lake imbedded underneath the transect on the navigation system, so I knew approximately where on the Lake I was, so I could tell if I was getting close to shore or whatever and appropriately slow down to two or three knots at that point. So if I did run aground or hit something, it didn't damage anything.

BBL: Right. Was it ever boring out there? Did you ever find yourself just bored?

RLB: During the routine data collection, if everything was working perfectly and it was nice and smooth and we had been up late the night before and fighting winds and processing data or had to go get fuel or whatever, at times we were…I don't know if bored would be the right term, but it was kind of like, *okay, let's do it*. I remember us talking about whatever and just to kind of keep us alert, because everything was just so…relaxing might be a good term for it, because everything, it can be, one minute it can be just extreme, you're crazy because something's happening, a piece of equipment is having problems and we're trying to connect things and one of us is steering the boat in a big circle while we get the equipment up and running. So when we get it up and running, we have to overlap the previous transect or get it reasonably close so then we can continue on in that direction. So we're both busy doing something or the cowling's off the engine, separating wires or replacing a wire or something. Then a little while later it's like, well, okay, nothing to do, nothing to do, because everything's working perfectly.

BBL: Back to calm.

RLB: Yeah. So it's not feast or famine, but it's crazy versus calm. It was very relaxing. You've got this nice *mmmmmmmmmmmmmmmmm* of the motors and Jane could be over there reading a book or studying for her exam and we're not talking and I'm just driving along. I can't say there was nothing to worry about, because there's always something to worry about, but it was never at the forefront because everything was working the way it should have. So we'd just drive back and forth. Yeah, probably something always went wrong every day, but it wasn't life threatening or an emergency or something like that. We'd have to change something out or we lost data communications once or twice during the day, or we had to change course slightly because there was a log floating in the water and we had to go around it. But other than that, it was pretty, I wouldn't say easy, but when things were going the way they should go, in my opinion, I think there wasn't a lot of difficulty in doing the data collection. It was just all the logistics and the preparation and all that. If something did go wrong, then there were lots of issues.

BBL: But you always got them solved one way or another, it sounds like.

RLB: Uh-huh.

BBL: Any animals. Did you see birds?

RLB: Oh, yeah. Pelicans were flying over all the time because, in the north part of the Lake, we were surveying basically under the migration route of the pelicans. From Pelican Island they would fly generally to the northeast, probably to the wildlife refuge or points beyond to feed, and then come back to Pelican Island, or Gunnison Island, I think is the correct terminology, when they were done. So we saw lots of pelicans back and forth. Rare to see seagulls; we did see some seagulls up in the north part of the Lake. Some small shorebirds, avocets, along the edges. But if a bird was in the water in the north part of the Lake, there was a chance it probably was having problems and it probably wouldn't survive because it would get salt crystals formed in the feathers and then it can't take off. There's no food there for them to eat, no fresh water, so we saw probably one or two pelicans in the Lake. There was no way we could have rescued them or gotten them out of there. Lots of rabbits along the shore. We were driving the truck and there were rabbits jumping out. Rats and mice. Snakes, quite a few snakes. Sheep. I can't remember if during that project we saw coyotes, but I have seen coyotes and foxes out there. Saw a litter of foxes out near the salt evaporation pond near Compass Minerals as we'd pass by when we were driving back and forth. But that's about it for wildlife.

BBL: Did you sleep pretty well out there?

RLB: Yeah, some of the mornings were pretty cold. Yeah, I slept well. Jane was in her tent and I don't know if she slept well, but I slept fairly well because they were pretty long days. We were up generally before the sun hit us and to bed well after dark. Even though it was at times pretty relaxing, you still had to be alert all the time because you've got all the instrumentation going and you're watching all this stuff out on the boat, so we may not have been that much physically tired, but since we were playing close attention all the time, at least whoever driving the boat was, it was pretty tiring by the end of the day.

BBL: So talk about analyzing all this data. You finished the fieldwork and now you analyze this.

