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Interviewer-John Howe

How fast is the West warming? And, should this be a cause for concern?

Jayne Belnap

The western U.S. is warming much more quickly than the rest of the country. In fact, the bull's eye is about on the Four Corners area of Colorado, New Mexico, Utah and Arizona. And yes, this needs to be of great concern because a lot of desert organisms are already at the limit of their ability to tolerate the temperatures that they experience. Also, agricultural people who are growing a certain crop in a certain area will suddenly find that temperatures are much warmer, soil moisture is reduced, and therefore they will no longer be able to grow the crops that they used to grow there.

Interviewer-John Howe

What are the effects of climate change, and what are visual examples that we might be able to see?

Jayne Belnap

We can expect many effects from climate change and probably the most obvious thing we'll see is prolonged droughts. The climate change models predict higher temperatures and reduced rainfall for the United States and that will all mean less moisture available for plants and animals.

Interviewer-John Howe

Anything specific that we can see there?

Jayne Belnap

One of the most obvious effects that we can expect from climate change will be a reduction in water whether it be in streams, lakes or rivers.

Interviewer-John Howe

Discuss the dusty, muddy snow and the dust layers. Describe what it looks like and why that phenomenon happens.

Jayne Belnap

In the western US, desert surfaces are very stable unless they are disturbed. Disturbance can be livestock. It can be cars. It can be mountain bikes. It can be anything like that. Once you destabilize the biological and physical crusts that hold these soils in place, they can blow. When they blow, they can get suspended in the air and they are carried to the nearby mountain range, where they are deposited on the snow. This makes the snow very dark. Those dark layers heat up when the snow hits it and accelerates the melt rate of that snow.

Interviewer-John Howe

What are the causes of global warming and climate change?

Jayne Belnap

There's many things that can cause warming of the atmosphere. Generally, most people believe that it's the greenhouse gases. These can be CO<sub>2</sub>, or carbon dioxide, that's released from burning of fossil fuels. It can be methane. Other things like that that really trap heat at the Earth's surface.

Interviewer-John Howe

You mentioned that solar panels and energy actually adds to warming. Tell me about that just a little bit.

Jayne Belnap

There's actually many land use activities that can actually accelerate warming, or, at least, create alterations in climate. One example is to clear vegetation so that you take a dark surface and you make it into a light surface. This can also happen with solar panels because you are basically taking dark vegetation, you clear the vegetation away and you're putting out a highly reflective surface. When you do that you cause air to rise off of that surface, and heat to rise off of that surface rather than being stored in the dark vegetation. That dry, hot air then pushes clouds away, which actually results in less rainfall in that area. And so, you are, in essence, accelerating the effects of climate change by altering the color of the Earth's surface.

Interviewer-John Howe

What kind of effect do ATVs have on the soil and the associated warming that goes along with that?

Jayne Belnap

Off-road vehicles are a major impact in the western United States, especially when it comes to destabilization of soil. For instance, when an off-road vehicle drives down a dirt road, it generates a huge amount of dust, even though it's on the road. When they leave the road, then they can actually destabilize areas that were highly stable because of the physical and biological crusts there. This dust can then go to the snowpack, and once it's deposited on the snowpack, creates a dark layer. This dark layer then heats up with the sun, creating much faster melt. The result of the much faster melt is that we end up with less water in the rivers, both throughout the season, especially in late season.

Interviewer-John Howe

You talked about the effect of warming on ranching and grazing, for example, grasses could be gone by 2045. Tell me why that is?

Jayne Belnap

One of the larger expected outcomes for warming is going to be the loss of shallow-rooted plants. Shallow-rooted plants include grasses, cactus, Mormon tea, pinion, juniper, all sorts of vegetation that we find in the western U.S.. The reason is that, since their roots are so shallow, they actually lose water faster than something that has deep roots. Grasses, of course, are an important part of the food chain. Livestock depend on grasses. Mice depend on grasses.

Rabbits depend on grasses, and, of course, predators depend on those animals. So, the loss of the grasses is expected to have a huge impact on the western U.S.. This doesn't apply to all grasses. Some grasses are better adapted to high temperatures than others, but certainly for the Intermountain West we expect to see a huge loss of the major forage species that are out there.

Interviewer-John Howe

You talked a little bit about increased off-road use. Is that a matter of need, or a matter of desire?

Jayne Belnap

I think one of the biggest issues that's going to face people in the western U.S. is that they're going to have to distinguish between need and desire. We tend to use the word "need" very casually. We say, "Oh, I need this," or "I need to go off-road driving," or "I need to go fishing," or "I need to do things," which actually are desires, and as resources become more and more limited, we're going to have to make more and more difficult choices. We're going to have to also distinguish between those two things. Need is something that's reserved for things like water and food. We need water and food. Desires are things that we can give up. And so, this is something that's really going to be painful for a lot of people in the U.S., but it's something that most people will have to deal with.

