

Quest #102 Winter Wise

(Christine Young, Program Host) Next on Quest... We look at Maine weather, its many fluctuations and our attempts to make better sense of them. The National Weather Service is modernizing itself, but how much is all the new technology really improving our ability to forecast the weather? And it's not just the weather that changes, our climate is also in flux. We'll hear scientists debate how we're headed for both global warming and another ice age. Also, many Mainers have figured out ways to get around our long winters and short growing season. We'll learn some of their secrets. Weatherwise--that's what this Quest is all about.

Promo and Music

(Christine Young, Program Host) Hi, I'm Christine Young, your host for Quest. Maine weather is notorious, for it can be fickle and ferocious, particularly here on the coast of Maine. Our weather is one reason why we're one of the least populated states in the country, but it's also why we have some magnificent natural resources. Our climate has given us bountiful timber, a landscape ideal for growing potatoes, and fish filled waters, all of which we've turned into major industries. But no matter where you are in Maine, weather is important to us. We begin our Quest called Weatherwise with a story on the seemingly futile task of predicting the weather. Dana Hutchins has more.

(Dana Hutchins, Segment Host) Historically, Maine has seen blizzards that pile snowdrifts that could easily bury toll booths on the turnpike. On average, one tropical storm every four years that either tears across the mainland or glances our shores. The most hours of fog on the Atlantic coast. And the sunniest winter weather on the east coast outside of Florida. That's weather as we've known it in Maine. Predicting it has never been a very precise science. Some of us just have a knack for knowing what's coming our way. Most of us though, must rely on others to tell us what's in store weather-wise. Scientifically there have been many improvements made in predicting the weather, but has anyone noticed?

(Lou McNally, Television Meteorologist) Well I think in some industrial senses, yes, people have noticed, and in aviation circles people have noticed, but in the general public? No, I think not.

(Joe Cupo, Television Meteorologist) I've got people coming up to me from time to time saying, you guys do a good job, you know that makes my day. There are some people who always are just going to remember the ones you missed, you know you could get nine storms right and miss one and you'll hear about that one. So it's hard to say, I think probably some people think we've gotten better, yeah.

(Dana Hutchins, Segment Host) It's little wonder that we don't have much confidence in weather predictions. Up until 15 years ago, forecasters relied on theories dating back to World War I for predicting the weather. Now they've come to depend on complex computer models that simulate shifting atmospheric winds and conditions. Using a combination of physics and mathematics, meteorologists are experts in what's called numerical modeling. Forecasters use current conditions as data in their modeling to gain insight in how the real atmosphere might behave in the near future.

(Kirk Maasch, Geology, University of Maine) The numerical weather prediction model is nothing more than a statement of the conservation of mass momentum and energy in the atmosphere. The solution of these is the description of motions within the atmosphere. These motions are our weather.

(Lou McNally, Television Meteorologist) We know how the atmosphere operates and we know the thermal dynamics and the hydro dynamics of the whole system, but if you come in and look at the models and then compare it to what's actually going on, that's where you find the trick. If you find that this model says the next weather maker is going to move a 100 miles from here to there, but you look at it right now and it's in a different place, well then you have to adjust, you see? So it's not a matter of taking the models as the Bible at this point, not yet.

(Dana Hutchins, Segment Host) But it doesn't matter how powerful or fast computers are now or how sophisticated the modeling gets, a weather forecast is accurate for only a few days ahead. Usually, after five days it really doesn't matter what method you use. Forecasting becomes less reliable and oftentimes wrong, and that's because the world we live in is chaotic.

(Honda commercial) It's 10:15 in the Amazon and a butterfly flaps its wings which spreads pollen and causes a caribou to sneeze igniting a massive stampede that adds wind to a mounting storm which alters the global pattern of weather and creates a downpour that knocks out the electricity so you couldn't blow dry your hair.

(Dana Hutchins, Segment Host) Chaos theory in the hypothetical butterfly have even become part of our popular culture. Meteorologists now believe that slight disturbance in the atmosphere can make a world of difference in the weather. They now incorporate the chaos theory in their computer forecasting. In making forecasts, they run a number of simulations. Any small error in data or the formulas they are using can throw a forecast off greatly.

(Kirk Maasch, Geology, University of Maine) Let's just make believe that these curves right here represent rain and that down here means it does rain, it's a rainy day, and up here means that it's a sunny day. I'm a forecaster and I input into my model the initial conditions for this day. I saw into the future up to this point, and I say it's rainy and then sunny. You bring your umbrella on the rainy day, you're happy. Now I continue without updating the initial conditions to predict into the future, if the blue is what I predict and the red is what actually happens, my model says sunny day. What happens is it rains. You get wet. You're not happy. You say weather forecasters don't know what they're talking about. Now the reason that that happened is because the system is sensitive to initial conditions and we can only predict so far into the future before it's necessary to update our initial conditions.

(Dana Hutchins, Segment Host) What chaos means for meteorologists is that they're never going to be able to get a weather prediction right every time. At least until they can know all conditions everywhere on earth all the time. In weather some elements are easier to predict than others. Temperatures, for instance, can be forecast with greater accuracy than precipitation because temperatures are more continuous and consistent. Forecasts for the higher levels of the atmosphere with their smoother patterns are more accurate than for surface zones. But a forecast made more than five days in advance is likely to be a prediction based on historical or statistical data. That's why you often hear long range weather predictions described in terms of how they depart from normal. To come up with that kind of a forecast, meteorologists find weather patterns in the past that most closely correspond to present conditions. The resulting long-range forecast is actually a dupli-

cate or average of weather that has occurred at an earlier time.

