HUBBARD BROOK ROUNDTABLE WINTER CLIMATE CHANGE IN A NORTHERN HARDWOOD FOREST

APRIL 23, 2012

Interview synthesis and catalyst for dialogue

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The following text is a combination of direct quotes and paraphrasing from interviews conducted with the people intending to attend the Hubbard Brook Roundtable on winter climate change to be held April 23, 2012. We have attempted to record faithfully the comments that were shared with us. No doubt, there are places where our own biases may have slipped in as we have made choices on what and how to report and synthesize what we have heard. This paper cannot aspire to the standards of science; rather, it will serve, hopefully, as a catalyst or "straw person" for discussion at the Roundtable. A copy of the more complete interviews is available on request from the Hubbard Brook Research Foundation. – *JB, DS, GW*

Question 1: Bio statements from participants [omitted]

Question 2: In your experience, have you perceived changes in any snowpack, soil frost, temperatures, snowmelt timing, or other characteristics during the cold- weather months, October though April?

Everyone has observed changes, most notably after this past winter:

- Maple syrup production always runs in cycles. Some say production is beginning and ending earlier.

- There is a much shorter season for backcountry recreation like cross-country skiing. All winter sports are unpredictable – you have to take advantage of storm events and plan around forecast snowstorms.

- Winter used to start about Thanksgiving and last through April. Conditions are more variable.

- It has been observed that increased rock falls in past decades are related to winter freeze/thaws.

- Water bodies are not freezing over like they used to. Planned logging operations not able to occur due to lack of snow/soil freezing. Reduced snowpack affects the seven commercial ski areas on Vermont state land, especially surrounding the financially important Christmas holiday.

- Agencies are thinking about more ice, less snow, less depth of snow, and changes in soil freezing. Last year there was lots of snow; this year there was little snow, there doesn't seem to be a

directional change.

- Some bird species that normally depart for the winter are sticking around in warm winters.
- Lilacs blooming earlier.
- At Hubbard Brook, we've seen concrete changes in the timing and amount of rain and snow. This winter was "way off the charts" – overall, it was warmer but jumped around from cold to warm. We have seen year-to-year variations over the past 10 years at Hubbard Brook. There are shocking changes in the data at Hubbard Brook which indicate strong climate signals across the board: soil temperature, soil moisture, ice in and ice out at Mirror Lake, snow cover. For example, since 1955 (when the study began), snow cover has declined by 20 days. In the Northeast (PA to ME), snow cover has declined by 9 days
- We see differences in invertebrate biodiversity, based on climate gradients with respect to different temperature conditions. Moose populations at Hubbard Brook have declined from levels 5-6 years ago and we think that might have to do with increases in winter and summer temperatures, with winter temperatures the more important of the two. Once a moose is stressed by certain conditions it may be more affected by parasites or less available food.
- Loggers are definitely affected. Shorter period of frozen ground and increased precipitation make it hard to harvest trees without damaging the soil and roots (through soil compaction, truncating roots). Standing water in ruts made by skidders damages roots.
- In the ski industry there are good years and bad ones – tremendous variation. This past winter we saw increased costs because of we had a record number of "start and stops" of the snowmaking system, which is expensive. We had to do this 54 times. The previous record was 32.
- It's more dangerous to be in the woods because of increased tick populations therefore more exposure to Lyme disease.

Question 3: Can these changes, if any, be measured or documented in some way, or are they largely anecdotal? Ways changes have been documented: Some changes in maple syrup production are noted in business and historical records, which include what time of year each activity was taking place. Caretakers at AMC huts keep detailed records on daily temperatures, weather conditions, conditions of trails for the three WMNF huts at different locations and elevations. US Forest Service snow ranger program keeps daily avalanche reports that would provide some interesting details.

- Bird data is generally very good and much of the change can be documented.

- At Hubbard Brook we have excellent long-term data and actual measurements of changes, across multiple sites. We can quantify the decline in snow depth and cover. We've measured changes in the timing and amount of rain and snow. We've measured increased leaching of soil nutrients, increased abundance of insects, trace gas fluxes, and calcium balances in trees. Changes in fauna (from invertebrates to moose) are measureable through research.