RLB: So basically out in the field we had two copies of the data. The data were recorded on the laptop computer, which I bought Sorbothane vibration pads that I put underneath the computer so the vibrations from the boat didn't vibrate the computer. So we had a backup there. We had that data, the original data, then we would always back it up on thumb drives or CDs or whatever media we happened to have, so we always had two sets in case the computer melted down or whatever, and brought it back to the office. The software I used out in the field—logged the GPS, and the depth, and all the derivatives of that position, and speed, etcetera—also was the software I used to analyze the data. What that entailed was for every line or transect and/or portion of transect, sometimes if we had to start and stop because we lost communication, or we had to leave halfway through a line because we had to get back to the harbor because of weather or whatever, you basically load that information into the software and go through and display the data basically like a graph, a line graph, where you have depth versus, and you could display either time or distance on the horizontal axis, and you go through and zoom in and look at all the data and look for these outlier spikes, spurious reflections in the water column, etcetera.

Occasionally we'd get bubbles, air bubbles, underneath the transducer. Because the transducer had both a transmitter and a receiver, it transmits the sound, listens for the sound. And I upped that speed to ten hertz, or ten transmits and receives, every second. Because we were going so slow in the boat, we got three to five depth readings for every meter horizontally that we traveled. So I maximized out as much data as I could get, because you can always filter out every five points, or whatever you want to do. I used as much of that information that I could just to improve the quality of the bathymetry. So the software showed this graph. We had the transducer fairly close to the surface so we could get into really shallow areas and record a depth. There was a problem with that. The speed of sound was so high that if we got less than about .7 meters in depth, the boat can operate in about half a meter of water depth, we would start to get what are called multiples, where the sound would go to the bottom of the Lake, come back to the surface, bounce off the surface of the Lake, go back down to the bottom and then be received by the transducer. Because the transducer has to send out a signal, turn off that signal, open up a little listening window to record the return, and it has to do that, it's got to do a send and receive with a little bit of time in between every tenth of a second, so it's operating extremely fast. But the sound velocity was so high that that was my distance, about seven-tenths of a meter, where if it got shallower than that, the sound would go down, back up, back and forth, while the listening window was open. So I'd get, all of a sudden, I'd be going along, getting shallower and shallower and, *boom*, the depth would double, because it's going twice as far, well, doubled plus a little tiny bit because of the distance between the transducer and the water surface. So you have to go through and find all those things and basically remove that data, because there was no consistent way to correct for that, because as you started to get more and more shallow, the distance between the transducer and the water surface would remain constant, but you would not know what the speed of sound was in that very shallow water and what the bottom was doing. Sometimes it would switch back if it got a little below that, so you'd have to go manually, go through all that stuff, get rid of those problems.

Air bubbles underneath the transducer. If there had been a little wave breaking or during a turn or something like that, we got some air trapped underneath the transducer, the depth would go to zero. If it was zero we wouldn't be going very far. So you'd have to go and pick out all these points that were zero and basically the software allowed you to either pick individual points or draw little blocks around the points. Hard to draw square blocks when you have a slope in the Lake, because you have to draw in little triangles, so sometimes you have to go there and hand pick every point. When you have to deal with 12.7 million points, it took a while.

If there was doubt as to whether it was the true bathymetric surface or whether it was something else, there were a couple of issues with the hypersaline water where there was so much reflection off of that that we couldn't trace the deeper part, the deeper reflection very well. We would just get rid of those points where there were any questions of whether that was the true bottom or not. Because we were shooting for the bathymetric surface, not reflections, we erred on the side of caution whether to include that stuff. But you'd just sit down at the computer and just process data all day long decidimg if this is a good point or not.

Most of the time, the system worked very well. There's not a lot of vegetation, if any, in the bottom of the Lake, there's none that I know of, so we didn't have to deal with large patches of vegetation that would mess up your signal. So generally the data were very, very clean, but still it all had to be reviewed. We could have a line segment or a transect that was twenty miles long and all those points would be crammed into the width of your computer screen. So you had to sit there and zoom in and look at little tiny chunks of that and just go across the entire transect, little tiny pieces at a time to make sure that you were cleaning the data appropriately. There are automated filters and things like that, but I didn't want to use those until we had gotten rid of the obvious bad points.

So then I went through the data with Jane, I taught Jane to do some of the processing and she processed some of the stuff on the north arm. Then we went through and once we had all that data cleaned up, I went through and…I've got to think of the various steps, because there were quite a few of them. Went through the data, cleaned it up, then went through and smoothed the data just so I didn't have 0.1 to 0.2, to 0.1 to 0.3, to 0.1 to 0.1 to 0.1, very minor changes. So I smoothed the data just a hair because I was looking for the bathymetry and I didn't want to have all these little spikes there if I was going to contour to a half of a foot, because then you'd have these little tiny bulls eyes everywhere because of contouring; the contouring package would just throw a little contour around them. But I was looking for the bathymetry of a lake-wide area, just not very detailed stuff.

