Climate Change Focus Group Notes
2008 FHM Workgroup Meeting
(02/13/2008)

Note: Please see the individual PowerPoint presentations posted on the FHM web site for additional detail.

<u>Lead-off Presentation: Climate Change and Related FS Policy (Al Solomon)</u>

- Global climate change is undoubtedly real, especially when correlated with natural + anthropogenic effects

- Regional effects more pronounced in the west than east. More drought in west, generally wetter in the east.

- Elevated temperature amplifies the effects of drought.

- 3 different scenarios result in various degrees of impact severity
    - Control the problem now
    - Business as usual
    - Accelerated growth/use of fossil fuels

- Implications for forest management:
    - Indirect effects:
        - Spreading insects and disease
        - More fire
        - Redistribution of tree species and forest biomes. Prehistoric rates of species migration about 3-5 km per century. Some new projections now predict 500 km per century.
    - Direct effects:
        - Alaska trees are dying because of melting permafrost
        - Hurricane intensity expected to increase
        - N, CO_2 increases in east

- Management Opportunities
    - Thinning (increases moisture availability to remaining trees)
    - Change species/provenances planted (to promote artificial migration). Plant variety and see what works best; some results

should be apparent in approximately 10 years when time to thin.
    - Establish priorities based on what is possible to accomplish.
    - Educate managers, stakeholders, and partners
    - Integrate response across all agency planning levels
    - Increase collaboration across federal and private ownerships
    - Reframe the role of uncertainty by learning to manage for change.

- FS Global Change Research Strategy plan has recently been completed

<u>Questions/Discussion</u>

Q. Are there any concerns about "assisted migration" and problems with invasive species?
A. Invasives are mostly annuals. Trees invade much more slowly. Be less worried about species, more concerned about structure and function of resulting forest.

Q. Are past tree migrations rates based on more based on what was necessary than what was possible? What species have been left behind by accelerating migration rates?
A. None, but we only have 30 years experience with climate change. Best example of species losing ground to date is spruce in Alaska.

> Comment: Warning signs (slower growth and increased dieback) are being observed in Pinyon

> Comment: Trees are more likely to die during extreme weather events caused by climate change (than by gradual climate change by itself). Such events have the potential to cause instantaneous shifts.

> Comment. Climate Change is more than just temperature—it includes all of the physical and biological interactions associated with it.

Q. Is microclimate management strategy a useful management strategy and worth more research focus?
A. Yes to both. For example, trees grown in forest setting are less susceptible to wind and other local weather events than trees grown in isolation.

Q. What is the FS WO policy on climate change?
A. Chief considers climate change a top priority. Fred Norbury and Dave Cleaves are co-coordinating efforts to address climate change at the WO level. This issue will have major policy implications for FS management and research priorities.

Comment. FS has lost scientific capacity that may hamper our effectiveness in confronting this problem. Fire suppression costs are eroding other priorities.

Panel 1

Threats to Forest Health (potential problems and issues posed by climate change to forest ecosystems)

Fire (Don McKenzie)

- Disturbances like fire re-set ecosystems. Regeneration following fire is more vulnerable to effects of climate change.

- Climate change effects differ by ecosystem in Western U.S.
    - Northern mountain region: fuel moisture + current year climate highly correlated with wildfire.
    - Arid ecosystems: fuel availability + previous winter's rainfall most highly correlated with wildfire.

- Severe and prolonged droughts exacerbate problems for both western systems. Patchy fuel will probably become more continuous, which is more prone to fire.

- Fire interacts with other disturbances that are also changing as a result of climate change. These interactions will exaggerate the effects of climate change.
    - Increased mortality from insects due to climate change creates more fuel.
    - Spruce forest in boreal zone (AK). Fire activity in last 5 years in AK is unprecedented. 95% mortality in White Spruce is killing white spruce ecosystem. Shift from conifer to deciduous species is occurring here.

- Summary
    - Warming will continue for at least next century no matter what.
    - Regions will be affected differently
    - Look for equilibrium forests that are least affected and consider favoring those forest types in management activities.