(Fred Ronco, National Weather Service) You get a long enough history or climatology of what has happened, then if you see certain patterns setting up that have happened in the past, then you can expect a similar type of thing to happen again.

(Dana Hutchins, Segment Host) The National Weather Service has high hopes for its new computer long range predictions, but these forecasts don't cover specific days or weeks, or say how warm, cold, wet or dry it will be.

(Al Wheeler, National Weather Service) Well, a lot of it gets into just the state of the science with computer modeling and the types of things, like the implications of chaos theory that place limits on our ability. We have improved in terms of getting more and more computing power, higher speeds, faster computers which enable us to run more complex models and run them out into longer time frames, but we still keep running into that basic problem, that any small errors that may have been in that initial field tend to magnify and cause problems later on, in terms of a model prediction that won't be accurate.

(Dana Hutchins, Segment Host) When you have highly unusual weather like we've had this past winter, you tend to lose faith, both in meteorologists and in the widely publicized old Farmer's Almanac, which predicted up to 30 major snowstorms.

(Joe Cupo, Television Meteorologist) When I was in college I had a brilliant professor who was the guru of all the synopticians, synoptic meteorology being the branch of it that deals with weather forecasting, and his pet expression was, "it's perfectly normal for the atmosphere to be abnormal."

(Dana Hutchins, Segment Host) There are two Farmers Almanacs, the one with the better record lately is the one published in Lewiston. It's called the Farmer's Almanac.

(Sandi Duncan, Farmer's Almanac) We give predictions for twelve to 15 months in advance and people that follow us say that we're 80 to 85 percent accurate, which I think is kind of amazing in this day and age when we don't use the computer tracking systems and satellites and, you know, once we put our weather predictions in print we can't go back the day before and kind of change it, I mean it's there and it's going to stay there so while we don't try to compete with the meteorologists on the news, we like to try to keep them on their toes and kind of like smile when we get it right and they get it wrong.

(Dana Hutchins, Segment Host) Both almanacs say they have secret formulas for predicting the weather going back to the late 1700s and early 1800s, but they also use updated mathematical formulas and data on the sun and the moon. Neither of them count acorns or observe woolly bear caterpillars anymore. They go to press in this summer long before such folklore events are evident. So what keeps us watching for weather forecasts even when we don't have much faith in them?

(Al Wheeler, National Weather Service) New England as a whole and of course Maine is notoriously unpredictable in that sense and I think that ties into the variety of weather and the weather extremes that we can experience here and the past few winters have been some good examples of that.

(Dana Hutchins, Segment Host) Until recently the National Weather Service has not been a high priority in the federal budget. Much of the National Weather Service's technology dates back to the 1940s. Some parts are so old their no longer available, when they break down the Weather Service

can't find replacements, so it has to make them. In the past few years, the Weather Service has had less sophisticated forecasting equipment at its disposal than some big city television meteorologists. But all that's changing. There's a massive effort under way to modernize the Weather Service by the end of this decade. The result is expected to be more accurate forecasts and more lead time for preparing for major storms. Satellites provide the big picture for weather predictions and have been the backbone of forecasting since they were first launched 30 years ago. The trick is to keep them in orbit, because if they're orbiting properly, they can give us good images of clouds and storms as well as other weather information from the earth below.

Music

(Dana Hutchins, Segment Host) There are two types of weather satellites. Both are necessary to get an overall picture of weather around the globe.

(Joe Cupo, Television Meteorologist) Satellite data is invaluable, I mean to be able to take a, run a loop such as I have behind me and in 30 seconds see cloud formation and cloud motion, because you can run time lapses sort of like a time lapse thing where you run say the last 24 satellite images and they come over every 1/2 hour, so you know, you see this motion. That is, a picture is worth a million words in this situation, because to be able to see that, you automatically know what's going on.

(Dana Hutchins, Segment Host) The Weather Service likes to have two of each kind of satellite in the sky at any given time. The big picture weather information comes from the geostationary satellites. They circle the earth in geosynchronous orbit, which means they orbit over the equator at a speed equal to the earth's rotation. This allows them to hover over one position about 22,000 miles above earth. That's high enough to give them a full disc view of our planet, even though individually each satellite can see only 1/3 of the earth's surface. Instruments on board measure energy radiated from the earth and reflected from clouds. Meteorologists use those measurements to determine atmospheric temperatures, winds, moisture, and cloud cover. The satellites continuously transmit these data to ground terminals where they're rebroadcast for weather services around the world. Mathematical analysis turns the data into weather forecasts.

(Fred Ronco, National Weather Service) A lot of it is very manually intensive. You've got people looking at satellite data, making computations at certain grid points and these data then are added into computer models, or into an analysis, at a certain grid point as to what those values are, and that's part of the input into the computer modem.

(Dana Hutchins, Segment Host) Complimenting the geostationary satellites are two polar orbiting birds. They constantly circle the earth in sun-synchronous north-south paths. They pass close to both poles at an altitude of 450 miles up. These two satellites also work as a pair, providing total global coverage four times a day. Since the polar orbiters are much closer to earth than the geostationary satellites, their instruments record actual temperatures, moisture sounding, sea surface temperatures, land surface temperatures, cloud cover and heights, precipitable moisture and ozone. These data are then used to make temperature charts, snow cover analysis, vegetation maps, and other forecasting tools.