But for each of these changes, we never changed the original data, so we have all this raw data all backed up, that was used for the bathymetry. All of the original data has been preserved so people can go through the same steps if they want to and regenerate, if they want to look at every single little tiny bump in the Lake, they can do that if they want.

So, anyway, we got all the data processed and then I exported all of it into an Excel format, of course, hundreds of thousands of lines long. Took that data, reformatted it again, put it into a flat file, a CSV format, and then imported that into a commercial geographic information system software platform and used that to create the surfaces, triangulated regular networks and even some raster surfaces. I tried a bunch of different methods, to see which method gave me what… [pauses] …we try not to bias any of our information here, we try to present it, but contouring is an interpretive process and so we have a preconceived notion that a lake or bathymetry is going to be rather constant over distance and there's not going to be any huge spiked variations in a surface. You're not going to see anything that's not smooth, especially underwater. The wave action is going to smooth things out. So once I put it into ArcGIS, I used some automated contouring routines, and it was noisy. There were spikes in various places, which told me that there were some data points in there that during the contouring routine were too far apart to be interpreted correctly, or there were lots of data in one area, but because we had to remove double reflections and multiples or we had to remove data in this location because there were problems, it's trying to contour between adjacent points further out that it shouldn't be. So it tries to connect the dots. I then had to go through that data and manually remove those spikes. I used the machine-generated contours as a guide to give me a general idea of, okay, this is the general shape of the Lake, and then I went back to the original data and said, Okay, why is this doing this for all of the "spikiness," for lack of a better term, and if there were chunks of data missing or whatever, I could explain, oh, so that's why it's occurring. So I'd go through and I'd manually re-contour those areas to correct for the machine-related problems.

I also went back out there once the contours were done, we put them all together with the other lake information, the topographical contours surrounding the Lake, etcetera, in ArcGIS to make the map. Arc at that time didn't have a lot of the cartographic tools to make things look nice, or it was very, very difficult to get around just the GIS part of it, and so I exported all of the various layers of information into Illustrator. We have an illustrator here, Joe Gardner, who is fantastic, and he actually generated the final map, cartographically pleasing, as it were, versus what we could get out of the ArcGIS software. So he made sure the colors and the line widths and all that other stuff were to USGS standards. USGS has really strict mapping standards, so we had all the information; we had to make sure it was in the correct format and placement of line widths and colors, etcetera.

But in terms of the processing, we went back out after the map was done and I randomly chose five points on the south part of the Lake and went there with a tape measure with a flat plate on the bottom of the tape measure when the Lake was calm and measured water surface down to the bottom of the Lake and got the exact location on the map and made sure that a tape measure—it was a steel tape, so there was very minimal stretch—made sure that those depths matched the map. Again, another quality control thing. We had the transects that crossed each other and this was just a check to make sure that, yes, the depths are correct.

Of course, I failed to mention that we have gages out there on the Great Salt Lake and every day, well, every fifteen minutes, we have the Lake elevation recorded. When it's windy, we have seiche effects, the Lake sloshes back and forth, so that that elevation data can be erroneous. But since we only collected data when the Lake was really calm, we would look at the record and say, okay, what's the slope of the readings when we were out there, what's the Lake elevation. All the depth data was corrected to lake elevation also and it was actually reported in elevation above sea level. The bathymetric map has contours, but they're not depth contours; they're elevation above sea level because depth in the Great Salt Lake, because it's a closed lake, depth is only good for the moment you take it. But if the Lake goes down three feet, that depth is not good anymore. It's good from the original reference point when you measured it, but you have to know when you measured it and what it was at that point. So it's in elevation so people can use that map to look at changes in depth versus elevation. So if the Lake's at 4,195 they can take and then follow that contour around and say, okay, at this point, because the depth is at that point 4,180, they can say, okay, it's fifteen feet deep at this point versus trying to correct every time they go out because I did the depth at some particular standard.

BBL: I see.