- Stakeholders such as loggers may have lots of measurable information, such as their records on timber production and timing of harvests.

- There are snowmaking log books and snow reports for the mountain which would indicate the snowmaking conditions each day/year.

- The climbing community may have historic photos of iconic ice routes. Ways changes are anecdotal:

- Hurricane Irene, considered a climate-related extreme event, had a major impact on trail and road infrastructure and the WMNF is still dealing with the effects.

- We can track how many people attended various winter education/recreation programs, but can't always blame the weather if it wasn't successful – maybe we didn't promote the activity well.

- In Vermont, changes are largely anecdotal but many are starting to be measured, particularly by partner organizations.

- Education programs have been directly affected by climate change – especially outdoor recreation programs including snowshoe weekends, winter mountain traverses. Warmer temperatures definitely affect peoples' interest and engagement in winter activities.

- This year it was noted that the increased soil freezing led to less erosion from skid roads. This may be something that is quantified in the future.

- Effects of winter warming on agriculture are anecdotal.

- In the logging industry it's mostly anecdotal, but measures such as precipitation as rain vs. snow and number of days above or below 10 degrees would correlate with better or worse logging conditions.

- There are anecdotal reports of changes to maple syrup production and quality.

- Smaller ski operations had a tough time making snow because the nights weren't warm enough. There wasn't enough natural snow.

- Warmer weather will promote better tree growth but it can't measure that in the short-term – other factors are important (e.g., amount of sunlight).

Question 4: Have you changed how you work or manage the land because of these changes? Noted changes in work methods or management techniques:

- AMC is doing more research and monitoring on climate effects on high elevation ecosystems to advise policy initiatives.

- As a maple syrup producer, I am using more technology, but that isn't necessarily driven by climate changes as much as reducing labor or increasing yields.

- Changes are being made to the way snowmobile trails are constructed: the typical snowmobile trail construction contains periodic, rolling dips for runoff management. Due to the lower snow packs, these aren't filling in enough for smooth riding and the snowmobile clubs are asking for box culverts instead.

- Advice for constructing woods roads has changed, and now includes sizing-up for culverts and/or making sure they are maintained regularly due to vulnerability to flooding.

- Climate changes have affected research questions – it's definitely driving the science. People want answers and funding is available.

- We are focusing climate change research on the transitions between seasons, which is the most interesting time biogeochemically.

- Earlier snowmelt is definitely affecting our ability to gather samples at Hubbard Brook. It can be a nightmare to get to our study plots during these times of the year With mushy snow conditions we can't use the mule (halftrack) to reach all the sites. What might take a couple of days now takes a week. We need to change how we move around in the field.

- We have traditionally sampled snowmelt at certain places at definite times of the year. We had timed these measurements to occur at the end of the semester at the end of April, and students were there to help collect data. It's ironic that climate change is impeding our ability to study climate change!

- Climate change will greatly affect logging operations and economics. Timber harvests are closely managed to prevent erosion and soil damage and the harvest season has been reduced over the past 10 years. Freeze-thaws shorten the season; snow with cold weather and no snow and soil frost both make for a longer harvest season. Mud season changes influence where logging operations are focused: there are places that are only suitable for logging in winter, and others

where you can log in the summer – some loggers are planning to just log in the summer. It will likely put negative pressure on operations heavily invested in large equipment, which is efficient but more constrained by site wetness/freezing. Smaller, more nimble operators who can work in a wider variety of conditions will be favored, as will larger operations with diversified operations (not just logging).

- Yes. We've had to. Harvest operations have had to change since winter conditions are often not suitable. We realize we have to change but are just starting to come to grips with HOW to change. Convened a committee charged with developing recommendations on adaptive silviculture in VT with regard to climate change. Currently managing with an awareness of climate change, but don't yet have a coherent plan.

