

"WILD WEST"

SHOW 601

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EPISODE OPEN

ALAN ALDA We love to make myths of our past. One of America's most enduring myths is the Wild West in the latter half of the last century. It was a time and place that dime novels, and later the movies, burned vividly into our imaginations. We thought it would be fun to look at some Wild West myths through our own particular lens. So, for the next hour, we'll be visiting some very twentieth-century scientists whose work and discoveries carry us back to those 19th century times- of gold rushes and Indian wars, cowboys and campfires, heroes and villains. Speaking of villains... In the movies, every Western has to have its villain - the guy with the cold unblinking stare and lightning draw who terrorizes the local population. Well, in this morning's newspaper here in Arizona, the role of the heavy with the stare and the quick draw is played by the rattlesnake. So we've come out here about 30 miles from Phoenix to find out if the rattler's villainous reputation is really deserved.

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NASTY CRITTERS

ALAN ALDA (NARRATION) Steve Beaupre and his colleagues from Arizona State University know every inch of this half square mile of desert - and most of the 1000 or more Western Diamondback rattlesnakes that call it home.

ALAN ALDA Now how do I know I'm not walking through a bunch of rattlesnakes down here?

STEVE BEAUPRE Well, let me check here for you first. Ah, looks clear. Of course, I've been wrong before.

ALAN ALDA Hello.

ALAN ALDA (NARRATION) My job is to locate a radio transmitter that Steve has surgically implanted into the belly of one of the snakes.

ALAN ALDA You know, I not only feel dopey doing this but I feel stupid - trying to find a rattlesnake with all this stuff.

STEVE BEAUPRE Well, imagine how I feel. I do this every day. There he is, right at the base of the bush. You see him?

ALAN ALDA That's incredible. You know, my eye caught that four times 'cause he's got a little sunlight on him. And I thought it was a stick, I thought it was like an old fallen branch or something.

STEVE BEAUPRE Yeah, they're really camouflaged. A little general rule we have, is that for every one snake we see we walk by 10 or 15.

ALAN ALDA (NARRATION) My first lesson in rattlesnake biology - they do every thing they can to avoid human contact. Which unfortunately can't be said of other desert wildlife.

ALAN ALDA Aah!

STEVE BEAUPRE Better fast than slow.

ALAN ALDA Shouldn't I have a bullet and a glass of whisky here?

STEVE BEAUPRE Sorry, that's only if you're snake bit - but that may be coming next!

ALAN ALDA (laughs)

ALAN ALDA (NARRATION) Springtime in Arizona is when rattlesnakes wake up from a winter of snoozing in dens along rocky bluffs like this, and begin looking for mates and for meals.

STEVE BEAUPRE So, right over here. Follow the edge of this rock down.

ALAN ALDA (NARRATION) Several hundred of the snakes here sport brightly painted rattles.

STEVE BEAUPRE Oh yeah, it's orange-yellow-orange. You're all right guy.

ALAN ALDA (NARRATION) The colors identify the snake as one in Steve Beaupre's study...

ALAN ALDA Is this where you found this snake?

STEVE BEAUPRE Yeah, this animal...

ALAN ALDA (NARRATION) And today he's returning to their homes several snakes he captured here a few days ago.

STEVE BEAUPRE Lucky us, this animal is right on the top of the bucket. You can see the paint marks, light blue, black, green.

ALAN ALDA They don't tend to hop out of the bucket, do they?

STEVE BEAUPRE Occasionally they do, but I think we're OK.

ALAN ALDA Occasionally they do, but I think we're OK.

STEVE BEAUPRE OK, honey.

ALAN ALDA (NARRATION) Surprisingly to me, rattlesnakes are deaf. Which left me wondering what that very noisy rattle is all about.

STEVE BEAUPRE That's a classic defensive indication. The rattlesnake is a little bit agitated and he's shaking it to make noise to let you know that he knows you're here and he's not particularly pleased with your presence.

ALAN ALDA Is it interesting to you, it is to me, that a snake, that's deaf, develops a defensive mechanism that relies on sound.

STEVE BEAUPRE It tells you almost immediately that it has very little to do with, for instance, with communication among snakes, which for a long time was one of the hypothesis that was used to try to explain the development of the rattle. It has a lot to do with other animals and not the rattlesnake. It's a defensive thing. Let me get her back up into her den site.

ALAN ALDA (NARRATION) Steve has never been bitten by one of his snakes. Eight years of experience keeps him just out of striking range.

STEVE BEAUPRE C'mon honey.

ALAN ALDA (NARRATION) These snakes, now that Spring has come, start moving from their dens to stake out ambush sites in bushes and under trees, where they wait, still and silent for hours, for a passing mouse or pack rat.

STEVE BEAUPRE Looks like a good-sized male.

ALAN ALDA (NARRATION) By checking likely ambush spots, Steve can track the movement of snakes he's captured and marked before.

STEVE BEAUPRE It's a recap. Outstanding.

ALAN ALDA (NARRATION) Snakes spot their prey through sight and smell - as well as sensory systems we humans don't possess.

STEVE BEAUPRE It's going to come over and investigate me. No, I don't want you going that way. Hang tight.