Tree Species Range Shift (Bill Hargrove)

- Statistical/Empirical Models by Iverson and Prasad are probably the best available predictive models for tree species range shift (and also birds)
  - They use FIA data to calculate importance values for 20x20 pixels.
  - They include 32 variables associated with climate predictors

- Species shift prediction models based on 3 levels of climate change severity were presented.

- The Western threat center is planning a course on the use of models to predict range shifts.

- Conclusions
  - Lots of models
  - Lots of predictions
  - Lots of disagreement
  - Long-term forest health monitoring is key to sorting it all out.

Weather (Steve McNulty)

- Average increase in temperature over long term is not highest priority concern to most people.
  - Land managers are interested in short-term weather variability—days/weeks instead of decades.
  - All politics are local (and so is weather)—people are most interested in what's going on in their back yard.

- While average rainfall over the long term has not changed much in the last century, the intensity of rainfall has increased substantially— 10% increase in intensity since 1900.

- Western US is becoming dryer; east is about the same (except Florida is wetter).

- The number of record cold and warm days (i.e., local short-term weather events) has huge potential to drive species migration by killing trees

  - In Raleigh, NC the number of record cold days increased until 1980, and then started trending downward.
  - Max high temperatures have gradually been increasing and are still rising.

- Raleigh is now experiencing an 800-year drought

- Take home message: it's not the fall (long-term climate change), but the landing (extreme weather events) that is driving the changes that impact forests.

<u>Insects and Disease (Susan Frankel)</u>

- New literature review has been assembled.

- How to think about forest changes and conditions:
  - How are stand structure and ecology influencing forest health conditions?
  - What forest insects and pathogens are active in the ecosystem?
  - What forest insects and pathogens are present at low levels?
  - What changes are occurring in your local weather pattern?
  - What impacts are those changes having in the environment?
  - How will those changes affect forest insect and disease conditions?

- There are direct impacts of climate change, but also ripple effects (such as changes in snow pack, rainfall patterns, drought, etc.) that influence forest insects and disease.
  - Mountain Pine Beetle example— 2 degree change in 70s
    - beetle moved up in elevation
    - 2-yr life cycle to 1-yr life cycle
    - Now moving northward into British Columbia

  - Red Band Needle blight intensified by rains in summer

  - AK Yellow Cedar decline.
    - Earlier snow melt made trees vulnerable to frost injury (note: Changes in snow pack important indicator)

  - Swiss needle cast. Warmer winters

    - Cycle of SOD mortality driven by extremes in weather variability. Increased moisture (which promotes SOD infection) followed by hot weather kills infected trees.
    - Spruce Budworm. Rise in sea temperatures increases larvae production/survivability. In this situation the pathogen changed, but tree species did not.

- How will humans adapt to climate change? Depends on observation, knowledge, and communication.

<u>Genetic Response (Kevin Potter)</u>

- Genetic variation = evolutionary potential to adapt to changing environmental conditions. Conditions associated with climate change may decrease genetic variation in some species.

- Climate change has happened before. What is different about the current situation:
    - Climate change is occurring at a much faster, unprecedented rate
    - The forest landscape is much more fragmented

- Potential genetic responses to climate change:
    - Toleration/adaptation
        - Existing adaptability to climate conditions
        - Regeneration of future stands that are better adapted
    - Migration
        - Wholesale redistribution of genotypes across the landscape
        - May have negative genetic consequences
    - Population extirpation/species extinction
        - Some species/populations may be unable to adapt or migrate
        - For others, genetic degradation may increase susceptibility to other stressors (pests, pathogens, etc.)