- More ski areas are investing in better equipment, such as low-energy/high-efficiency nucleating snowguns which work well up to 27 degrees, and water pumps to move more water in a shorter time to take advantage of shorter snowmaking windows.

- No changes, but agricultural decisions are made more closely tied to the current weather than the general climate. Still, issues like spring flooding/drying could influence whether some fields are usable in a given year. Note: Some replied that they had not changed the way they work of manage the landscape due to observed/documented changes.

Question 5: Have you identified specific thresholds or tipping points for climate- change effects that will seriously affect your work or activity? If so, what are they? If you can, identify whether the changes would affect your work or activity positively or negatively. Effects that will seriously affect activities:

- Recreational activities would change – less skiing, less winter hiking/cross-country, snowshoeing. Both the ice climbing and ski mountaineering seasons essentially ended earlier than ever.

- Climbers wonder how winter changes would affect bug season (primarily black flies).

- Ski area operators need temperatures at or below 27 degrees F to blow on a closed trail. Once all the trails are open, we need a lower temperature of 24 degrees F to blow on that trail (higher than that and the new snow becomes sticky and not desirable to immediately ski on).

- Standards that guide the logging harvest season (e.g., sedimentation and road rutting) might need to change. If things are wetter, logging either can't happen or requires expensive road upgrades, which affect the economic viability of operations.

- With migratory birds, much of the climate change effects of concern are in the wintering grounds.

If the Caribbean dries up as models suggest, this is bad for migratory birds.

- Increases in extraordinary natural events (e.g., Hurricane Irene) are beginning to change trail and roadway management practices like installing culverts. Extraordinary events make the Cooperative Extension very busy.

- There is increasing threat of invasives and crop pests caused by winter climate changes. There are currently some devastating crop pests not far to the south, and although some fungal diseases currently can't overwinter here, they do show up through transport.

- If snow cover happens late, then the soil freezes and stays frozen – this is a "state change" that can affect plant roots, microbial processes, and the movement of water through the system. (A state change is a disturbance to the system that the ecosystem can't recover from - another complete ecosystem develops in its place.) At Hubbard Brook, because of soil freezing, we believe a state change may have occurred, or will occur in the future. Note: Several said they had not observed particular thresholds that would affect their work.

- We've seen mostly gradual changes at Hubbard Brook – we haven't seen real shifts or "state changes." This could happen if we go from continuous snow cover to intermittent snow cover. But at this point it's mostly theorizing. Some people talk about changes in vegetation cover – for example, there would be no spruce-fir forest at Hubbard Brook. But the vegetation researchers aren't seeing this yet, and may not. Established species don't go marching up the hill.

- We haven't identified any tipping points yet in our research about soil invertebrates.

- We need to do more research to determine whether tipping points have occurred at Hubbard Brook. Experiments on-the-ground are very expensive so we're planning greenhouse experiments with sugar maple saplings where we change ambient temperatures to compare various freeze-thaw cycles. We are working on modeling and predicting what the impacts will be when snowpack is no longer continuous – we think it's coming sooner than we thought. Ten years ago we hadn't thought to look at this issue but now we do, plus now we have tools to study it better.

- We're asking new science questions at Hubbard Brook: How are the changes we're seeing affecting the ecological processes? The scientific inquiry itself is evolving.

Question 6: Do you think that effects of a changing climate could be positive overall – economically or environmentally – or negative?

Negative:

- No, less winter will be challenging for the four-season tourism economy in the North Country. There are more miles of snowmobile trails than mileage for cars, which is especially true in places like Coos County, where the extent of snowmobiling is phenomenal. This affects the whole winter tourism industry: snowmobile clubs, ski areas, climbing schools, guides, motel owners, etc. There was about a month of lost business in the past winter.

- Having natural snow on the ground in New England really matters. If people in Connecticut don't see snow on the ground where they are, they are not likely to plan a ski trip, which is a large, negative impact on North Country economy.

- There are reports of increased snowmobile accidents for lack of snow on trails which created faster conditions, more ice.