ALAN ALDA (NARRATION) That flicking, forked tongue, for instance, is sampling the air.

STEVE BEAUPRE What he's doing is picking up fragments or particles from the air - some right off of you.

ALAN ALDA You had to mention me. It's like getting a smell?

STEVE BEAUPRE It's much more sensitive than a sense of smell even.

ALAN ALDA How else does he sense what's around him besides his tongue?

STEVE BEAUPRE They're pit vipers. And what that refers to is heat sensing pits that they have in the front of their face, and they're focused forward in much the same way that your eyes do, which suggests probably that they have three-dimensional heat vision as well as regular light vision. They're in a very different sensory world than we are and it's very difficult to say exactly what that's like. I can't even imagine what that would be like myself.

ALAN ALDA (NARRATION) This snake is due for a check-up at Steve's lab - where it immediately took offense at our microphone. This did not inspire confidence.

ALAN ALDA Maybe you should tell me every time you lift the lid.

ALAN ALDA (NARRATION) Worse was to come.

STEVE BEAUPRE Now, the next trick is to get the tail of the snake out of this little hole down here. Like to grab that tail for me?

ALAN ALDA Grab the tail. You have the head? Oh-oh, the tail is shaking, the tail is shaking! Aah, I'm holding the tail of a rattlesnake here! Aah, this thing is alive, you know? You understand what I mean? I can feel its muscles, I can feel the rattle going b-r-r-r like an alarm clock. Oh man, I don't want to do that again. While you're at it, what can you tell from the number of rattles here?

STEVE BEAUPRE Since the last time we had it in the lab and we painted this bottom section gold, probably at least a year ago - that section was actually here at that point. And since we last captured this animal it's shed its skin twice, and added these two segments, this one and this one.

ALAN ALDA When they shed their skin, I can see how that makes the outside of the rattle. But what makes the thing that shakes around inside the rattle, what is that?

STEVE BEAUPRE Well, actually, there's nothing in there. What the rattle is is a series of bony rings of the same material as your finger nails, and they lock together and rattle against each other. And it's loose enough so that when the snake vibrates its tail at a very high rate of speed, the segments rattle against each other.

ALAN ALDA So really all it is is like clicking your fingernails?

STEVE BEAUPRE Yeah.

ALAN ALDA (NARRATION) Finally, our rattler gets a new paint job...

ALAN ALDA Very tasteful color.

STEVE BEAUPRE Yeah, kind of regal.

ALAN ALDA (NARRATION) And the rattler's lab visit is over.

ALAN ALDA Bye, Veronica.

ALAN ALDA (NARRATION) Steve Beaupre does his research to answer questions about how rattlesnakes fits in to the desert ecology. What do they eat? How fast do they grow? When do they reproduce? But science isn't his only motivation.

ALAN ALDA You handle them all the time. What are your feelings during the day when you do that?

STEVE BEAUPRE I find them to be beautiful and fascinating creatures. I guess that may not be a popular opinion, but it's enough for me.

ALAN ALDA (NARRATION) But if the rattlesnake doesn't quite deserve its villainous reputation, there's another desert creature - one that all but owns the desert by night - that more than lives up to its evil image. This is the Mojave Desert of Southern California.

GARY POLIS I think it's real close to a New Moon. So, it'll be real dark and it's pretty warm, so I think we'll probably find a lot of animals.

ALAN ALDA (NARRATION) Biologist Gary Polis and his brother Dan are tracking down one of the Wild West's most vicious predators. Their ultraviolet lamps give their quarry - the scorpion - an other-worldly glow.

GARY POLIS This is a great trait to study these animals, because if they're out there, you can see them. I've seen up to 700 animals a night. I'm using these forceps instead of my fingers because I really don't want to get stung. These guys hurt. They're not too bad, they're like a honey bee or something like that. In fact most scorpions are not deadly. There's only about 25 deadly species in the world out of over 2000 species of scorpions.

ALAN ALDA (NARRATION) Scorpions may not be deadly to humans. But as they emerge from their daytime lairs, scorpions take over the desert. This cricket, like almost anything else smaller than the scorpion, quickly falls prey to the paralyzing toxin in its stinger.

GARY POLIS Their rule of thumb on their diet is that anything that's smaller than them, anything they can subdue, is potential food, and they'll eat it if they can get it.

ALAN ALDA (NARRATION) And that includes their own. Young sand scorpions are a major part of the older sand scorpions' diet. In this typical battle, the larger sand scorpion on the right is able to inject its venom while staying just out of reach of the other's stinger. But in this fight, the bigger scorpion almost makes a fatal error. As the victor begins its meal, the loser's stinger stabs into its open mouth. But in vain. A final twist of its own stinger secures the larger scorpion's victory - and its supper. For desert scorpions, cannibalism is a way of life.

GARY POLIS Cannibalism is really important in a lot of environments, but here in the desert it's particularly important. There's very little food available, so the

cannibalism, when you eat an individual of the same species not only represents a big food item that you're eating, but also if you think about it reduces competition for what little food is out here.

ALAN ALDA (NARRATION) The sand scorpion may rule the desert night. But even though bigger is usually better in scorpion combat, the sand scorpion is not the desert's largest.