- Genetic Degradation Risk Factors:
    - Intrinsic risk factors
        - Limited range
        - Small and scattered populations
        - High elevation habitat

        - Long life span
        - Long time to reproduce
        - Low fecundity
        - Habitat specialization
        - Limited seed dispersion
        - Low species-wide variation

    - Extrinsic risk factors
        - Extensive fragmentation
        - Pest/pathogen infestation
        - Large geographic range shift
        - Over-exploitation

- Recommendations
    - Develop indicators of genetic diversity, such as those proposed by Brown et al. (2000)
    - Select indicator species
    - Monitor indicator species using demographic indicators
    - For species that appear susceptible to genetic degradation, apply genetic indicators
    - Feed results of monitoring efforts into models such as Iverson and Prassad's

<u>Phenology Effects (Mark Losleben)</u>

- Phenology: Study of the causes and consequences of recurring biological phases.

- Phenophase: Identifiable life stages of plants and animals

- Lengths of growing seasons have increased. Springs are coming earlier. Effects…
    - Earlier leafout affects microsite conditions.
    - Carbon/Water exchange rates are affected
    - Ecosystem productivity is affected

- Warmer winters result in less snowpack, earlier stream flow

- More change in west than east.

- Radiative effect dominates over advective in Western U.S. due to complex topography

- Advective dominates over radiative due to complex topography in the east

- First leaf date for lilacs is used as an index for start of spring; getting much earlier.

- 1 degree of temp change advances spring by 5 days.

- Interactions among species will drive changes.

- Specifics were presented on what observations/models/tools we need to adapt to longer/hotter growing seasons.

- Phenology, by its integrative nature, reflects climate change, thus a national phenology data base is a valuable and necessary resource to inform adaptive strategies and tools development, including models. Infrequent observations at individual sites may not be thought informative by themselves, but aggregated over time and/or with other sites gain value rapidly. Thus, any and all phenology observations become valuable as long term or in conjunction with other observations in a region as aggregated in the National Phenology Network data base (usanpn.org).

Panel 1 Follow-up Discussion

Comment: We need to be careful to preserve genetic stock for less commercially important species.

Comment: FIA might help monitor the effects of climate change by intensifying the sample of rare species

Q. Should tree species have different phases of their life cycles ranked by vulnerability to climate change?

A. Yes, Iverson is working on it.

Q. Current species distributions are not just the result of past or current climate, but also the result of other major incidents like chestnut blight. How much confidence can we place in climate-change models when so many other factors have had major influence?

A. Empirical models are based on assumptions and errors. Models have error bars. We acknowledge that the number of assumptions that go into these models can be a serious problem.

Q. There are many examples of past disasters that ultimately have few consequences with respect to major factors such as net biomass. What is different about climate change?
A. We have not previously encountered major changes because we have never experienced the loss of a functional group. Major shifts can occur when entire niches and ecosystems disappear. We really need to be monitoring ecosystem ranges as well as species.

Q. What should be added to our current FIA and FHM monitoring systems?
A. Consider adding phenological observations (key calibration species are available) to the current P2 and/or P3 networks. Phenology observations at instrumented sites are particularly valuable to identify climatic drivers of phenology and thus the species and ecosystem impacts of climate change.

> Comment: Current FIA data can be examined to locate, examine, and track zero-growth isoclines.
>
> Comment: Query existing data in areas that are obviously stressed.

> Comment: 5-year cycles are not enough to monitor regeneration, which is a critical phase in tree vulnerability to climate change.

> Comment: Regeneration after disturbance is an important thing to look at.

Q. Should climate change be addressed with a holistic approach, or should related studies be divided into smaller pieces with which we have more experience and understanding?

A. It depends on the available data. Singular effects should be studied when enough data are available to study individual aspects of the issue. The next step would be to study interactions among the various pieces of the problem.

Panel 2

Perspectives of FHM partners working on climate-change issues (in terms of current research, information gaps, and opportunities for further research on the effects to forest ecosystems)

Western Wildland Environmental Threat Assessment Center (Jerry Beatty)

- The mission of the WWETAC is to generate, integrate, and apply knowledge to predict, detect, and assess environmental threats to public and private forests and grasslands of the west, and to deliver this knowledge to managers in ways that are timely, useful, and user friendly.

