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## AMERICA'S RIVERS AT RISK: CLIMATE CHANGE

### Salmon Tell The Story

#### In The Sub-Arctic, A Worrisome Warming Trend

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TANANA, Alaska -- On a warm evening this summer, with the sub-Arctic sun still high, about two-dozen adults and children gathered on the south bank of the Yukon River for a picnic supper, many miles from any road.

In the river were their boats, their nets and their fishwheels, lumbering contraptions fashioned of spruce and tamarack limbs that trap salmon as they migrate upriver. These were families and couples catching fish to preserve and sustain them through the long Alaskan winter.

It was an idyllic evening, but the warmth in the air only underscored a new climatic reality in Alaska, one that threatens the way of life of these Alaskan families.

Alaska is a much warmer place than it used to be, even if warm in winter means 30 below zero and not 60 below zero, and that change in weather is affecting everything from Alaskan vegetation to the health of the salmon.

Climate change, whether caused by civilization's fuel-burning excesses or a natural shift in climate, is happening here on a scale not yet seen in the rest of the country. Even Alaskans who are not ready to blame the industrialized world for global warming agree that the Alaskan weather is heating up.

Ruth Althoff, who, with her husband, Charlie Campbell, preserve their fish in a rudimentary smokehouse at river's edge, said the winters have been so mild that at times there isn't enough snow to run the family's 32 sled dogs.

More ominously, river temperatures have risen so much that the salmon appear vulnerable to a parasite that, research suggests, once was kept in check by colder water temperatures. Althoff worries about the long term.

"Without the salmon run, it is going to change the whole watershed. The whole thing," she said.

Ironically, if pristine still exists anywhere in the United States, it is here in the Yukon River Valley, where people are few, and where nature is still the boss - perhaps. The storied Yukon is enduring the kind of rapid change that could throw one of the last wild expanses in the United States into eco-chaos.

What is happening on the Yukon demonstrates abundantly that no river, no ecosystem, is untouched by continental or global environmental trends such as climate change, which could have profound, if as yet unpredictable, impacts on many rivers.

Climate change is among a series of problems facing the country's rivers that, at least in places, is undermining the substantial progress made since Americans got serious about water pollution three decades ago.

"There were major strides made because of the Clean Water Act," said Margaret A. Palmer, an aquatic ecologist at the University of Maryland. "But there are so many other assaults on our waterways that we haven't begun to address."

### **King Salmon Under Siege**

By traditional water quality measures, such as bacteria levels, the Yukon is a comparatively clean and healthy river. It is big and brawny, more than 1,900 miles long. Only about 130,000 people live in the entire Yukon Valley of 330,000 square miles, an area nearly five times the size of New England.

Here in central Alaska, far from the more accessible Alaskan cities and parks that draw the tourists, the river runs a chalky, silty, gray-green, partly due to meltwater from glaciers. It is graced by mountains and by the spruces and cottonwoods that grow almost to water's edge. Tiny villages of a few hundred people are often 50 or 100 miles apart, with no road network to connect them. The highway is the Yukon; there is no traffic congestion.

River temperatures in the Yukon have been rising steadily since the 1970s, though, now hitting the upper 60s in June. "I remember 10 or 15 years ago, the highest temperature you would get in the summertime would be, like, 63, sometimes 64 degrees, that was the highest," Campbell said. "In the last couple of years it's gotten as high as 67 and we're noticing it. In some ways it's a plus. We swim. We never used to swim in June."

That the Yukon's king salmon appear to be affected is especially troubling. In so many of the nation's other rivers, salmon populations have been wiped out or severely reduced, often because of dams, while the Yukon, which is all but free of dams, is still host to a sizable migratory run.

But the run in the Yukon isn't what it was 20 years ago, either.

By the late 1980s, fishermen noticed something odd about the salmon. Bill Fliris, one of the subsistence fishermen on the Yukon who catches salmon every summer, was among the first to see it.

"A pole of salmon strips in our smokehouse had a funny odor," he said. "I had just put them in. I walked by and I could smell this kind of fruity smell, which is unusual because fresh-cut fish doesn't really have any odor. After it has hung and smoked for a while it starts to smell smoky, but these had just been put in. So I moved them aside and set them in a separate part of the smokehouse. As days went by, they didn't dry like the other strips, and that odor got even stronger."

Before long it became obvious that this wasn't a single bad batch of fish; all the fishermen were discovering that some fish had an odd smell and didn't smoke properly. They'd get puffy and fibrous and would never completely dry.

Fliris was concerned and began asking authorities to investigate. It took time, but by the late 1990s the question attracted the attention of Richard M. Kocan, a microbiologist and professor emeritus at the University of Washington, who launched a study.

Kocan identified the problem as ichthyophoniasis, a disease caused by a protozoan parasite known only by its scientific name, ichthyophonus. It was the first time a salmon species had been known to be infected by the parasite.

Kocan's findings, published only last year, strongly suggest that the warmer water in the Yukon make the salmon more vulnerable to the parasite. In all likelihood, he found, the parasite is killing many of them before they ever reach spawning water hundreds of miles from the sea.

The parasite's growth is essentially stopped in water temperatures of 41 degrees, the temperature of the Bering Sea at the mouth of the Yukon, where the salmon enter the river, Kocan said. But growth "explodes" as temperatures reach the mid-60s - the very temperatures now seen in the Yukon during the salmon run in late June and July.