- Increased extreme events or droughts wreak havoc and are not desirable. Overall, both in terms of habitat and recreation, a changing climate will not be positive.

- No positive effects. We as a society do not adapt to changes well, at least in the short term. Indirectly, there is some potential for a positive outcome if they serve as a wake- up call and instigate a consciousness regarding the connections between human activities and climate.

Positive:

- One positive is that warming has forced the ski industry to operate more efficiently. For example, our snowmaking electricity budget is about 75 percent of what it was in 2004, but we are blowing more snow on more trails with that money.
- Trees will grow better. We can't measure this in the short-term. This will mean shorter age cycles for tree harvests.
- Industry/shipping could benefit. The sea was ice-free off Siberia in February – that was never seen before. With no sea ice or thinner sea ice, the shipping industry can move between Asia and Europe using the northern route, which takes 8 days to complete instead of 20+ days. This has been a huge economic boon to industry. The same holds in the U.S. It's much better to move ships north than south.
- Positive effects could include lower heating costs; lower clothing costs (winter shoes, boots, mittens, etc.); traveling could become less expensive.

- Summer sports could benefit (hiking, birding, kayaking).

- A warmer winter doesn't mean that summer temperatures will be much hotter – it might simply mean that warmer temperatures start sooner. Many people like that.

- At Hubbard Brook, we often see acidic events – ionic pulses – during snowmelt. Nitrate and sulfate pushes out of ice crystals in a huge pulse of acid in to streams, and that can negatively affect species such as trout. In the future there could be a lessening of this harmful pulse.

- Culvert re-sizing and replacement will save money for towns. Eventually we might not have a mud season, and that could help with road maintenance. Positive and negative:

- Trees are very genetically diverse and will figure it out. It might be different species assemblages, but the forests will persist. The problem comes with human adaptation to the changes in the forest. Humans are way behind when it comes to being able to adapt to changing forest characteristics/conditions. There will always be winners and losers, but the less we are positioned to be adaptable, the more negative the overall effects will be.

- For maple syrup production, warmer equals less work and less fuel costs, but also probably less sap. We might eventually lose maple syrup.

- There are winners and losers. Wildlife scientists know that some species will do well, others not. For example, resident birds will do well and expand; migratory birds will likely not thrive. We have a lot of information on species composition. The speed of change will make a difference.

- In agriculture, there would be longer growing seasons and we could grow a wider variety of crops. Then maybe climate change is positive, but that would be unlikely because of increased pests and diseases.

Question 7: Can you suggest ways that climate scientists at the Hubbard Brook Experimental Forest can interact positively with members of the public regarding climate issues? Share data in innovative and useful ways, including more roundtables:

- We need to make our data more accessible. We can do this through these kinds of roundtables, through programs like HBRF's Science Links projects, through newspaper articles. We must train students to communicate science effectively. I'm doing this with a class that deals with climate change and population management. This can be difficult for scientists who are trained to be complex. I always tell my students, if you can't explain a concept so that your grandmother understands it, then you've failed.

- A network of people sharing common or related data that benefited everyone would be useful. No agendas, but real data/the truth is appreciated.

- Keep churning out good science, meaningful data, with an eye towards expressing it in a way meaningful to non-scientists. Get the data out there in a de-politicized manner. The signal to noise

ratio around climate change is very bad. Good, non-political data expressed in a way people can relate to helps correct that.

- This and other Roundtables are a good way to share information. Other stakeholders – including snowmobiling community – could be involved. It's important for scientists to use data in ways that make real-world connections. It's good to have the ability to think lofty global thoughts, but it's also important to discuss how our lives are affected.

- Ongoing discussion between the scientific community and other groups, where everyone is exchanging information, would be very positive. This meeting is an important step in that process. Education efforts, including partnering with other organizations:

- Interaction with the Cooperative Extension would be good, as they are a state-wide network aimed at getting information into communities.

- While there are some existing information campaigns (such as "keep winter cool"), they generally lack science content and are poorer for it. Partnering with other organizations and providing the science content would be beneficial.