- Especially interested in synergisms between climate change and other forest stressors

- Climate Change Planned Work…
    - Coordinate West-wide Climate Change Initiative case study assessments (FY 2008).
    - Develop a west-wide climate change initiative workshop (June 2008).
    - Represent PNW Station on the Region 6 climate change strategy group.

- West-wide Climate Change Initiative, a 3-western research station effort to:
    - Assess climates at scales relevant to national forest management,
    - Develop tools to quantify effects of climate change on natural resources; and
    - Promote new strategies for national forest planning and management.
    - WWETAC'S Role: facilitate and coordinate portions (Lead: Becky Kerns)

- Upcoming Workshops

- Synthesize existing knowledge and develop "climate-smart" pest models (June 2007).
- Exploring quantitative approaches for vegetation management and forest planning under a changing climate (January 2008).
- Regional Climate Change 101 workshop (May 2008).
- West-wide climate change initiative workshop, HJ Andrews EF (July 2008).

- Ongoing Projects/Activities
  - Forest Management and Climate change – genetic and silvicultural options for Pacific Northwest (OSU).
  - Historic analysis of Wildfire, Insects and Climate Change Interactions (PSW, U Idaho, UC Berkeley).
  - National Environmental Threat Assessment Maps - NETAM (FHTET, RSCA).
  - Climate Change Resource Center website (PNW, PSW, RMRS

<u>Eastern Forest Environmental Threat Assessment Center (Danny Lee)</u>

- Eastern Center's Mission Areas:
  - Threat Assessment
    - Emphasizes integrated approaches to detecting and assessing forest threats
  - Southern Global Change Program
    - Examines consequences of climate change
  - Forest Health Monitoring
    - Tracks health and sustainability of nation's forests

- Primary Forest Threats:
  - Insects and Diseases
  - Invasive plants
  - Wildland fire
  - Severe weather
  - Land-use changes
  - Pollution
  - Climate change

- Focus of climate change research
  - Better document and quantify climate-induced changes in forests and forest resources (experimentation and observation).
    - Intensive

        - Extensive
    - Develop tools to predict climate change effects and interactions with other threats (prediction).
    - Help develop and implement strategies to reduce negative effects of climate change (mitigation and adaptation).
        - Increase knowledge
        - Risk assessment
        - Risk management

- Goal: Develop a dynamic, repeatable business process for collaborative decision making.

<u>FS Research Perspective (John Hom)</u>

- Indicators for Detecting Climate Effects on Forests
    - Species distributions: composition, geographical range, abundance
    - Vegetation structure
    - Phenology
    - Natural disturbances and mortality
    - Hydrology
    - Possible causes: e.g., climate, air pollution

- Indicators for Monitoring the Carbon Cycle
    - CO_2 flux
    - Net primary productivity
    - Net ecosystem productivity
    - Land use/land cover
    - Vegetation structure and biomass
    - Soil carbon
    - Natural disturbance and management
    - Harvested products
    - Climate and meteorology

- Examples of Climate Change Research
    - Can the NJ Pinelands Monitoring System Detect Impacts of Climate Change: Multi-tier, multi-scale monitoring and research approach
    - Effects of Long term, ecosystem level CO_2 and O_3 fumigation on Aspen clones and other deciduous species: AspenFACE

  - How can you predict multiple stress interactions: Ecosystem process modeling
  - Effects of Elevated CO_2, Temperature on Invasives: Urban to Rural Gradients

- How to Adapt Forests to Climate Change
  - Reduce the impacts of other stresses: air pollution, insects and diseases
  - Avoid creating barriers to species migration such as forest fragmentation
  - Monitor forest health to provide "early warning" of impending effects
  - Continue research to understand how forests are vulnerable and what managers can do
  - Help resource managers understand current and prospective threats from climate change

- Conclusions
  - Objective research, science-based monitoring and analysis is needed for policy and management – debate can focus on actions rather than data
  - Need for reporting and verification for carbon management
  - Current monitoring networks can be integrated and augmented to address specific analysis needs

<u>FHP Perspective (Rob Mangold)</u>

- FHP does methods development, not research. Finding sensible things we can do to address climate change now is essential.