Disease rates among salmon are as high as 30 percent of the migrating fish at times. Although the parasite poses no human health threat, Alaskan fishing families typically feed infected fish to their sled dogs.

"We still think the evidence for a link between rising water temperature in the Yukon River and ichthyophoniasis is strong," Kocan said. "This is based on actual rise in temperature in the river since 1976 and experimental evidence that shows ichthyophonus to increase in pathogenicity as water temperature rises, and for increased growth of the parasite in proportion to increased temperature."

## **The Big Picture: Climate Change**

Tanana, with a population of about 250 people, many of them Athabascan, the native people of interior Alaska, is one of the villages on the Yukon, about 700 miles upriver from the sea. Tod Kozevnikoff, 68, half Athabascan, has lived most of his life in the area.

"The winters are a lot warmer than they used to be," he said one afternoon, standing outside his cabin. "We used to get long spells of 60-below weather. I don't see that anymore."

What is happening on the Yukon is a more dramatic example of what is happening in many other parts of the country, where more subtle shifts in climate already are discernible.

In the Connecticut River Valley in Connecticut, for example, precipitation has been slowly rising over the past century from about 40 inches a year to 50 inches a year now.

"From a physical point of view, that 25 percent increase in mean annual precipitation is just startling," said James G. MacBroom, an engineer involved in many river restoration projects in the eastern U.S. "What is it going to do to riverine systems?"

In a book published last year, "Climate Change and Biodiversity," three scientists, David Allan, LeRoy Poff and the University of Maryland's Palmer, warned that climate change will in all likelihood lead to the elimination of some species in freshwater ecosystems. Direct or indirect effects of warming and altered river flows below dams, "combined with human modifications of natural landscape, present a grave threat to native biodiversity throughout the world," they wrote.

Rivers will adapt to change, as they have to pollution and other degradation. "Unfortunately, that adaptation is likely to entail a diminishment of native biodiversity," they said.

Scientists studying the Yukon Valley see trends that, if they continue, will mean serious long-term problems. As the climate in Alaska warms, glaciers melt, or ablate, as the process is more formally known. At the moment, those melting glaciers are thought to be the cause of increased flows in recent years in glacially fed Yukon tributaries.

"The big player in the whole climate change picture in the Yukon basin is the glaciers, because right now the glaciers are degrading, so the flows in the rivers are increasing," said Larry D. Hinzman, research professor of water resources at the University of Alaska at Fairbanks. "But that is not going to continue forever. Eventually these glaciers will degrade to the point where flows start decreasing."

When that happens, flows could drop precipitously on some rivers, with potential harm to fish and other aquatic species.

Two of the major tributaries of the Yukon, the Tanana River and the White River, provide 29 percent of the total flow into the Yukon, according to the U.S. Geological Survey. Both are fed by glacial meltwater - and if those discharges were to disappear, the effects on the Yukon would be dramatic.

Even a moderate reduction in flow could disrupt village life. At the moment, Yukon River villages receive large equipment, building supplies and major home appliances during the summer, when barges motor down the Tanana from Fairbanks.

"When those discharges decrease it will be much harder to get supplies to those villages," Hinzman said. "Right now they can come only for a short period in July when the discharge in those glaciated basins is at its highest, when the glaciers are melting the

most."

One day this summer, dozens of firefighters were battling a blaze on a mountain behind Tanana village. Labeled by the Bureau of Land Management as the Mission Stream fire, for the stream nearby, it was considered a small fire - "a campfire" as one native Alaskan put it - but it still consumed 1,850 acres over a few days and cost more than \$500,000 to control.

Kozevnikoff is among those who think fires are more common as temperatures rise. "I only remember one summer when I was young that the smoke clouded the visibility on the river. Now it does that more frequently," he said.

Scientists say such anecdotal evidence is backed up by the statistics. With higher temperatures and degrading permafrost, fires have in fact been increasing.

According to research by F. Stuart Chapin III at the University of Alaska at Fairbanks, fires were more extensive last year in interior Alaska, including the Yukon Valley, than in any other recorded year. He is convinced that the increased incidence of fire is directly related to the warming climate, which he also believes is caused by burning fossil fuels.

Once there is fire, a series of other impacts can follow, some of which degrade rivers such as the Yukon.

"We are seeing more transported sediments into the streams because of those fires," Hinzman said. Excessive sediments can seriously disrupt aquatic life, including the viability of fish eggs.

"We are seeing rapid degradation of the permafrost," he added. "We expected that the response of climate change would be gradual, but in fact, with the increasing fires and then the subsequent change in the permafrost, we are seeing rapid changes in response to warming climate."

### **'All Bets Are Off Now'**

Meanwhile, the families living along the Yukon are dealing with the changes as they go about their lives. They don't necessarily complain when they get a mild winter - one without those weeks of unrelenting 60-below-zero weather - but they also know that the entire ecosystem is shifting, that some animals will flourish while others will suffer. Already, scientists have documented that the tree and shrub species growing on former permafrost is different from what used to be there.

As he sat on the bank of the Yukon that warm night, his fishwheel revolving rhythmically in the powerful current of the Yukon, Campbell wondered about it all.

"The main thing I think is that all bets are off now," he said. "It used to be with winter you could depend on a certain length to it. There was a certain stability to it. But it seems like all stability is gone now. You just don't know what will happen."