RLB: And it's in feet because that's what the Lake's been measured in, feet, for a gazillion years. And that's what they wanted it in, rather than meters, which nowadays, generally the Survey and most scientific products are produced with the metric system, but because the Lake's been researched so much and it's always been feet, they wanted the map in feet. So I generated the map in feet, which it can be easily converted into metrics if they wanted it, because everything is still digital.

BBL: How long did it take you to do all the analysis and come up with the map?

RLB: The first time, the south part, it took me probably six months. But that was not full-time working on just that project. There's always, as with most projects here, or most scientists here, you have two or three different projects going on at the same time. There's never enough money for you to just concentrate on doing one project and getting that done and out the door because there's always new stuff coming in or there's training issues that you need to deal with. But it took me quite a while to do the first one. The second one probably only two or three months to do it, because I had had extensive experience doing it with the south. The north, there were fewer data points and we had worked through the process of what we needed to do to produce the map and we basically used the same color scheme, the same scale, everything on the north part of the map. So you can actually take that map and cut off the bottom of it and line it up and it lines up perfectly with the south part of the Lake. So if you wanted to see the entire lake, you could do that and actually see the entire lake. Because the two efforts were done as two separate projects, the state agencies didn't want to pay for us to put them together into one map. Money's always, always tight. So we had two separate maps produced, one for the north, one for the south. I since have done that myself. Joe and I had worked on that in our free time—nights and weekends—free time. We have since done that, but it's not a USGS product. It has not gone through technical review. Everything we do has to go through this process of basically a peer review, internal and external peer reviews, where someone goes over every single line and every single point and checks all the data, etcetera, to make sure that we put out the best product that we possibly can. So the combined map, because we did it by ourselves, not on Survey time, has not had that peer review. We just use it for internal purposes, or we gave a copy to State Parks just for, they made it into a wall display, I believe, but it's not an approved USGS product. But they're just being used for display, visitor purposes. Friends of Great Salt Lake has a combined map for their newsletter that they put out, and things like that.

BBL: Can you say how the knowledge that you got from this survey, how it has had an effect on how the Lake is managed? What is the outcome of these maps?

RLB: It actually turned out to be a very valuable product. Whenever you deal with a lake or reservoir, there are lots of people that are experts in modeling, lots of people with geochemistry and limnology, etcetera, and they want to understand how a lake works. There are lots of issues with heat transfer and meteorologic issues with the Lake, brine shrimp industry, mineral extraction industries, and every one of those particular aspects of investigating the Lake and understanding the Lake relies upon a good understanding of the physical characteristics of the Lake. How much water is in there? What is the shape of the bottom? What's on the bottom? What's the shape of the Lake? Where does the wind come from that helps control circulation? How deep is the water? Where's the water deep? Where's it not deep? What's the light penetration, because if it's really deep and light can penetrate all the way down to where there is no light, that is different than can light hit the bottom and heat up a very shallow layer of water. It affects the physical properties of the Lake itself. So you need, at least in my opinion, to actually start any real research into a body of water, like a lake or a reservoir, you need to know the physical characteristics of that lake.

You need to know the bathymetry, what the topography of the bottom of the Lake is because that controls so much of the chemistry, the circulation, the transport of materials around the Lake, whether it heats up quickly or cools down quickly, how water moves through the Lake, etcetera. Until this effort, the bathymetry of the Lake was kind of known about along the shallow areas. There were spot measurements in various locations in the Lake, but there was no data telling us exactly when those spot measurements were made and what method they used. Did they use a depth finder and didn't correct for sound velocities? Did they drop a weighted measuring tape down there to measure it? And then what was the Lake elevation at that time. So there was no good bathymetry of the Great Salt Lake in the deeper areas of the Lake.

For the mineral extraction industries, for those people that utilize the Lake, especially now that it's getting much shallower, even though this map is not designed for navigational purposes, because there are hazards in the Lake that, because the Lake's so large and so shallow, we can't identify all the hazards. I know we've hit some, like telephone poles and other various things sticking up out of the bottom, but the bathymetry gives you a general idea of, when the Lake goes low, this area is going to be exposed. Or we're going to be in trouble if we get closer than this to shore. So it's used for safety purposes also. When the rangers have someone say, "I'm just east of Antelope Island," they can look at the map and say, "Oh, they must be there in Farmington Bay somewhere. We can't go get them." So there are a lot of uses for the Lake.