- Climate change framework by Fred Norbury—"Sweet 16" actions not yet endorsed by executive management

- FHP's initial response was to defer to threat centers. FHP is now involved and intends to do more.

- J. Hubbard ordered production of a climate change risk map and FHP has delivered the first draft.

- We need to figure out how climate change integrates with other problems.

- FS is losing talent in our effort to adapt to and mitigate the effects of climate change.

- Tree species threatened by invasives (pines, ash, butternut, and hemlocks) are currently targeted for priority. If other species are identified as threatened by climate change they will be added to the priority list.

- The managers need to meet the modelers—we need to act, not model.

- Climate change is currently the flavor of the month. Attention will not always stay focused on climate change. Climate change is just one more stressor to be managed.

- Other problems are exacerbated by climate change.

- What we know/safest bets:
    - local seed is safest,
    - diversity is good,
    - monitor in the margins
    - Identify which trees are most threatened and do something about it.

<u>FHM Perspective (Borys Tkacz)</u>

- The effect of climate change on forests is hard to predict

- Current hypotheses suggest that the effects of global climate change could:
    - Result in species shift,
    - Increase invasiveness,
    - Increase drought and fire disturbance
    - Lead to extinction

- FHM Objectives
    - Establish a monitoring system throughout the forests of the United States to determine detrimental changes or improvements that occur over time.
    - Provide baseline and health trend information that is statistically precise and accurate.

- Report annually on status and changes to forest health.

- FHM Program Components
  - Detection Monitoring
  - Evaluation Monitoring
  - Intensive site monitoring
  - Research on monitoring techniques

- Existing P3 Indicators are important:
  - Tree Growth
  - Tree Regeneration
  - Tree Crown Condition
  - Tree Damage
  - Tree Mortality
  - Lichen Communities
  - Ozone Bioindicator Plants
  - Soil Morphology and Chemistry
  - Vegetation Structure
  - Plant Diversity

- Mining available data in new ways is extremely cost effective and has much potential

- Northern White Cedar Crown analysis currently underway is a good example of evaluating potential problem affecting an individual species)

- Lichens—canary in coal mine.

- P3 VEG indicator can be used to evaluate species range shifts

- We are tracking disturbances thru time which can be used to evaluate changes

- Evaluation Monitoring is designed to determine the extent, severity, and causes of undesirable changes in forest health identified through Detection Monitoring. EM has supported a number of projects related to the potential impacts of climate change, such as
  - Species shifts
  - Drought
  - Fire
  - Invasives

State Perspective (Mark Tjoelker)

- Precipitation and landform shape the savanna ecotone in Texas

- Savannah ecosystems are changing due to woody plant encroachment (post oak, juniper and E. red cedar). How will intensified summer drought and climate warming affect the savanna ecotone?

- Climate change issues for savanna woodlands
    - Warming
    - Intensification of precipitation event
    - Shift from summer to winter rainfall
    - Prolonged summer drought

- Texas Warming and Rainfall Manipulation Experiment (WaRM)
    - Five species mixtures (three monocultures and two tree-grass combinations)
    - Two precipitation patterns (redistributed and control)
    - Two warming treatments (+1.5 °C warmed and control)
    - Results
        - Juniper height growth was reduced more (-15%) than post oak (-7% ns) in response to increased summer drought.
        - Juniper growth was enhanced (diameter +16%) by warming, post oak shows a negative response (height, -19%).
        - Grass competition effects were greater for post oak than juniper, as little bluestem presence facilitated juniper growth in Spring.

- Implications for post oak savanna
    - Post oak establishment may be suppressed to a greater extent than juniper in response to climate warming and/or intensified drought.
    - In the absence of fire, and if regeneration continues, juniper will likely increase in dominance in warmer, drier climates of the future.