(Al Wheeler, National Weather Service) Special instrumentation on the polar orbiters, in essence, fill in the holes for us where we don't have weather balloon stations. The oceans are a good example. We just don't fly weather balloons out there, but we need to know that the temperature and humidity and wind profiles in the atmosphere in order to have an accurate model run.

(Dana Hutchins, Segment Host) But, what will put the weather service on the cutting edge is something that doesn't sound that high tech, an upgraded radar system. Doppler Radar, also known as NEXRAD, or next generation radar, is considered one of the most significant improvements in weather forecasting. Doppler Radar gives meteorologists an extraordinarily detailed look at what goes on inside a storm. These high resolution displays of wind patterns and rain motion help forecasters identify storms in their earliest stages. Some meteorologists say looking at a storm through Doppler Radar is like putting on your first pair of prescription eyeglasses.

(Joe Cupo, Television Meteorologist) Doppler Radar is going to play a role in "now casting," in being able to make forecasts in the next hour, few hours, picking up things like wind shears and microbursts, which are very dangerous to aircraft. These are the kinds of things that Doppler Radar is going to play a role in.

(Dana Hutchins, Segment Host) Traditional radar works by sending off signals that reflect off of raindrops or snowflakes. It's good for seeing bad weather coming and gauging how bad it's going to be. Doppler Radar can calculate the speed and direction of the air based on shifts in the frequency of return signals.

(Lou McNally, Television Meteorologist) So, if you're standing at a railroad crossing and you hear a train coming by, blowing its horn, it's going to go hmmmrrrrrr, right? I mean, you hear that even if you're standing on an expressway and hear the tires from a truck, whrrrrrrr. Well, that's because it's the sound compressing as it moves towards you and expanding as it moves away.

(Dana Hutchins, Segment Host) Doppler Radar helps meteorologists predict the severity of a storm, and gives them a good idea where it's headed. The weather service is installing more than 150 Doppler Radar systems to provide blanket coverage for the country. In the name of modernization the weather service also is in the process of closing about half of its 250 weather stations nationwide. The number of employees will be reduced and in some cases their jobs will be changed. Technicians who have been collecting weather observations will monitor automated observing systems, which will provide more frequent updates, but many of those who collect data in rural areas are there to stay.

(Dennis Pike, Oxford County Sheriff) The most universally talked about subject on the face of the planet is the weather, in every language, in every country, probably because as we speak we still have very limited ability to do anything about it.

(Dana Hutchins, Segment Host) The weather station in Caribou is one of those slated to close due to modernization cutbacks, but if farmers in Aroostook County have their way the weather station in Caribou will stay open. Those in agriculture have always wanted to know as much about the weather as they can. What's new is they now have several choices for getting what they need.

(Dottie Hutchinson, Lavoie Applicators, Presque Isle)...a U.S. satellite picture....

(Dana Hutchins, Segment Host) Lavoie Applicators in Presque Isle, for example, is one of a handful of subscribers in Maine to on-line weather data services. Lavoie likes the service because the data are updated every 15 minutes, 24 hours a day, all for less than \$40 a month. Farmers can download their own satellite images to supplement those from the National Weather Service.

(Dana Hutchins, Segment Host) Weather forecasting is not an exact science and the chaos theory

may virtually ensure it remains imprecise, and since we do take our weather so seriously here in Maine, we're more than weather watchers, we're becoming weather experts, as well.

(Music)

(Christine Young, Program Host) The landscape here in central Maine is dominated by the vastness of its timberlands. It's one of the richest sources of soft woods in the country, but Maine woods have not always looked this way, and from a geologic perspective we've only looked this way for a short time. If we step back and take a larger view of our state and its weather, we can better appreciate the role climate has played and is still playing in Maine. Kate Arno has this story:

(Kate Arno, Segment Host) In our quest to find the best ways to forecast future weather, there are those who would use past weather as a gauge. As strange as it sounds, there's a whole other type of study of weather that uses trends from the past to make links with current weather patterns. It's not only a different way of looking at weather, it gives us more information about our climate as well, and it shows how climate, vegetation, and wildlife change, much like our weather. Professor Dave Smith has been a fixture on the University of Maine campus in Orono for 40 years. His specialty is the study of weather from historical information of the past 350 years. Historical Climatology is what it's called in academic circles. Smith and his colleagues have gathered weather records for New England from as far back as 1630. Smith uses information from state records, the Army, and many weather amateurs, which the National Weather Service still relies on for observations. His most unique method of gathering weather data is through personal diaries. We all like to talk about the weather, a lot of us must like to write about it, too.

(David Smith, Agricultural History, University of Maine) Invariably, those diaries start with what the weather was at that time. For instance, this is one from West Paris and it's in July, 1943. This person starts off "fair, hot, awful hot." The agriculture, the weather is the important thing.

(Kate Arno, Segment Host) Smith and a former graduate student came up with a computer word analysis program that allows them to cull private journals to find comments about the weather.

(David Smith, Agricultural History, University of Maine) What we did was take these and we applied a dictionary definition to not only "hot," but "awful." What does "awful" mean in this context, and gave it a number, a series of numbers, applied those numbers using a computer technique which analyzes word counts and developed a numerical record of the weather based on this theory, but what we would do is put, maybe, 50 diaries together within a 20-mile range, so we could in fact draw a weather map.