GARY POLIS Great, a couple of desert hairies.

ALAN ALDA (NARRATION) That distinction belongs to the hairy scorpion... the biggest in North America.

GARY POLIS That's really a big female...

ALAN ALDA (NARRATION) It's big, but it's rare. And Gary has discovered why.

GARY POLIS The reason it's so rare is that almost all it's young die before they get to this size. And the reason most of them are is because they are eaten by other scorpions, particularly the sand scorpion.

ALAN ALDA (NARRATION) When young, the hairy scorpion is one of the adult sand scorpion's favorite snacks. But the lucky few hairies that escape the sand scorpions' constant attacks - mostly by taking off for less desirable environments where the food is scarcer - eventually grow to be big enough to turn the tables on their former predators.

GARY POLIS This one has gone through probably 3 or 4 years of vulnerability to sand scorpions, and now it's bigger than any sand scorpion and it can eat any scorpion here in the system. And it's king of the heap right now.

ALAN ALDA (NARRATION) Rattlesnakes may be scarier, but for sheer nastiness the scorpion wins hands down - a point even Gary Polis concedes.

GARY POLIS Their success and their nastiness actually may be correlated with each other. It's a tough world out in nature, particularly in the desert its eat or be eaten. So they've earned their reputation and it's probably made them very successful.

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DEAD MEN'S TALES

ALAN ALDA In the 1840's, there were only a few thousand settlers west of the Mississippi. One of them, a carpenter named James Marshall, got a job building a sawmill here on the American River in California. On the morning of January 24, 1848, Marshall found a few shiny bits of gold in the water channel of the mill. The gold rush that was triggered by his discovery brought people from all over the world - a quarter of a million of them.

ALAN ALDA (NARRATION) The promise of gold became a magnet pulling people west. In 1874 a Civil War hero, George Armstrong Custer, led a military expedition that found gold in the Black Hills of Dakota. Soon tens of thousands of prospectors flooded in, despite a treaty ceding the Black Hills to the Sioux Indians.

ALAN ALDA Two years later, Custer was back, this time as part of a military expedition to move the Sioux out. What happened next became legend. And more than a century later it sparked a remarkable tale of scientific detective work.

ALAN ALDA (NARRATION) In eastern Montana, this is the site of the Battle of the Little Bighorn - Custer's Last Stand. In just half an hour, one June afternoon in 1876, Custer and some 210 of his 7th Cavalry were wiped out by an overwhelming force of Sioux and Cheyenne. Custer's Last Stand has gripped the public's imagination ever since- inspiring a half-dozen movies, including this 1941 production starring Errol Flynn as Custer and Anthony Quinn as Crazy Horse. But not all of Custer's men died at the Little Bighorn. Half his force was here, three miles from Last Stand Hill- where most of them survived a day-long siege. A stone marks a makeshift hospital.

DOUG SCOTT One of the men wounded on the line was Corporal George Lell. He was brought here to the field hospital with an abdominal wound which was mortal. And knowing he was going to die, as one old veteran remembered years later, this very poignant story, Lell is supposed to have said: "Lift me up, boys. I want to see the boys one more time before I go." And then he was laid back down, and died a short time later.

ALAN ALDA (NARRATION) George Lell was one of the few 7th Cavalry troopers to have left behind a photograph. But like nearly all the men killed in the battle, his body was never identified- buried anonymously as one more Unknown Soldier.

DOUG SCOTT There's a great deal known about George Custer and the officers who died with him. Very little is known about the men who died, the privates and the corporals and the sergeants. They are the unknowns. We know from the register of enlistments how old they were, how tall they were, but we know very little else about them. Three years ago, Doug Scott excavated the graves of five

of the unknowns- men killed, along with George Lell, during the hilltop siege. The five skeletons, one of them thought to be Lell's, came here to Chico State University in California, where anthropologist P. Willey seeks in dead bones, clues to lives.

P. WILLEY Dead men do tell tales. And they can tell tales in terms of how they lived and how they died. What their age was, what their sex was, what their race was, that their stature was. So they do tell tales. You just have to listen carefully.

ALAN ALDA (NARRATION) A common tale told by the bones was of backaches.

P. WILLEY One of the things that these vertebrae have, which many of the vertebrae from the troopers... was there were depressions indicating they had chronic back problems. Instead of having nice, smooth surfaces, many of them had these pockets, these cups, probably due in large part to riding long hours over tough trails on hard saddles.

ALAN ALDA (NARRATION) One of the skeletons told vividly of the way he died- shot in the back.

P. WILLEY This is a wound that came in from the person's back, and right side, perforated through the hip bone just above the socket for the thigh, and then came through the other side of the bone, must have perforated the large intestine, then exited on out the abdominal wall.

ALAN ALDA (NARRATION) The hip wound allowed this first of the 5 soldiers to be identified as being fatally involved in one of the the battle's most famous incidents. In the final moments of Custer's Last Stand, the troops waiting 3 miles away sent out a scouting party to see what was happening. Spotted by the Indians, the men were chased back to their hilltop. One of them fell, shot in the hip. A stone marks the spot. And now, over a century later, Vincent Charley's remains can also bear his name. Of the other skeletons, one was especially intriguing- though his identity would prove much more elusive. From how closely the plates of the skull have grown together, Willey is able to estimate its age. And by measuring the long bones of the legs, he can tell the skeleton's approximate height.