- 50 percent of the public doesn't believe in climate change. Public perceptions are based on politics and not scientific evidence. Our role as scientists should be as educators. Scientists should become more involved in policymaking, vulnerability analyses, dialogues with stakeholders:

- Getting involved in policy and regulation changes would be helpful. Climate change means rethinking the way we do business and this would apply to the scientific community as well.

- Get involved with vulnerability analyses. These have been done on large scales, but more focused efforts on particular landscapes or industries are needed. For example, in terms of winter climate change, a winter tourism and winter recreation focused vulnerability assessment would be helpful. What would it mean to lose snowmobiling as a cultural and economic activity?

- Companies that make snowmaking equipment (pump and high efficiency snowguns) would be interested in hearing this story, if we can demonstrate that the snowmaking windows are shorter.

- I think scientists should advocate for the role of science in decision making. There's a current perversion of science that casts doubts on scientific research on issues such as climate change. This happened in the past with tobacco and cigarette smoking. Because the tobacco industry raised doubts about the link between smoking and cancer, tens of thousands of people died. I don't have specific ideas for how to do the interaction between scientists and the public – I'm

hoping the Roundtable can suggest ways to do this.

- I hope this and other Roundtable discussions will identify what kind of information stakeholders need to support their businesses – which information will be most relevant and practical.

- We as scientists can do a lot to improve our communications. At Hubbard Brook, we are switching from our decades-old analog data collection system to a state-of-the-art digital collection process that can tell you what's happening in the watershed in real time. We need to make this available on the web, and translate what it means, locally, regionally, and globally. We can be a "go to" place. Communication tools need to be better, move more quickly. It needs to be relevant to various communities. Other thoughts:

- Acknowledging the limits to the knowledge and understanding is important, as is accepting that even with the most current/best knowledge the public might not make the same decision you would.

- This is definitely a topic that needs further discussion. Overall scientists aren't good at communicating their findings. It's hard for them to break out of scientific-speak to general-speak.

- It's important for scientists to use the long-term data to educate people about climate change. The problem is that weather variability inhibits our ability to perceive changes to climate. That's where the long-term record can help people come to grips with climate change.

- Find ways to get the information beyond the scientific journals (i.e., websites, public presentations). Identify the interesting work and get it out there.

Question 8: What do you hope to learn from this meeting?

From non-scientists:

- I'm interested in hearing different perspectives.

- I'm looking forward to engaging with the group members overall, networking.

- I'd want to learn about what Hubbard Brook scientists are doing and the scientific basis for their work. What does Hubbard Brook have for data? I'm interested in the background of what's happening.

- I'm interested in specific science content, model projections and alignment with current observations; substance.

- I'm interested in specific information for the state climate plan.
- I'm interested in sugar maple health and regeneration (or lack of).
- I'd like to see how other people are being affected by the winter weather. Sometimes I think it's just me and the ski industry.
- I look forward to being part of the conversation and brainstorming new ideas.
- I'm particularly interested in what is expected to happen with snow.
- I'm interested in any logical follow-up, collaborations, new partnerships.
- I'm looking for ways to relate the information to people who are otherwise preoccupied or not terribly interested.

From scientists:

- I wonder what loggers are thinking. I don't think they're reading my studies and I don't have personal interactions with them. I think we need to fill that gap. I want to understand what they're doing so that I can help with a kind of technology transfer. I hope to find out what kind of information stakeholders need to know so they can make decisions on how to manage the land. I suspect they want to pin us down on our answers by asking for specific values – how warm will it be, when exactly will changes occur. We probably won't be able to give the kind of definitive answers they're expecting. In my classroom I like to do "engaged learning" – an interactive process between students and teacher. It would be great if we could have an engaged conversation between stakeholders and scientists.
- I'm looking for exposure to a wider community. Currently I'm exposed to the military side through CRREL, but I'm looking forward to discussing how what I do can help others. So I'm looking to educate myself at the roundtable.
- As a scientist, I'm particularly psyched to talk with the snowmaking guy and timber harvesters and other stakeholders. I'm curious to learn what people who really work the land are seeing and what they think can be done.
- I'd like to learn the perspectives of others outside the scientific community.
- I'd love to hear from stakeholders: 1) are changes really happening and how they are impacting their businesses; and 2) what information they would like from scientists so that we're not just publishing our results in journals.