(Kate Arno, Segment Host) Smith says his data from 1720 onward are quite thorough, and they tell him much about variations in the growing seasons of this area.

(David Smith, Agricultural History, University of Maine) Maine farmers and people who lived on the land constantly had a need to know what had happened in the past. They knew that there are cycles, they didn't know, they couldn't predict day to day what was going to happen, but they did, nevertheless, understand that if you could think about the past, you could then make predictions about the future.

(Kate Arno, Segment Host) Smith borrows from both science and history for his studies. It's an interesting combination, and something that one of his students can use in his work nearly every day.

(Lou McNally, Television Meteorologist) I combine the historical effects of other storms that I've been through, other weather patterns that I've seen in 20-25 years of doing this. That helps a lot. If we can get trends that go over ten, over 100, into the thousand years, then we're going to have a much better handle on what may happen to us in the next ten, or 100, or 1000 years.

(Kate Arno, Segment Host) Professor Smith uses the historical weather data he's collected to help understand what he calls long waves in our climate. In this data are some clues to where our climate may be headed.

(David Smith, Agricultural History, University of Maine) What we're doing is trying to provide as good as possible a record prior to instrumentation, and then with instrumentation, to develop whether or not, and we think there are, cycles that are occurring in, as the climate has developed over time.

(Kate Arno, Segment Host) Smith and many other scientists are watching the recent warming trend in the last decade. Scientists hypothesize the warming trend is due to industrial and agricultural gases, mainly carbon dioxide, methane, and chloroflourocarbons which trap infrared energy and cause heating. Smith for one is not convinced this man-made global warming is going to have a major impact on our climate. He said if the climate was warming up the seas would be rising. According to his evidence, they don't seem to be doing that. Here, east of Ellsworth, Smith has been taking measurements of water depths. His data show the waters just off the coast of Maine are actually falling. Smith is part of the University of Maine's Institute for Quaternary Studies, which is the study of the most recent geologic period which began two million years ago. For he and his colleagues glacial ages come and go. There have been 20 or more ice ages in the quaternary period alone, and so, it is quite normal for Smith to think about pending ice ages. The last ice age was 13,000 years ago. They usually return every 12,000 to 16,000 years. Smith's data tell him we're in a period of high unpredictability climate-wise, which is typical just prior to ice ages.

(David Smith, Agricultural History, University of Maine) In terms of the near future, it seems to me that what we have going on now is a real warfare in which we are the subjects. The long waves, the climatological long waves, which is going to produce the glaciers is there and it's a constant, it's part of our life. At the same time we're interfering with it by dumping chemistry into the atmosphere, which is giving us a short term global warming.

(George Jacobson, Botany, University of Maine) You can't fill the core with water...

(Kate Arno, Segment Host) George Jacobson is a botanist at the University of Maine's Institute for Quaternary Studies. Like Smith, he reconstructs environments in his work, but Jacobson's studies of Maine's forest and climate go back 14,000 years. He's found that Maine has been in recovery from the last ice age for the entire 14,000 year period. That means Maine's white mantle of ice, which made a dramatic and relatively rapid retreat, was replaced by ever-changing kinds of green vegetation.

(George Jacobson, Botany, University of Maine) At 14,000 years, Maine really would have been virtually covered by ice. Only the very southern part of Maine down around Kittery would have been free of ice by then. As the ice began to melt globally and sea levels rose so the sea began to encroach upon the Maine coastline and as land became exposed for the first time, it was cold water and cold air coming off the ice heap nearby so it was a very, very difficult environment biologically.

(Kate Arno, Segment Host) Over the past 14,000 years since the last glacial age, Jacobson has

found many different Maines. The coastal region has been flooded by ocean waters. The terrain has had little or no vegetation cover. Vast treeless tundra and diverse forests that have evolved over time.

(Kate Arno, Segment Host) To determine these vegetative and climatic changes Jacobson studies pollen, old pollen. As strange as it may sound, he thinks fossilized pollen is the most important evidence left behind by nature in Maine.

(Kate Arno, Segment Host) Enormous numbers of pollen grains are produced by plants and these microscopic particles are blown and washed into our lakes and wetlands where they are well preserved in the sediments and peats. The soft living contents of the grains decay rapidly, but the hard wall is extremely resistant to decay. The walls of the grains remain in excellent condition for thousands of years. Each species of tree, shrub, and herb produces a unique pollen grain. Under a microscope the form and sculpturing of the grain's outer wall tell what kind of plant it came from. Jacobson and his co-workers also have found well preserved seeds, leaves, and spores to study. These fossils are pulled out of core samples from lake and wetland sediment at varying depths.

(Kate Arno, Segment Host) The age of each depth of sediment is determined after it's analyzed for Carbon 14, an isotope that undergoes radioactive decay at a constant rate. This natural clock for determining the age of a fossil is known as carbon dating.

(Kate Arno, Segment Host) Jacobson believes his pollen seed and leaf fossil records indicate a number of distinct climates in Maine since the last ice age.

(Jacobson) The climates that Maine has experienced during the last 14,000 years vary quite a lot. We actually have good evidence that there was a time thousand of years ago, maybe 6,000 to 8,000 years ago, when the climate was probably somewhat warmer and drier than it is today.