P. WILLEY It was a person who was in his mid-30's, 30 or 35 perhaps, and who was short, about 5 ft. 6.

ALAN ALDA (NARRATION) Unremarkable so far. But what was completely unexpected was the excellent condition of the teeth, at a time when dental care for most people meant a visit to the blacksmith's. These teeth even had gold

fillings. Willey sent the skull to Chicago dentist Richard Glenner- who is also a keen historian of his profession.

RICHARD GLENNER The first thing that strikes me is that he has pretty good teeth, just looking at it. And the thing that I see next of course are these gold fillings. They just hit me right in the eye, they looked so terrific.

ALAN ALDA (NARRATION) As with all Dr. Glenner's new patients, the next step was a set of dental x-rays.

RICHARD GLENNER It's interesting, when they were developed and mounted, we looked at them, and you couldn't tell whether it was a live person or a dead person!

ALAN ALDA (NARRATION) The hollow chambers inside the teeth- which narrow with age- confirmed that they came from someone in their early 30's. But it was those gold fillings- bright spots on the X-rays- which most fascinated Glenner- and were to provide a vital clue to the skull's identity. We take the paraphernalia of modern dentistry for granted. But back in the mid-19th century, a dental office as sophisticated as this was a rarity. Dental drills were almost unknown. And only the very best dentists were using gold for fillings. So the mystery skull can have come only from someone with access to state-of-the-art dentistry. The hunt for the skull's identity now shifted back to the battle site, where historian Doug McChristian joined the search by checking through the enlistment records of the 7th Cavalry. Among the candidates...

DOUG McCHRISTIAN George Lell. Here he is.

ALAN ALDA (NARRATION) ...Corporal George Lell. And at once, fortune smiled. Lell enlisted in Cincinnati- in the 1870's, home to only the second dental school in the world, and a pioneer in using gold for dental fillings. But no sooner did the enlistment record suggest Lell than it all but ruled him out. The skeleton is 5 ft. 6. Lell's height is recorded as 5 ft. 9. So when the skull returned to P. Willey at Chico State, he was forced to look for other candidates- other candidates who may also have had good dentists. Willey superimposed on a video image of the skull the photograph of one of these candidates- an army surgeon named DeWolfe.

RICK VERTOLI Looks like the ear holes are lined up and the bridge of the nose is pretty close, but the chin...the chin is way off and look at the top of the head...not even close.

ALAN ALDA (NARRATION) Candidate number two was Lieutenant Benjamin Hodgson. West Point, where he had been a cadet, had the only practicing dentist in the military.

P. WILLEY Our nose and eyes are in completely wrong places. Looks like this isn't our guy either.

VIDEO TECH No, I don't think so, P.

ALAN ALDA (NARRATION) As a last resort, Willey checked out George Lell- despite the 3 inch height discrepancy. And to his astonishment, the face fit.

P. WILLEY Looks like our guy. George Lell.

P. WILLEY I was surprised. I felt we'd ruled out Lell pretty effectively, but now it looks like he's back in the running.

DOUG STOTT I think most of the evidence shows that it is George Lell. The single point of deviation is the height. And that could be nothing more than a historical transcription error by a clerk. We have mistakes that happen all the time, clerical errors that occur today. Why not in the past?

ALAN ALDA (NARRATION) Today at the Little Bighorn Battlefield, the five skeletons Doug Scott exhumed in 1992 have been re-buried. Vincent Charley now has his own headstone. Because his identity still can't quite be clinched, George Lell remains for the moment an Unknown Soldier.

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LOOPING THE LOOP

ALAN ALDA (Narration): Whisper Alexander has been tending cattle on her family's Montana ranch since she was a toddler. The skills she needs go back centuries-and they've been refined over the generations into the West's home-grown sport, rodeo. And when the chores are done, it's the rodeo Whisper lives for.

WHISPER ALEXANDER: I love it. It's just the adrenaline rush and the competition. I love the competition.

ALAN ALDA (Narration): But Whisper-a top-notch rider-has a weak point. And roping is a key rodeo event.

WHISPER ALEXANDER: I just need to throw it out there. I'm kind of soft-looping it. Throwing it bad. I'll get it though.

ALAN ALDA (Narration): But try as she might, practice is not making perfect. Which is why Whisper is a volunteer subject in a brand new program at Montana State University. The project is being run by sports physiologist -and former rodeo rider-Mike Myers.

MIKE MYERS: What we want you to do is not make any practice throws. We want this to be a real rodeo run...so act like this is the last calf, the final performance, last run. It's taking off like a rocket.

ALAN ALDA (Narration): The bright lights and high speed cameras that will track the reflective markers on Whisper's body and rope are now familiar tools in established sports.

MIKE MYERS: Even though rodeo's been around for a long time it's really considered a non-traditional sport. And so a lot of this scientific expertise that we've used in other sports such as baseball, track, and so on have not been utilized in this field. What we're trying to do is find out how these athletes are really operating. We're trying to define basically what the sport is.