In fact, even though I have not been involved in the process, the State is using this bathymetric map to define zones of management for the Lake, when the Lake's from X elevation to Y elevation, then this is how the Lake will be managed. If it drops down below this elevation, then this is how the Lake will be managed, because it changes the dynamics of the Lake, changes the chemistry of the Lake, because as the Lake is dropping it's getting more and more saline, or vice versa.

It changes access to the Lake. Right now we can't get out of the Antelope Island harbor. The south harbor, there's talk about it being dredged because there's only a couple of our boats, our boat and one of the State boats, I know they can get out of there without any trouble. A lot of the sailboats had to be pulled because the Lake was dropping so much.

But the bathymetry, the physical characteristics of the Lake, then, give you the basic information you need to model various things, circulation, exchange of contaminants along the shorelines, whatever. Just that basic information that you need to understand how the Lake works.

BBL: I think the work that you've done on the Great Salt Lake, I told you before, I think it's been a huge contribution to the knowledge of the Lake and its management. It's historically so important what you have accomplished out there with your research. I'm really impressed with what you've done. I think it's just cool! It just sounds really nice.

RLB: It's very interesting, at least to me. It's nice to identify there are some other basic things, there are a lot of people that are specialists in certain aspects of research and they do some great stuff, but it's like there are some basic concepts that have never been addressed, and bathymetry is one of those. What is the physical characteristic of the Lake? Utah Lake, same way. From what I can discover, the bathymetry there was done back in the early '60s through the ice by someone drilling holes through the ice and physically measuring the Lake. It's very shallow, the bottom is very soft and gooey, but what's the quality of that data? No one has ever even checked that. So if you want to go to a circulation model or look at nutrient fluxes or whatever in the Lake, you need to have the basics to actually discover where we are. The Lake's been around for a long time, we've been around for a long time, and no one had ever done that. To figure out a way to actually make that happen, that was very fulfilling that I could actually do that and help out the Lake and help out everyone else that's researching the Lake by providing that information.

BBL: Absolutely. I agree. I think that's phenomenal.

I think you told me you took quite a few photos.

RLB: Yes, I've got lots of photos.

BBL: And did you also keep a diary or a log or journal while you were out there?

RLB: Not a personal one. Just time starting, and a lot of that stuff was recorded digitally anyway, so I have records of the scientific part of it, but I didn't keep a written log.

BBL: You didn't keep a reflection journal.

RLB: No. I've never done that.

BBL: If you had to do this again, is there something you would do differently? I'm sure there's some, maybe technology—although that was fairly recent—that you could add to it. Is there something that you would add now or do differently if you had to do it again?

RLB: Boy…*mmmm*.

BBL: Is that a dumb question?

RLB: No, it's not a dumb question at all. There's lots more that I could have done, but we have to balance the scientific goals of what we want to do against the funding that's available. I donated quite a bit of time, unpaid time, to complete these projects because the funding is just not there to do them where they're paying me for all the hours I'm putting in. They just never would have funded that. I could have run a side scan sonar or multibeam equipment, everything, because the largest expense in these surveys generally is, number one, equipment acquisition, and, two, personnel time. To have two people out there all the time, paying salaries, insurance, overhead, is expensive. So if you can, when you're out there, collect as much data as possible, just saturate the data streams. That's always, at least for me, a good thing. Get as much as you can. That's why I got the analog, I got the digital data all at the same time using the best equipment that I could come up with to do that.

There's also the drawback that if you get all of this extra data, if you've got side scan sonar, you're dealing with huge, huge volumes of extra data. That all has to be looked at and processed and the time spent in preparation of a product, then, starts to climb exponentially because you have so much data. It's like taking a picture with a camera five years ago and it was 1.8 megabyte for a digital camera and now you're getting in a little tiny cigarette pack size camera, you're getting 25 megabytes of data. What extra information does that 25 megabytes get you when all you need to do is identify and recall a memory from that initial picture. So the bathymetry here, it would have been nice to collect twice as many lines, twice as much data, four times as much, eight times as much, complete coverage of the entire bottom of the Lake so I could identify every single feature there. But the method we used was the, as far as we could identify—and I talked with a bunch of other people—at the time, it was *the* best method to get the best, most precise bathymetry of the Lake that we could within the funding and timeframes that we were allowed.

BBL: Balancing all of the constraints and needs.