(Kate Arno, Segment Host) When the glaciers around the globe started melting about 18,000 years ago, sea levels rose. Most marine fossil deposits in Maine are found near the coast, although some have been found as far as 100 miles inland along major river valleys, such as the Penobscot and Kennebec. Right after the glaciers melted and moved northward, Maine had a barren landscape along with a cold climate and supported little plant or animal life. As the melting ice front retreated northward plants gradually spread into Maine from the south. As plant cover expanded increasing numbers of herbivores and carnivores came to feed on them, such as the woolly mammoth and short-faced bear. On an average every 3,000 to 4,000 years since the last ice age vegetation in Maine took on a new look. At times it took as many as 3,000 years for changes that began in southern Maine to reach northern parts of the state.

(George Jacobson, Botany, University of Maine) As the ice melted away from the landscapes and the first bare soil became exposed, we had the same plants that occur as part of this north today, in Canada, and then as the climate got warmer we began to have the first few trees come into the landscape and those trees were the same ones that are the most northerly trees up in Canada today.

(Kate Arno, Segment Host) Maine's fame to north woods are not primeval and ancient as many of us would like to think. That's a myth. The woods as we know them have been around for only 500 years, or so. The earliest plants after the glaciers were Arctic and sub-Arctic species, sedges, dwarf willows, birch and alder shrubs, and some ferns and mosses. At that time Maine looked much like northernmost Labrador does today, treeless or covered by tundra.

(Music)

(Kate Arno, Segment Host) In the past thousand years or so Maine's modern forest developed. These abundant forests of spruce and balsam fir that we know so well had just taken over the landscape when our colonial forebears arrived here. Using equations derived from modern pollen and climate data, Jacobson estimates Maine has cooled about a degree Fahrenheit during the last 500 years.

(George Jacobson, Botany, University of Maine) A change of a degree or two, or even half a degree, can be enough to be, to allow the presence or absence of a species to be determined.

(Kate Arno, Segment Host) Jacobson expects even more changes in our forests and landscapes as we finish out the current interglacial period, and thousands of years from now it'll begin all over again as another ice sheet overruns the state.

(George Jacobson, Botany, University of Maine) Changes in climate weather, in fact in warming or cooling, are important to all of us who are living on these landscapes, the basis for most of Maine's economy is the forest products industry, which is strongly reliant on the spruce fir forests in the state. It's really the trees that are growing today, the young seedlings, that are growing today in the forests of Maine that will be experiencing these changing climates in the next century, and coming to maturity either as healthy individuals or as ones that are struggling in the face of a climate to which they are not really very well adapted.

(Kate Arno, Segment Host) Researchers at Bates College also have evidence that Maine's overall climate is cooling off. Their sampling of Lake Auburn show water levels much lower than they are today. Warmer temperatures raise ocean waters, but in lakes higher temperatures lead to lower water levels. Over several thousand years time warmer temperatures caused more evaporation, less precipitation, and ultimately, less water in Lake Auburn.

(Kate Arno, Segment Host) Wildlife in Maine also has undergone changes since the last ice age, since we've gone from cold to warm to cooling off again, but fossils of animals are hard to come by in Maine. The clay along the coast is good for preservation, but the rest of the state isn't because of acids in the soil.

(Kate Arno, Segment Host) It was along the coast in Scarborough that Gary Hoyle of the Maine State Museum was part of an exciting discovery.

(Gary Hoyle, Maine State Museum) Well, we found a mammoth that is very good proof that there had to have been grasslands in the area somewhere. It indicates that this animal probably lived close to 13,000 years ago. That was a time in which there was a rapid change in Maine, the glacier was melting, but still it was very cold and temperatures would get down to 50 below zero, 50 to 60 below zero, and with 30-40 mile an hour winds at times, so it was a severely cold environment.

(Kate Arno, Segment Host) Arthur Spiess of the Historic Preservation Commission is another expert on prehistoric Maine wildlife. He says there have been bits and pieces of wildlife left behind in Maine for the past 11,000 years.

(Arthur Spiess, Historic Preservation Commission) The State Museum has excavated a shell midden called the Turner Farm on North Haven Island where there are 5,000 years of layers of Indian occu-

pation and that site tells us that the coastal environment has changed dramatically in the last 5,000 years. We know from other evidence that there was much less tide 5,000 years ago and in the bone from the site we see that the native Americans were making their living in the summer by hunting swordfish.

(Kate Arno, Segment Host) Besides swordfish, oysters also were once bountiful in Maine, but were exterminated because of changes in our climate. In the woods the caribou was once dominant, then came the moose. The white-tailed deer is a relative newcomer to the woods. Deer in eastern Maine were non-existent until about 1,000 years ago. In the Canadian Maritimes deer became plentiful only in the last century. Spiess believes the comeback of the moose is a sign of the cooling trend.

(Arthur Spiess, Historic Preservation Commission) The reason, I think, is because the cooling of the coastal water has changed the forest cover of the islands and the mainland shore from a hardwood forest, which tends to support deer, to a mixed evergreen, a mixed conifer forest, which is, tends to be more favorable to moose than to deer.

(Kate Arno, Segment Host) Arthur, how reliable is this evidence? It's a big reach for a novice to this subject matter. How reliable is the evidence? How hard and fast are your conclusions?

(Arthur Spiess, Historic Preservation Commission) Our conclusions are very accurate. We're counting actual fragments of bone from archeological sites with known ages on them. We can track the changes in climate and the changes in the forest and the temperature of the coastal waters by the changes of ratios and the changes in the numbers of different species or types of animals that show up in the archeological record.