Interviewer-John Howe

What is the future of water in the West? What effect does the climate change have on water and sustainability?

Jayne Belnap

Water in the West is, of course, a huge issue, and one of the problems with climate change is warming. Warming means greater evaporation of what water we have. And so, we are looking at reduced water supplies at the same time populations are booming throughout the West. We're facing a time when we're really going to have to decide, carefully, what we want and actually plan how we're going to use the limited resources that we have. Trying to find a way to sustain life in the West is going to become more and more difficult as every year goes by, especially as things get warmer and warmer. Lakes will dry up. Streams will have less water in them. As we pump more and more aquifers down, they're going to be replenished less rapidly. As people and populations increase, lawns increase. All the ways that we use water increases and we are going to have to really decide what's important to us as a culture, because we are going to have to apportion our scarcer and scarcer resource.

Interviewer-John Howe

Do most scientists believe global warming is man-caused, and why?

Jayne Belnap

Most scientists believe that warming is human-caused. One of the most compelling reasons for this is that, if you look at a graph of temperature increase during the last century and you compare it to a graph of the carbon dioxide increase in the atmosphere over the last century, they're almost in lockstep. There's no other good explanation for carbon dioxide increase in the atmosphere other than the burning of fossil fuels. So, it's a really compelling argument. There's

a lot of other hypotheses that have been advanced, but they have pretty much been discounted through time.

Interviewer-John Howe

Why do you think climate change science is controversial? Is education the answer there?

Jayne Belnap

The idea that climate change is caused by humans is not very controversial within scientific circles. It's certainly controversial within political circles, and I think the main reason here is that it forces us to make very difficult choices. If we're truly going to address climate change, we're going to have to reduce our carbon emissions. All the choices that seem so small every day add up, so we're going to have to think very hard about everything that we do. Well, that also implies that you're going to have a change in the way that businesses are run, and it's probably going to be economically expensive. And so, it really is a harsh reality for businesses and politicians who are facing a reduction in business profits, for instance, to make a choice that says, yes, we're going to have reduced carbon emissions.

Interviewer-John Howe

How do all of these warming issues and climate change affect wilderness?

Jayne Belnap

Wilderness is going to be heavily impacted by climate warming, and the reason for this is most wilderness areas actually are at higher elevation. So, we are talking about all sorts of regional materials moving from lower elevations to higher elevations. It can be dust. It can be nitrogen. It can be ozone. It can be all sorts of--fertilizers, pesticides, insecticides--anything that can get airborne is going to move in and impact the wilderness areas. This could have tremendous impacts, because most of these areas really have very low fertility, so when you're talking about adding nitrogen, for instance, you can completely change the plant community composition. You can change the invertebrates that live in a high alpine lake. You could have a huge, huge effect on how the ecosystems function in these areas by lowland activities.

Interviewer-John Howe

What do you see for the future of the West if steps are not taken to prevent climate change?

Jayne Belnap

I suspect the West has a very unpleasant future if steps are not taken to correct climate change, and the reason that I say that is that we already have systems that are on the edge in terms of their ability to cope with high temperatures, their ability to cope with low water. So when we exacerbate that, when we make temperatures even higher, or we make water even more limited, a lot of these ecosystems are going to change dramatically and become much more hyper-arid desert-like, like the Sahara, so we're really looking at dramatic changes in these landscapes, which will then impact the animals and the people that inhabit those landscapes. We're talking about probably a lot more dust in the air. We're talking about scarce water, you know, all the things that we tend to value, great visibility, wonderful, open vistas, the ability to go where we want and to experience things how we want are really going to change. If we can address climate change and stop the CO<sub>2</sub> emissions, we still are going to see increases in temperature for

a long time, but at least they aren't going to continue to climb throughout time. So really, it's very, very critical that we address these issues, because if we don't, we're making choices now for many, many generations of people into the future.

Interviewer-John Howe

What do you say to critics of climate change science? And, why should we care about that?

Jayne Belnap

There are some critics that say that climate change is not human-caused. My response to that is, it really doesn't matter what the cause of climate change is. The fact of the matter is that temperatures are increasing. The climate change is upon us, so I think it behooves us to do everything that we can to slow it, regardless of the cause, because we know it's going to have a tremendous impact on our lives and our choices in the future.

Interviewer-John Howe

How fast is the West warming? You mentioned the glaciers, and should this be a cause for concern?