ALAN ALDA (Narration): Justin Davis is another volunteer in the new program. He's brought along his favorite roping dummy for the experiment, but the reflective tape is something new.

JUSTIN DAVIS: Nobody's ever touched my rope like this before or put any tape on it or anything. But it shouldn't affect my swing or anything like that.

ALAN ALDA (Narration): The swing produces a spinning loop. The faster and tighter the spin, the better-because when the rope is released the rope's centrifugal force is what keeps it from collapsing in on itself as it flies to the target. The Montana State research team is still finding out if the methods used in other sports will work in this new arena.

BILL SKELLY: Initially it looks good. I'm needing to see the different points standing out against the background and they do look pretty good.

ALAN ALDA (Narration): A computer is able to take the reflective points and connect the dots to create a 3-D stick figure of the roper and the rope. Now Justin's throw can be analyzed in detail. It shows near-perfect form-each high speed loop creating a path almost identical to the one before. Now it's Whisper's turn. And the computer isn't kind.

WHISPER ALEXANDER: Oh my gosh.

ALAN ALDA (Narration): It reveals something neither she nor her coach had suspected.

WHISPER ALEXANDER: Whoa

MIKE MYERS: We're getting a loss of rope velocity by looking at how the rope dips in the front. Actually the rope is dying before you draw it back.

ALAN ALDA (Narration): The disc traced by the loop is warping because Whisper's not spinning it at a constant speed.

MIKE MYERS: If you can increase the centrifugal force, or increase the velocity of the rope during the spin, we'll typically see a narrower loop pattern there. Notice how wide the pattern is.

ALAN ALDA (Narration): A comparison between Justin's and Whisper's form reveals she is wasting energy spinning a big loop. Where Justin's loop is tight and flat, Whisper's is wide and uneven.

WHISPER ALEXANDER: I can't believe that I'm making these mistakes. I thought that everything was pretty consistent. But I'm ready to go out and make things right.

ALAN ALDA (Narration): Two months later, and the summer rodeo circuit is in full swing. It's Whisper's first competition since the lab visit.

ANNOUNCER: Ladies and Gentlemen, the chutes are shaking, the ground's a trembling, it's time for the bull-riding here at Lame Deer.

ALAN ALDA (Narration): The women's roping event is next and Whisper's getting focused on her swing. In women's roping, the rope breaks away once the calf has been snared. But today most contestants are missing altogether, and with only one throw allowed, there's no room for error. For Whisper Alexander, two months of working on her technique are about to be tested.

WHISPER ALEXANDER: My technique felt really good. I got my loop up fast and got my tip down. And went ahead and extended my arm. Felt really good today.

ALAN ALDA (Narration): Seeing herself as a computerized stick figure helped Whisper's roping enough to earn her second place overall in the women's events-her best finish ever.

ANNOUNCER: Ride her home, Whisper.

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ALL THAT GLITTERS

ALAN ALDA (NARRATION) A pan and a shovel. Add luck and persistence and once upon a time in the West, you could strike it very, very rich.

ALAN ALDA Thanks. I haven't eaten in a week!

ALAN ALDA (NARRATION) And it can still happen. Chuck Fipke has just become one of the most successful prospectors in history.

ALAN ALDA Get it all muddy?

CHUCK FIPKE Yup, that's right. Now, shake it down again...That's perfect.

ALAN ALDA (NARRATION) Like all prospectors, he needed luck and persistence. But his real secret, as we'll see in this story, was a high-tech version of a gold pan.

ALAN ALDA Oh, I see...I'm making the gold or whatever go to the bottom. Do you see anything good yet?

CHRIS FIPKE Ah, not yet. But it's probably down there.

ALAN ALDA Once you get down to the...

ALAN ALDA (NARRATION) Today, only traces remain of the gold of the Old West. But Chuck Fipke was prospecting along a new western frontier, in the far north of Canada. And it wasn't gold he had a hunch lay hidden in this empty landscape, but something far more valuable - diamonds. The diamond business worldwide exceeds \$30 billion a year. Virtually all diamonds come from giant mines in just three regions of the world- Southern Africa, Russia and Australia. Almost no one thought commercial quantities of diamonds could be found in North America - except Chuck Fipke. Fifteen years ago, already a well-known mineral prospector with a good track record, Chuck persuaded a few trusted friends and associates to join him in the far north of Canada's Northwest Territories- braving the mosquitoes- on what most of his professional colleagues thought was a wild goosechase.

CHUCK FIPKE I remember a time when I was at a conference, I was behind this poster, and I heard two people talking about me. And one of them basically said I

was nuts, I was crazy. So I went behind the poster to see who it was, and it turns out it was a guy that I had been working with.

ALAN ALDA Why did he think you were crazy?

CHUCK FIPKE Well, at the time, people just thought there were no diamonds in Canada.

ALAN ALDA (NARRATION) But Chuck saw here in Northern Canada a feature also found in the known diamond-producing regions- a patch of the Earth's crust thick enough to create the pressure needed to squeeze carbon into diamond. Those other diamond-rich regions depend on chimneys of molten rock, called kimberlite pipes, to lift the diamonds to the surface. Only a few of these pipes contain diamonds- and even in these, diamonds are rare.