- Knowledge gaps and opportunities

- Are there bottlenecks in tree establishment in retreating range margins of oak in Texas?
- Is there evidence of increased drought stress and growth declines in mature forest trees?
- Are there important interactions with other disturbance factors, such as fire, grazing, and forest fragmentation?

Panel 2 Follow-up Discussion

Q. Can Borys' list of Indicators be used in a synthesis to evaluate climate change?
A. Yes, we are moving ahead with a synthesis of EM Projects, which may illuminate a path forward.

Q. Does the rotating cycle of "stress of the moment" point to constant state of chaos? Are there examples where our efforts have become focused to the point that problems are actually resolved?
A. We are getting there with Invasives. Pathways are being blocked and the situation improving. We need to focus on active forest management.

Comment. In some cases (Pinyon-Juniper) things will probably get worse until we run out of vulnerable species.

Q. Is there a window where phenology data needs to be recorded?
A. Yes, but record phenology data should be collected on plots anyway. One NRS study is recording such events via camera.

Q. Do we currently have a list of species that are genetically vulnerable?
A. No.

> Comment: At-risk species may not be around long enough to be useful for climate change monitoring.
>
> Comment: The "triage" approach of ranking at-risk species is appealing, and may be factored into risk assessments.
>
> Comment: We also need to look at widely distributed species because margins can be useful for monitoring change.

Q. Does FHM have an official statement or position on climate change?
A. Nothing that specific. This could point to a potential Focus Group Resolution such as a statement that FHM needs to be at center of climate change monitoring.

Comment. Consider revising the EM Call letter to make state a preference for climate change projects

Comment: Mine FIA database efficiently to look for species at sensitive edges of their range.

Comment: Electronic data not commonly available prior to 1980s. Can we catalogue and possibly digitize these data sources? This is a possible Focus Group resolution.

Comment: Examine the climate change issue from other angles besides biology, such as from a sociology standpoint.

Comment: Tropics are very threatened. Mangrove work proceeding in Hawaii might tap into FHM.

Comment: Spruce kill in AK, now grass understory. Big change has already happened—look at the lessons that could be learned from this experience.

Comment: FIA is taking a hard look at the value of retaining P3 indicators. Perhaps we should suggest pursuing matching funds to keep these indicators going.

> Comment: If it has not been done already, power analysis for P3 Indicators needs to be done to validate their worth.
>
> Comment: Lichen gradients have already been established and evaluated for climate effects

Comment: FHM needs a strong communication plan.

Preliminary Focus Group Resolutions Presented to General Session

1. FHM reaffirms the importance of P3 indicators to monitor the effects of stressors including climate change. FHM re-emphasizes the need to continue collecting data associated with these indicators.

2. FHM MT should commission a report to demonstrate the statistical power of FIA P3 indicators to detect change (and to the extent possible, the effects of climate change). Protocols for organizing this analysis might be similar to the process used to produce the QA analysis of P3 indicators.

3. Commission an assessment of the risk of climate change and related susceptibility to genetic degradation, extirpation, or extinction of North American tree species. Make recommendations on which trees to monitor and how to monitor them.

4. Identify and locate historical data sets that are relevant to climate change trends and related impacts on forests. Some data will need to be digitized.

5. Actively solicit climate change EM proposals to help fill in gaps identified in EM synthesis.

6. Review and modify the 2004 FHM Analysis and Reporting Plan to 1) include relevant social issues related to climate change, and 2) add a Communication Plan to convey the results of our analyses.

7. Encourage analysis proposals to query FIA database to show where trees are under stress or decline (e.g., zero growth isoclines). Note: there may be EM examples already.

8. The lichen indicator data have demonstrated their importance in climate change analysis. FHM should encourage analysis proposals that investigate similar applications to other forest health indicators to demonstrate linkages to climate.

9. The Management Team will promote FHM as a major player regarding the effects of climate change on forests.

10. The FHM MT should encourage analysts to include data from Canada and Mexico in FHM analysis and reporting efforts when available.