Jayne Belnap

One of the most obvious results of global warming is the dramatic melting of the glaciers and the ice caps, but actually low elevation lands in the western US are some of the most rapidly warming landscapes in the United States. This should be of great concern because a lot of the plants and animals are already at their thermal tolerance, namely they won't be able to handle higher temperatures. Also, surface waters are evaporating, and so there's less water available for those plants and animals to utilize. This will have tremendous impacts on people, whether it be the availability of drinking water, the availability of wildlife for hunting or for viewing. All the aspects of life that we value in the western U.S. are at risk due to global warming.

Interviewer-John Howe

What do you see for the future of the West? What do you think is going to happen over the next decade or so?

Jayne Belnap

The next decade in the western United States is going to be very interesting to watch, and the reason that I say that is that we're seeing increases in temperatures at an accelerating rate and we're already seeing changes in ecosystems. We're already seeing the loss of grasses. We're already seeing less water available for people's use. We're already seeing dust storms increase. We're already starting to see the things that we can expect to have happen over the next century. And so, it's becoming more and more apparent the impacts that climate change is going to have on the West. And so, I think that it's something that if people are aware of to start noticing, that it will become more and more apparent that we really are in the midst of increasing temperature and decreasing precipitation patterns.

Interviewer-John Howe

Tell me the reasons behind dirty snow.

Jayne Belnap

One of the major results of climate change in the West is that we are now getting dust on our snowpack. And one of the major reasons for dust increasing on the snowpack is human activity in the low elevation landscapes. These activities can be off-road vehicles. They can be livestock. They can be energy exploration and development. They can be mountain biking. Just about anything is capable of destabilizing desert surfaces. Without that sort of disturbance, surfaces are actually very, very stable, but once you destabilize them, you leave soils exposed to wind erosion. And the wind comes. It picks up that dust and moves it to the nearest mountain where it's deposited. When it's deposited, it makes the snow dark. That dark layer then heats up more readily with the sun, and so the snow underneath that layer melts more rapidly than if it didn't have the dust on top. What that means then is that snowpack is melting earlier in the spring than it used to. In a heavy dust year, it can be thirty days or more earlier, and means that we then have more water coming down early in the season rather than late in the season. In the West, we depend on late-season water because we already have very, very low supplies in July and August and September. And so, this has dramatic impacts across society. It can be a dramatic impact on dam storage because, if you suddenly have a lot of water come down early they can't store it in the dams. They have to let it through. It can have huge impacts, then, downstream on agriculture and other people that depend on that water storage. It can have huge impacts on the wildlife that depend on those streams and springs because the water will not be available late in the summer. The other impact that it has is that it leaves soils exposed to evaporation up in the mountains, and that soil water that evaporates is no longer available to enter the stream. And so, you also have an overall reduction of water going into springs, streams and rivers in the western United States.

Interviewer-John Howe

What would you say to politicians who simply believe that warming is just another geologic cycle?

Jayne Belnap

Some people say that warming is just another geologic cycle, and my response to that is that I don't think it really matters what the cause of the warming is. The truth and the facts are that it's going to have a huge impact on our lifestyles, regardless of what the cause of the warming is. And so, I think it behooves us to take steps to address the warming, regardless of the cause. We know that it's going to interrupt all sorts of lifestyle choices that we have made. If you want to be skiing in April, you're probably not going to be able to do that anymore. If you want to grow crops in a place that you used to grow crops in the last hundred years, you may not be able to do that anymore. So, regardless of the cause, I think we really have to take action and adapt to what we can already see is happening. It doesn't really matter if it's geologically-caused or human-caused at this point. What we do know is that there are steps that we can take to slow the warming, and we need to take those steps.

Interviewer-John Howe

You were saying its not all doom and gloom, that there are actually solutions to these issues.

Jayne Belnap

So, it's important for me to emphasize, this is not all doom and gloom scenario. There are solutions. We can manage for dust. We can manage for water scarcity, but we need to make the decisions now so that we're not just at the end going, "Oh no! What do we do?" We have lots of opportunities. For instance, we can assess the timing and intensity of different activities on soils that are more vulnerable to dust production. We can say, "OK," you know, "We're only going to use those areas in the winter," for example, and maybe not in the summer when it's really dry and hot. There are a lot of choices we can make. For instance, when we do oil development, we put in an oil pad. Rather than have five or six roads leave that oil pad to connect to the next one, we could put in one road. So, it's not a matter of not using the desert, it's a matter of being smart about how we use the desert, and realizing that we are going to need to make choices and to be clever about it and to plan rather than doing things as we always have.