CHUCK FIPKE Even in the best kimberlite pipes, diamonds only occur in one part per billion by volume, and so geologists that have worked five or ten years in the open pits never ever see an actual diamond in the host-rock kimberlite.

ALAN ALDA (NARRATION) So finding diamonds means that you must first locate kimberlite pipes- itself an extraordinarily difficult task. With no roads here and- at the time- not enough money for a helicopter, Chuck relied on float planes. But because of what he was looking for, that turned out to be an advantage. Chuck didn't expect to see the kimberlite pipes themselves. In the millions of years since they erupted at the surface, their craters have been filled in by water or sediment. Instead his plan was to search along the shores of the region's innumerable lakes for grains of minerals that form alongside diamonds- but are thousands of times more abundant.

CHUCK FIPKE These are diamond indicator minerals, some of which actually grow with diamonds. These purple pyropes, here, they actually grow with diamonds.

ALAN ALDA (NARRATION) Finding these minerals would mean diamonds must almost certainly be nearby. Only for 3 months a year is this land not frozen solid- so Chuck had to go to work just when the mosquitoes do. Chuck took more than a thousand samples like this in the 10 years he searched. Each sample, once the large gravel was screened out, contained 20 to 30 million grains of sand. He was looking for the one or two grains that would mean he was on the trail of kimberlite.

ALAN ALDA It's really looking for a needle in a haystack, isn't it?

CHUCK FIPKE Yeah, it is, but if you keep at it, if you go through every straw in the haystack, you'll eventually find the needle.

ALAN ALDA (NARRATION) And now we come to Chuck's secret weapon- his high-tech version of a gold pan- a lab he designed and built 20 years ago to find mineral needles in a haystack of sand. In a gold pan, the heavy gold sinks to the bottom as the lighter sand is washed away. But unlike gold, the minerals Chuck is looking for are only slightly heavier than most of the sand, and in a gold pan would also get washed away. So Chuck has built a series of separation steps- some of them so secret we couldn't film them- to tease out the one grain in 10 million he's searching for. This is one of the critical steps. It's like a gold pan that uses a liquid several times denser than water, floating off the lighter minerals, allowing any indicator minerals to sink. Next come machines that take out any grains that can be given an electrostatic charge, or that are magnetic. In the end each 20 million grain sample is reduced to a few thousand...

CHUCK FIPKE Oh. There's one right there.

ALAN ALDA (NARRATION) ...and these must be checked one by one. Chuck's crazy hunch was paying off. He began finding the minerals that can only come from kimberlite pipes. But that was the easy part. Now he had to find the pipes themselves. And months of searching, even near spots where the indicator minerals were the most plentiful, turned up nothing. Chuck seemed to have come to a dead-end- until he had another of his hunches. He'd been searching most intensively where his samples were best, near the base of the Canadian Rockies. But what if the indicator minerals hadn't come from pipes nearby, but had been transported and dumped here thousands of years ago by glaciers?

CHUCK FIPKE I kind of draw an analogy to a big bulldozer. The glaciers decapitate the top, say, of the diamond-bearing pipes and move them for distances of four or five hundred miles and leave little bits along the way. And so once you're on the trail, and you know which way the glacier has moved, well, then you can work your way back to the source.

ALAN ALDA (NARRATION) Over the next few summers, Chuck criss-crossed an area 800 miles long by 200 miles wide, collecting another 800 samples.

CHUCK FIPKE It's right there, it's right on the very end. Chuck's wife Marlene then spent much of her winters analyzing the samples and working on a map to display the results.

MARLENE FIPKE OK, red?

CHUCK FIPKE Yeah. Each sample was color coded according to the type and quantity of its indicator minerals.

MARLENE FIPKE Four?

CHUCK FIPKE OK, and three diamond inclusion chromites.

ALAN ALDA (NARRATION) As the map filled, its colored spots peaked 400 miles east of Chuck's original search site, then faded out. It was at a spot just before where the fading started that Chuck now placed a million dollar wager. With rumors of his discoveries leaking out, Chuck teamed with investors willing to pay for a helicopter to stake out mineral claims to approximately a half-million acres of the Northwest Territories. The investment group also promised the Canadian government to spend at least a million dollars developing the claim- still with not a single kimberlite pipe actually located. But as test drilling began, core sample after core sample revealed kimberlite pipes.

CHUCK FIPKE We're finding them right now as we're talking, so we'll probably end up having quite a rich diamond bearing area up here in Canada.

ALAN ALDA (NARRATION) "Quite a rich" could be a Canadian understatement. Already the investment partnership of BHP and Diamet has found 44 diamond-bearing kimberlite pipes. And the first five test mines here all produced diamonds. This handful alone could be worth \$100,000.

CHUCK FIPKE Well, the quality of these is excellent. They're very, very white, of the best color and flawless crystals.

ALAN ALDA When you were standing behind that billboard and heard your colleague say he thought you were kind of nuts for looking for these diamonds, you didn't really know that you'd be sitting on top of real diamond mines one day, did you?