- We need to know what the public/individuals care about – what are their questions? How can we make data relevant? How are they using the data? How is our research relevant and what are the gaps we should address?

Question 9: What next steps might be taken? Do you see any specific potential for cooperation between the scientific community and the field or activities you are associated with? If so, what do you think might be a good way to generate interactions with the scientific community?

- Develop a network with a common means of collecting data that corresponds with the work done at the HBEF so the work there can be tied more directly to the larger landscape.

- People want to know what they can do about it – information to help them understand what steps can be taken, what the impacts will be.

- Good trend data and peer-reviewed literature is very helpful for managers, who need to make decisions based on the most current scientific understanding. So something that answers the questions relevant to managers but published in peer-reviewed literature is very helpful. Conversations with stakeholders (such as this meeting) are also helpful.

- Think about collaborating with Manomet Center for Conservation Science's climate adaptation work. Climate change adaptation issues avoid a lot of the "who or what is causing it and what should be done" issues and thus have a lot of potential to be productive and inclusive.

- Lots of potential. Scientists have already been involved and it is positive. Adaptive management requires ongoing data and research, which means there is a lot of potential for interactions/cooperation with scientists. Building the connections between the research community and land managers means the managers will know who to call with technical questions.

- I'd like to have stakeholders on speed dial – to answer questions, to have them come to my classes. Then maybe stakeholders could approach scientists individually for information – not view scientists in the abstract or have to search for information in our journal articles. I know that agencies have extension people and others who place "interface" roles, but those can be regulatory in nature (someone needs information in order to get a license or permit). It would be better if stakeholders could establish real relationships with agency personnel and researchers.

- New Hampshire has a great logger/forester education network (NH Timberland Owners' Association, Timber Harvesting Council, Cooperative Extension, Society for Protection of NH Forests) and this would be a great network to tap into. The operators will want to hear things with emphasis on the factors they can prepare for or do something about (like downsizing or other

business strategies).

- I keep going back to the smoking example. If we had this meeting 30 years ago, half the people in the room would be smoking. What happened was that a diverse group of people looked at the evidence and said enough is enough and they started to pass laws to restrict smoking in public places and to make other changes. The obfuscation of science by the tobacco industry was overcome. Perhaps with climate changes, groups like loggers and ski area operators will say, "This is happening, let's do something about it." Societal change may or may not happen. The energy companies have a LOT of money to spend obfuscating the science. It may take a climate similar to Atlanta's happening here in New Hampshire before real change occurs.

- Getting together to talk; hearing what's useful and relevant.

- We have information in real time – how can we move quickly to get this out to the public? What format? How can we pay for this?

- Any information related to forecasting or model projections would be very useful to the ski industry.

- Continue with Hubbard Brook Research Foundation's tradition of using science to inform policy, but also work to inform scientists of the information needs of managers and forest users. There are many user groups not currently interacting with the Hubbard Brook community which could both inform and benefit. For example, silviculturists rely on knowledge of site characteristics and tree life-histories to manipulate competitive outcomes in forestry operations. Hubbard Brook has extensive knowledge of changing site characteristics which would be of interest to the forestry community.

- There is a lot of potential. There will be good ideas generated at this meeting and timely follow-up/timely action will be crucial for successful long-term outcomes. It's impossible to say what the ideas are beforehand, but there will certainly be some and following up on them should be a priority. Don't make this a listening session that doesn't go anywhere.

- I want to broaden my perspective. Scientists should know more about the practical applications of their research; practitioners should know the scientific facts and what scientists are projecting. I'm interested in educational aspects – there is no magic bullet – all sorts of avenues.
- Get to politicians – legislators need to be approached.