(Kate Arno, Segment Host) Some scientists now predict the greenhouse effect from pollutants could raise temperatures by four to five degrees, which would more than offset the projected long term trend for a colder climate, but it may not matter whether it's going to be warmer or cooler. We've seen how just a few degrees difference either way can cause significant changes in plant and animal life. That means the many Maine industries that thrive on plant and animal resources will want the best information science can offer on our changing climate.

(Christine Young, Program Host) Coffee and talk about the weather are never in short supply up here in Aroostook County. You'll find snowmobilers and locals comparing notes about the weather any day of the week, here at the Four Seasons Restaurant in Ashland. They take weather seriously up here.

(Christine Young, Program Host) The County is part of Maine agriculture, despite its location in the northernmost region of the state. This far north where the growing season is even shorter than elsewhere in the state, weather is of critical importance. Mainers, particularly those in farming are figuring out ways not only to lengthen the growing season, but also beat the weather. Diana George Chapin tells us how they are doing it.

(Diana George Chapin, Segment Host) The weather is unpredictable in Maine and that may mean our climate is changing, but we're accustomed to the vagaries of our great outdoors and we've had to learn to make the most of it. We have ways of trying to exert our own control over Mother Nature.

(Diana George Chapin, Segment Host) For the past ten years we've been turning water into snow when we don't get enough of the real stuff to cover our ski slopes. We're growing salad greens in the winter, keeping frost off strawberry plants by watering them when it's cold, and raising chicks

year round by the warm sunlight in greenhouses. Who says we're not trying to make the most of what we have?

(David Handley, University of Maine Cooperative Extension) Well, I think to be a farmer in this kind of climate you've either gotta be a gambler or very religious, 'cause you're either betting against Mother Nature, or you're praying to her all the time, but you can hedge your bets and I think that's what we do a good job of up here.

(Diana George Chapin, Segment Host) Over time there have been numerous instances around the world where we have deliberately tried to alter weather and climate. For thousands of years we irrigated to compensate for not enough rain or snowfall. We tried seeding clouds with silver iodide, or dry ice, to induce precipitation. We had more success controlling fog with special heat sources at airports and generating smoke with smudge pots in orchards to stave off frost. Perhaps some of the worst ideas proposed for deliberately changing the climate came from Russia, where much research took place to find ways to make its northern land masses warmer and more hospitable to settlers. Melting the ice by blackening its surface with soot was one proposal. Most of us could probably predict that that idea would be discarded for being impractical and expensive, but there are many more examples of how Mainers successfully skirt our weather, and most of them are in agriculture. After commercially gardening for 15 years Frank Gross III has learned how to grow salad greens year round in Maine. With the exception of a two month period from late November to late January, Gross says there's plenty of sun in Maine for growing. Even on the shortest day of the year, December 22nd, there are nearly nine hours of daylight, still enough for plants to grow, and Maine does have more sunlight in the winter months than anywhere else in the East Coast, with the exception of Florida. Credit a so-called downslope effect for that. Snow and the moisture in clouds get wrung out over the mountains of Vermont and New Hampshire before they reach us. Gross also tends outside gardens year round. He covers his Chinese cabbage with several layers of polyester all winter.

(Frank Gross, Organic Grower) Many greens, endive plants, spinach, of...numerous things in herb and herb plants will winter over, with some protection. You must keep the ground from thawing and freezing.

(Diana George Chapin, Segment Host) Salad greens soak in sun and Gross has four greenhouses, all of which are heated by wood at night. Gross has eight cords of wood ready each winter. Even more important than sunlight is warmth. Plants should be kept at a minimum of 40 degrees all the time.

(Frank Gross, Organic Grower) Well, the big thing is you never want the ground to freeze. So, like I have in the cold frame, it's passive solar and when the sun's out it will be quite warm, 80 to 90 degrees, but at night the temperature can go to 20 degrees, but these are real hardy plants anyway, so they can take the freeze and the warmup, but in the greenhouse behind me you need a nice, warm temperature of maybe 55 to 60, minimum, for rapid growth, and of course, when the sun's out it's hot.

(Diana George Chapin, Segment Host) Even on cold winter days, if the sun is strong the greenhouses will warm up to 70 to 80 degrees, but cold, cloudy days are tough. That's where the eight cords of wood help.

(Frank Gross, Organic Grower) The greenhouses I heat, I use wood, and, but even so, the sun even on a cold, cloudy day in the winter, you will get some solar gain from the sun. It's strong enough to keep, even in the unheated solar greenhouse. I don't think it ever goes below freezing, only if you

had a cloudy day and it was well below zero, but this winter, it's made it above freezing every day.

(Diana George Chapin, Segment Host) Gross grows 100 kinds of salad greens. He delivers more than a ton of them each year to the Haraseeket Inn in Freeport as a ready to use salad mix. On the restaurant menu it's called mesclun, a French word for mix. Even though some people consider some of his greens to be weeds, Gross says they're surprisingly tender when grown indoors.

(Frank Gross, Organic Grower) Many of the things I grow in the wintertime, grown in the summer would be too coarse and too tough for a salad vegetable, but in the limited light of a greenhouse in the wintertime the cell structure is filled with water and it's really succulent and juicy, so there's no problem. They're a much different type of plant than grown traditionally in the summertime.

(Diana George Chapin, Segment Host) Rockport Hydroponics is a whole other kind of greenhouse business in Maine. Joseph and Joyce Marble have been growing plants in nutrient filled water and soil for over ten years. Tomatoes, peppers, and cucumbers have been their mainstays. They supply Hannaford Bros.' Shop 'N Save grocery stores with fresh produce year round.