CHUCK FIPKE No, but I wouldn't give up. But I must admit, I thought about it and at times, I thought maybe perhaps I was a little crazy.

ALAN ALDA (Laughs) But you kept at it.

ALAN ALDA (NARRATION) Unlike in the days of the Wild West, environmental concerns must first be satisfied before full-scale mining can begin. If and when it does, these frontier lands could soon be producing diamonds worth well over a billion dollars every year.

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MODEL PLANET

ALAN ALDA Here's an image right out of the Wild West: the lonely campfire the only sign of human life in miles of empty prairie - or here in Arizona, empty desert. The West was never really empty of course. But its native peoples lived lightly on the land, and the land itself - especially here in the desert - supported plants and animals that were adapted to getting by on not very much. But today Tucson, just to the south, and Phoenix a hundred miles north of here, are two of the fastest growing cities in the country. What supports the millions of new people is the equivalent of tens of millions of campfires like this - oil and gas being burned to power the cars and air conditioners - to pump the water and bring in the food. One campfire is relatively harmless. But across the planet, billions of campfires' worth of energy is being burned every day - so much that the atmosphere itself is being changed. There's been a lot of guessing about what the changing atmosphere will do to the earth, to it's ability to support life and to the biosphere we live in. But facts are hard to come by. How do you experiment with the planet? Well, out here in the middle of the Arizona desert is one possible answer. You build and operate a planet in miniature- another biosphere. Biosphere 2.

ALAN ALDA (NARRATION) September 1991. With much hoopla and hype, four women and four men embark on what is billed as one of the great scientific adventures of the century. With the sort of press coverage once given space missions, the eight so-called Biospherians are shut away inside what is claimed to be a sealed steel-and-glass structure that covers over three acres. Their mission: to be totally self-sufficient in air, water and food for two years. As tourists came to window-gaze at the Biospherians, problems began almost immediately. Carbon dioxide built up in the air. The Biospherians' farm failed to produce as much food as expected, leaving its inhabitants - like Linda Leigh - hungry and weak. Linda Leigh was in charge of the Biosphere's miniature rain forest - which was originally intended to remain an unexploited wilderness.

ALAN ALDA So, as you started to get hungrier and hungrier, did you find yourself foraging a little more?

LINDA LEIGH Yes. So we were foraging a little bit more and a little bit more, and realizing when we were really hungry that we were in trouble with food. And we started planting more bananas in the rainforest, and more papayas. In fact, the reason there are so many papayas right around this little pond is because we wanted more food for ourselves to eat. Our priorities changed. They changed over from the wilderness into producing food for the humans and I think it's really an interesting lesson. It really parallels what is happening on the earth.

ALAN ALDA (NARRATION) But by the time the Biospherians emerged from their 2 year stay, Biosphere 2 had gone from a grand experiment to the scandal-plagued butt of late-night TV jokes. A few months later, its benefactor and sole funder, a Texas billionaire, pulled the plug. Today, under new management, Biosphere 2 attracts fewer tourists. But for the first time since it was built, scientists are looking at it as a useful model of our own planet. Helping convince them is one of its builders, Bernd Zabel.

ALAN ALDA You built it and you were on the crew.

BERND ZABEL Yeah. So I had the knowledge, the very intricate knowledge by building it, but also I was in training for four years here to be part of the crew of how to operate it. So, yeah, I know it very well.

ALAN ALDA (NARRATION) Which is fortunate because it's Bernd's job to keep the Biosphere running. No one lives in here now, but managing a miniature earth, complete with a desert, swamp, rain forest and million gallon ocean, is a 24-hour-a-day job. And it's easy to make mistakes.

ALAN ALDA So you artificially regulate the rainfall. You can make it a desert rainfall over there?

BERND ZABEL Yeah, in all these biomes we are able to control the rain, except I show you what happens in the desert where we, where the rain run a little bit out of control, which had an incredible impact. This really doesn't look like a desert. I mean, it's far too green and lush for a desert.

ALAN ALDA How did it get that way?

BERND ZABEL It rained too much in here.

ALAN ALDA (NARRATION) One of the reasons the desert got too much rain was that water unexpectedly condensed on the roof at night, and then dripped down. And the desert wasn't alone in not quite working out as planned. Biosphere 2's ocean supports a coral reef, but barely. Keeping the ocean's million gallons as clean as real sea water has so far proved impossible.

BERND ZABEL The ocean is hanging in there, but it's really not flourishing.

ALAN ALDA (NARRATION) Of course, it's the problems of making Biosphere 2 work that make it so fascinating as a model for the earth. And some of the most intriguing insights it provides are from the things its designers left out.

ALAN ALDA You know what else I noticed that you don't seem to have- out in this big open space, anyway- is wind.

BERND ZABEL That's correct.

ALAN ALDA That's a big element that's missing, isn't it?

BERND ZABEL Which causes a problem for these trees. When you look here, these acacia trees, they have very funny forms. And what we found out later on, that if a tree grows, to harden the tree it needs wind action. Every time when a tree moves, it builds actually outside what is called a stress wood.