RLB: Oh, yeah. It would be nice to build a really nice ranch house out there on the north part of the Lake with air conditioning and have our own private chef and masseuse after a long day on the Lake, but that's just not going to happen. So we just have to make things work with the tents we have, as best we can.

The emphasis is always on, number one, safety. It's one of the reasons we don't go out when the weather's really bad; but, two, to get the best data in the most economical fashion. I could have bought a system twice as expensive as I had, but that wouldn't have given me any better data. So the economy of data collections is important as long as the data is the best you can get. So that's the key.

Then, of course, you need to understand how to process the data and that other, all the little physics-related things, beam angles and Snell's laws and all that sort of fun stuff, so you can actually understand what you're doing with the data because it doesn't do you any good to get the best data in the world if you mess it up when you're processing it, or you change it in some fashion so it doesn't reflect reality. You know, there are lots of different things that go into a project like this.

BBL: It sounds like it was fun. You enjoyed it?

RLB: Oh, definitely. Definitely. You're not sitting in an office. It's completely strange, especially the north arm, an environment that very few people have ever encountered. And just the amount of time I spent up there; I probably hold the world's record for the amount of time spent on Great Salt Lake, or at least the north arm. Just to experience that sort of thing, and see the natural conditions, not looking up and seeing along the edge of the mountainside, or big smokestacks, or inversions out there, and just looking out over the Lake and not seeing any evidence of man's involvement. This is what it may have looked like before Lake Bonneville formed. It's like wow! And just the sunsets. So it was nice. And I don't mind hard work. So hard work is fine if you can get something out of it.

BBL: That's great. Those were all of my questions. Anything else you think you want to add to this? Any final thoughts?

RLB: We printed the map on plastic, artificial paper, so you can spill water on it and things like that out in the field, so we can put it on top of a pickup truck. I take classes out there a few times a year, a couple of German groups that come into town, and give them a tour of the Lake. I can take these bathymetric maps and put them on easels and they can get wet, and they don't tear.

BBL: If that map purchasable at the map store?

RLB: Not any more. They sold out, actually fairly quickly.

BBL: Oh. Are they going to have another printing, you think?

RLB: Well, again, that's up to the State of Utah. They're expensive to print, especially on the plastic. But they're available digitally and now everybody, they just have them on their computers or their Android or iPads or whatever. They will print you one on plotter paper, just off of the plotter if you want at the bookstore. But all of the north and south versions are gone. They sold out relatively quickly. But printing them on plastic, printing is expensive. That's why everyone now is just posting everything on the web and not really printing hard copies. But they could be reprinted fairly easily.

BBL: I think you're right in saying that this had to have been a really gratifying project for you to do, a lot of satisfaction in getting it completed and putting it together and having it be so successful. I think that's terrific.

So these groups that you take out, you take them out on the Lake on a boat?

RLB: No, I generally take them up to Antelope Island. There are some international groups I take around, but not on a boat. There are some German exchange groups that come over a couple of times a year. One is from East High and another one visits Bountiful High. There are a couple of groups out of Bountiful High. I take them out to the Great Salt Lake and teach them about why is the Lake here and how did it form. How has it changed over the last 100,000 years? The biology of the Lake, a little chemistry, the bathymetry, of course, and march them up to the top of Antelope Island and talk about how big it is and compare it to other lakes in the world. Show them around Antelope Island, bison herds and antelope and things like that. Just generally educate them about the Lake and its effect on the Wasatch Front. When we get snow, extra snow, extra water, fresh water off of the Lake. The Lake moderates temperatures in the valley. If the Lake goes away, our fresh water supply goes down because there's no more lake effect snow or lake effect precipitation. It also causes more extreme changes in temperature for the valley, so it will get colder in the winter because the Lake keeps it warm and it will get hotter in the summer because the Lake tends to cool off the Salt Lake and Davis County areas. So I teach them about those sort of things, just get them out of the classroom for a little while and teach them a little bit about what's going on.

BBL: In a cool place. I'm sure they really love that.

RLB: Yeah, because they've never been to any place like this. I take them out and have them sample brine shrimp. I have students go put nets in there and pull them out and talk about brine shrimp and the birds and the ecosystem, things like that.

BBL: Wow. All right. I'll turn this off for today. Thanks again. I appreciate it.

RLB: Okay.

END OF INTERVIEW 2 OF 2