(Joyce Marble, Rockport Hydroponic Farm) It's been wonderful. I call these produce managers every week, and I think that we now have established a reputation for a quality product, and we're reliable.

(Diana George Chapin, Segment Host) But, to service a large chain like Shop 'N Save, the Marbles often have to go to other growers and buy their products. Rockport Hydroponics started growing flowers two years ago. In the spring, 50,000 freesia and 20,000 snapdragons bloom in their greenhouse.

(Joyce Marble, Rockport Hydroponic Farm) This year we have taken and built raised beds throughout the greenhouse and we have filled them with perlite and promix, and that is what we are going to grow our freesia in. Probably from now on, because we're going to get a much better flower, a much bigger flower, and perhaps with a longer shelf life.

(Diana George Chapin, Segment Host) The Marbles will be the first to tell you hydroponics is not easy. Greenhouses are expensive to construct. They had to learn chemistry and electricity to get where they are today.

(Joyce Marble, Rockport Hydroponic Farm) Hydroponics is very complicated. You need a chemistry background. You need to be an electrician and a plumber, and a builder, and you need to be able to market your product.

(Diana George Chapin, Segment Host) Finding trained help may be the hardest job for them. Joyce Marble says very few Mainers know about hydroponics. Even college courses give it a short shrift.

(Joyce Marble, Rockport Hydroponic Farm) Some do and some don't. There's a lot more interest now than when we first started the business back in 1984. There's a lot more publications out on hydroponics. If we ever go into outer space, hydroponics will be the way that food is grown. You utilize water so much better. you give a plant an ideal environment and it's just amazing what that plant will do when it doesn't have to worry about getting its food source or getting water, or being warm or having too much sun. They will produce ten times greater than a plant grown outdoors.

(Music and lyrics)

(Diana George Chapin, Segment Host) Statewide greenhouse and nursery businesses are undergoing rapid growth. The industry has grown so much it now claims it's larger than Maine potatoes.

(Diana George Chapin, Segment Host) Yet another kind of greenhouse is the kind you see on Sunset Acres Farm in Brooksville. Anne Bauze and Bob Bowen put animals in their greenhouses. Laying hens are in one, meat birds in another, and chicks in the third. The chicks come by mail year round. When they first arrive they go into the barn, then they're moved to the greenhouse three weeks later.

(Diana George Chapin, Segment Host) Well, where do you get these chicks from?

(Bob Bowen, Sunset Acres Farm) These chicks come from Connecticut, through the post office. They come every three weeks and we get about 100 to a box. You know, we get three to five boxes every three weeks.

(Diana George Chapin, Segment Host) The bulk of Sunset Acres' processed chickens end up in the cafeterias at Bates College. The greenhouses may look artificial to those of us accustomed to classic New England barns, but to Bowen greenhouses are more natural than barns.

There's more light, and no matter how cold it is they're warmed by sunlight and by a manure pack that doubles as bedding. The pack is several layers of manure alternated with composting material. Bowen says it's like a hot pad.

(Diana George Chapin, Segment Host) Well, tell me about the bedding in the greenhouse? What's it made of and how does it work?

(Bob Bowen, Sunset Acres Farm) The manure that we use is a manure that we call manure pack bedding and that's where without the manure and the sawdust build up and we rototill it periodically, which makes it air in with the manure and the sawdust, and that action starts the breakdown and creates heat which then the birds lay on to stay warm, so it keeps them warm in the wintertime, just by the composting, if you will, of the manure piles.

(Diana George Chapin, Segment Host) An underground hydrant provides the birds with drinking water. It gets shut off at night in the winter so the pipes don't freeze, yet the birds can still drink the water that's left in the lines. Bowen also likes the greenhouses because they protect the young birds from predators.

(Diana George Chapin, Segment Host) What kinds of predators do you have around your farm?

(Bob Bowen, Sunset Acres Farm) Well, primarily, we have a problem with birds here. It seems though we have an eagle's nest and that created most of our problems with the birds. The eagles come and lug the birds off, and we have some raccoon problems, but that's all sort of the price you pay, I guess, for farming in the animal's area basically. The animals were here before I showed up, so, you know, we realize we're gonna lose some to them.

(Diana George Chapin, Segment Host) The agriculture industry has some other new twists on existing technology. Frost in the beginning and end of Maine's already short growing season have always been troublesome for fruit and vegetable growers. They found that spraying water on their tender plants during cool nights prevents frost damage. Watching thermometers and turning water on in the middle of the night can lead to many sleepless nights for growers but it saves their fruit. Here's how

it works: the strawberries, or tomatoes, are watered when the air temperature at the plant approaches 32 degrees. Heat is generated as the water sprayed into the air reaches a freezing point. In the process of the liquid water turning to a frozen solid there is an even greater release of energy in the form of heat. There are measurable BTUs generated by the water cooling and by the water changing to ice. It's what called the heat of fusion and as long as plants are kept in this ice and water interface, much energy and heat are released and neither plants nor strawberries will freeze.

(David Handley, University of Maine Cooperative Extension) Ice is a very good conductor of heat, okay, so as long as there's heat being released it will pass right through that ice and on to the tissue, the surface that it's on, so as long as you keep water and ice forming, then you're going to have that heat happening. The heat is being transferred to the plant tissue so the plant tissue never drops to the freezing point.