ALAN ALDA So that strengthens the tree?

BERND ZABEL So it strengthens the tree. In our case here, the tree is growing without any wind, without any disturbance, and it actually becomes so top heavy that they break off.

ALAN ALDA (NARRATION) Biosphere 2's builders left out the wind, but they included something I wished they hadn't.

ALAN ALDA These ants are covered! Every time I look down, I've got another ant on me. And look at this, they're all over the place!

BERND ZABEL Yeah, they're everywhere. Everywhere in the Biosphere.

ALAN ALDA Did you bring them in?

BERND ZABEL Yeah. They were not intentionally introduced, this species of ant, but they came in with some plants or we obviously...It's a rainforest ant.

ALAN ALDA (NARRATION) Like the rain forest ant, the rain forest itself is flourishing.

ALAN ALDA What's it like when it rains in here?

LINDA LEIGH Well, I think I'll just call in some rain and we'll find out.

ALAN ALDA Oh, good.

LINDA LEIGH Could we have rain in the northwest quadrant of the rainforest? Over.

ALAN ALDA (NARRATION) Knowing how much the producers like to put me in situations like this, I 'd come prepared.

CHRIS Are you ready for it, Linda?

LINDA We're ready. Thank you, Chris.

ALAN ALDA We're ready.

LINDA (laughs) I never had an umbrella in here before.

ALAN ALDA What kind of a rain would you call this?

LINDA LEIGH This is about the normal rain for the wet season in the rainforest here. It's nice, isn't it?

ALAN ALDA It's very nice. The nicest part is watching the camera crew get drenched.

LINDA LEIGH Yeah. (laughs)

ALAN ALDA (NARRATION) It's the Biosphere's rain forest that is perhaps its most valuable scientific resource. In just 4 years it has grown thick and lush, providing a textbook example of how vital the rain forests are to the earth and its atmosphere. Littering the forest's floor are its own decaying leaves.

LINDA LEIGH When this stuff falls to the ground, it starts to decompose. It breaks down into what we see right here, which is leaves that might have some of their matter gone. And they look really pretty like that. What this leaf becomes, when it's like this is it has become carbon dioxide in the atmosphere. Carbon dioxide is released in the atmosphere and oxygen is consumed. So this leaf, the carbon of this leaf has now gone into the atmosphere. We are breathing it, and so are the plants. The plants are using that carbon dioxide to grow.

ALAN ALDA (NARRATION) Right now, the world's burning of fossil fuels is pumping more and more carbon dioxide into the atmosphere. How plants will respond is a critical question for the earth's future- and it's one that the Biosphere's new director of science believes his earth-in-miniature can help answer.

BRUNO MARINO Biosphere 2 is a unique facility especially suited for these kinds of experiments because we have so many kinds of trees and plants under one atmosphere. Not only can we measure this leaf and many leaves of the same plant, but we also have many types of plants in the Biosphere. Of course,

now we're in the rainforest. Rainforest is obviously important because a large part of the CO₂ that's taken up by plants occurs in the world's tropical rainforests.

ALAN ALDA (NARRATION) Four years after being shut in here, the air in Biosphere 2 now has much more carbon dioxide than the air outside. Which is why Bernd is heading for the Biosphere's depths. And one of its most astonishing sights. Designed by Bernd, this is one of a giant pair of lungs.

ALAN ALDA This thing moves up and becomes a dome when it fills?

BERND ZABEL Yes, this thing is an aluminum saucer. It is airtight welded, it weighs 26 tons in itself and it is connected with a membrane, with a flexible rubber membrane to the outer ring, onto the outer tank. So this whole thing can move up and down.

ALAN ALDA (NARRATION) Opening this door for the first time in 4 years, Bernd allows the lung to breathe out the stale air and breathe in fresh air from the outside.

BERND ZABEL OK. Open the outer lung door.

ALAN ALDA (NARRATION) It takes just 20 minutes for Biosphere 2 to take one great gasp.

BERND ZABEL Door is closed.

ALAN ALDA (NARRATION) The plan is to set Biosphere 2's carbon dioxide levels at those the earth is likely to reach in the near future, then find out how food production, for instance, will likely change. The research is just beginning. But already Biosphere 2 has provided a new perspective on the world outside.

ALAN ALDA You walk past a plant in the outside world, and you're taking a breath and the plant in its own way is taking a breath. Do you really think about your relationship to that plant?

LINDA LEIGH I think about it every time, just like with this plant. This plant is producing oxygen that we are breathing. It's using the carbon dioxide that we're exhaling. We're dependent on each other. And that became so obvious inside this small world. The small world's very tangible. We know where the walls are, we know where the limits are, we've our glass exoskeleton on the outside. If you pollute your atmosphere in here, you know about it right away. Outside on the planet earth, we can pollute our atmosphere and it will end up in our neighbor's backyard. We might not think about it. In here, you think about it all the time.

ALAN ALDA (NARRATION) The thinking inspired by Biosphere 2 is the opposite in every way to the thinking that inspired the Wild West a hundred years ago. Then the world seemed to go on forever. Today we're only too well aware of its edges. From the former Wild West, this is Alan Alda. See you next time.

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