(Diana George Chapin, Segment Host) This irrigation technique works until the air temperature gets too cold, which is below 25 degrees. Other forms of irrigation are also more widely seen in Maine now, because most vegetables need one or two inches of water a week, more farmers are considering watering their plants. Large scale pivot irrigation is one way to go. Trickle irrigation is another. It's done with tubes or tapes that run along the base of plants and potato farmers are starting to look at trebling gun irrigators. It's a sprinkler gun that oscillates on the end of a long hose that an automatic spool reels out and back. Maine typically runs four to five inches short of rain to maximize potato yields. Irrigation to supplement that rainfall has been around for ten years in Maine. In the last five years more farmers have been looking at it.

(Leigh Morrow, University of Maine Cooperative Extension) We look at irrigation as supplemental, not something you need all the time, but if we want to compete with the big potato production areas in the United States, we're going to...and keep our processing industry here, we're going to have to increase our yields, and one of the ways that we see doing that is to manage the soil water better.

(Diana George Chapin, Segment Host) For most Maine potato farmers finding a tuber that will mature in our abbreviated growing season is of utmost importance, but it also is good to have a potato can withstand a dry summer. Farmers and researchers are always trying to perfect the Maine potato. There are now about 90 certified varieties. Farmers are constantly switching potato allegiances to meet market demand or to follow their own instincts, but it's not easy developing new varieties. It takes about 15 years to develop a new potato through a complicated cross pollination and selection process.

(Leigh Morrow, University of Maine Cooperative Extension) Even though ten or 12 years may be spent on evaluating these new varieties as they come along, you really never have the final analysis until they're commercially grown on a large scale and stored in a big storage, just one variety, and then, there are other problems that might show up that you just can't find on a small scale study.

(Diana George Chapin, Segment Host) Other painstaking plant breeding work is going on at the University of Maine. Paul Capiello searches for winter hardy ornamentals and low bush blueberries.

(Diana George Chapin, Segment Host) Capiello began his project five years ago and it could take another five to complete, because most blueberry growers are interested in improving the varieties they already have as opposed to planting new species. Capiello and his students are trying to determine which of the varieties are the toughest. He's finding Maine blueberries differ significantly in how well they tolerate cold temperatures.

(Diana George Chapin, Segment Host) So, you've been looking at low bush blueberries and trying to rate their cold hardiness. What have you found?

(Paul Cappiello, Horticulture, University of Maine) We're finding a lot of variations out there in the field. We're finding that in the middle of the winter if we look at blueberry plants from across a wide field, some of these plants are able to withstand temperatures as low as 40 below zero Centigrade, whereas some plants in the same field can only handle temperatures as low as maybe ten or 15 degrees zero Centigrade. We're finding that the buds in the blueberry plants are far more tender and damaged at a much higher temperatures and their stems are much tougher. Most of the stems can handle very, very cold temperatures without any damage at all.

(Diana George Chapin, Segment Host) There are other ways Mainers are trying to get around, and even capitalize on their weather. The state is earnestly trying to drum up more winter visitors. Caribou's low temperatures in the winter months are often featured as among the nation's coldest. That in turn gives tourists the impression that Maine has a lot of extreme winter weather. People like Carol Ann Dube in Fort Kent are actively seeking to turn that impression around by offering visitors colorful winter events.

(Carol Ann Dube, Fort Kent Chamber of Commerce) If you like winter, if you like snow, this is where you need to be. I mean, you know, if you're searching for it, we've got it and we'll deliver.

(Channel 13 News Anchor) I scraped the ice off my car so many times today, I broke my ice scraper.

(Diana George Chapin, Segment Host) The state's tourism promoters believe local broadcast meteorologists tend to over-dramatize Maine winters. That can be good for ratings, but it can also scare tourists away.

(Joe Cupo, Television Meteorologist) As a scientist, as someone who has been trained in meteorology, I'm well aware of the shortcomings of the science, and so I really try to stay away from making outrageous forecasts more than a few days down the road. If I see the potential for a rainstorm, say coming on a weekend, here it is a Tuesday, so we're talking, you know, Wednesday, Thursday, Friday, Saturday, say it's day four. Well, I know from my experience and from my training that in four days things can change, so you might say "chance of rain," you know, you don't want to say "ah, Saturday's gonna be a washout" because you're right, those are the kinds of things that really scare people away, but, if you say chance of rain, they're still saying okay there's a chance it might not rain, so I try to play it that way.

(Diana George Chapin, Segment Host) Yet what local Chambers of Commerce are doing seems to be working.

(Carol Ann Dube, Fort Kent Chamber of Commerce) We're able to take advantage of our long winters and we've been able to promote it in such a way that the area is full of people, that the hotel rooms are booked, that restaurants are full.

(Diana George Chapin, Segment Host) The state has seen a consistent upswing in the number of winter tourists as far north as Fort Kent and Caribou.

(Christine Young, Program Host) The mountains in western Maine are another big draw for winter tourists. Ski areas like Sunday River, here, leave the state in attracting out of state money during the

winter months. There may not be much we can do about our weather and we don't know whether we're headed for global warming or another ice age, but we're still getting much smarter about whatever Mother Nature wants to send us weather-wise. I'm Christine Young. Thanks for joining us on Quest. See you next time.

(Narrator) Maine Public Television's production of Quest: Investigating the World We Call Maine is funded through a television demonstration grant from rural, economic, and community development, part of the USDA.

Music