

Natural Resources Sector Report

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INTRODUCTION

The Natural Resources working group consisted of 25 participants. The specific number in attendance varied slightly among the three breakout sessions. About half of the participants represented government or non-governmental organizations with interests in natural resources; most of the others were university faculty and staff with expertise in natural resources or agriculture, some of whom have had considerable experience working with related industries. One of the co-chairs and co-authors of this report works as a consultant with the timber industry in New England.

The four questions related to climate change that we were asked to address were the main focal point of discussion in the breakout sessions. We found it necessary to begin by addressing concerns of major industry components (forestry, agriculture, commercial fishing) separately, and then sought common issues of concern and cross-cutting themes. The "Significant Findings" emerged from these discussions. Early drafts of the report were circulated by electronic mail to the participants for their feedback.

One point that was raised early on in discussion was that the value of natural resource-based industries, such as timber, agriculture and commercial fishing, to the New England economy (see Natural Resources-Appendix I) is often underestimated, even by residents of the region. A negative climate change impact on New England natural resources could have serious economic consequences. One approach to raising the awareness of this stakeholder group and the general public to climate change issues would be to develop better information on the potential economic impacts specific to key industries and regions. We identified several high priority research and education programs to address this issue.

In addition to the economic value of these natural resource-based industries, the scenic beauty of the region's landscape adds to the quality of life of the residents, and this aesthetic feature itself has a real

economic value. One example is when the proximity of forests, waterways, and peaceful rural areas to our urban centers lures professionals and new businesses to establish here. Climate change may alter the landscape, seasonal vegetation patterns, and species composition of wildlife habitats in undesirable ways.

Yet, ecological parameters such as plant growth and vigor are influenced by several abiotic, biotic and human factors simultaneously, and the complexity of these influences is extreme. What this means is that future changes in climate need to be specified in an extraordinary degree of detail to support sound predictions on the impacts to agriculture, forestry and natural systems. A prediction stating that total growing season precipitation will increase by an inch or that season average temperature will rise by so many degrees does not provide enough information to assess impacts to this sector.

Overall, there was a concern that the interaction of multiple stressors resulting from the rise in greenhouse gases and climate change will lead to a destabilization of both managed and natural ecosystems during transition and adaptation to a changing environment. It is during this period of transition when the greatest ecological disruption is likely to occur and have significant economic and political consequences for our region.

SIGNIFICANT FINDINGS

- The timber, agriculture, recreation, tourism, and commercial fishing industries are important components of the economy (see NR-Appendix) and are rich natural resources of the New England region that will be particularly sensitive to changes in climate.
- The supply of clean, safe drinking water for urban population centers within New England is directly dependent on precipitation patterns, streamflow amounts, and the health of watershed ecosystems, all of which could be affected adversely by anticipated changes in the chemical and physical climate.

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- The New England region has a unique geography and landuse history that leads to a fragmentation of natural and managed ecosystems. This will make it more difficult for some species to respond to climate change. It also leads to a diversity of those industries dependent on natural resources. Industry diversity can weaken our competitive position when the size of any one component of the industry is not large enough to compete effectively and support an adequate infrastructure. Lack of critical thresholds of infrastructure will be a disadvantage during transition to new climate conditions. On the positive side, a diverse industry will have more options for adaptation to climate change.
- Shifts in species composition, invasion by exotic species, and habitat loss are likely to be exacerbated by climate change, even though productivity of some managed and natural ecosystems may, in the long-term, be unaffected or increase with warmer temperatures and increased CO₂ levels (assuming adequate precipitation during the growing season).
- Atmospheric deposition increases ecosystem productivity on some sites, but could exacerbate other environmental stressors (e.g., by increasing water demand), and lead to nitrogen saturation of the landscape.
- Agricultural productivity of the New England region may survive a climate change (with adequate research and extension support), but there will be significant economic and environmental costs associated with shifts to new varieties and new crops, investment in new infrastructure (such as development of new water supplies for irrigation), and increased pesticide and herbicide use to control more severe insect and weed pressure.
- For some farm families adaptation will not be possible because of lack of capital, lack of available land or other resources, lack of markets for new crops, or environmental constraints. There will be losers as well as winners within the farming community, with some possibility that the New England region will have a disproportionate share of the former.
- Climate change will likely result in more severe infestations of some pests and pathogens in agriculture and forestry, and invasion of undesirable vegetation.
- Regulations and availability of labeled pesticides may constrain the ability of commercial producers to cope with this consequence of climate change.
- It will become more challenging to develop “low input, sustainable” production practices with increased pest and weed pressure. Conflicts between producers and the general public regarding acceptable levels of chemical loading into the environment will undoubtedly be exacerbated by climate change.
- Landuse conflicts are likely to become a major issue with climate change. Pressure for shifts in agricultural zones are likely, and in some cases this may involve decisions regarding migration of agriculture into natural ecosystems. It is possible that there may be pressure to expand agricultural acreage overall in the New England area if agriculture in other regions of the U.S. (e.g., southern plains) is more negatively affected by climate change than our region.
- Despite the fact that natural resource-based industries will be particularly sensitive to climate change, this issue is not currently well understood or appreciated by this stakeholder group. One solution to this is to raise the priority of research and education programs focused on potential impacts at the regional level. Research priorities include the following suggestions.
 1. Improve climate models and their interpretation to indicate likely temperature and precipitation variability scenarios for specific regions within New England. This should include initiatives and supporting research to determine the interactive consequences of these changes in the physical climate with chemical climate factors such as nitrogen deposition or tropospheric ozone. Consider using expert judgement approaches in addition to computer modeling.
 2. Improve our understanding of the impacts of climate change on plant and animal species important to the region. For example, most agricultural research on crop response to climate change and crop modeling efforts have focused on the major world food trade grain crops such as soybeans, wheat and rice. These results are not particularly relevant to assessing impacts on agriculture in our region, where cool season vegetable crops, apples, grapes, and milk production by dairy cattle dominate the economy.
 3. Identify environmental thresholds for climate change impacts on plant and

- animal species and ecosystem function within the New England context.
4. Put dollar values (or other quantitative or semi-quantitative values) on animal species and ecosystem function within the New England context.
 5. Put dollar values (or other quantitative or semi-quantitative values) on impacts to natural and managed ecosystems for our region for various climate scenarios (e.g., loss of revenue to state parks, or economic losses to specific components of the agriculture industry such as dairy, cabbage, or apple). This will be essential to increasing the interest of the New England population in the climate change issue.

We identified several research priorities which represent a “win-win” coping strategy in that they would be of immediate benefit as well as help in the long-term adaptation to climate change. Example win-win strategies include:

1. improving our understanding of the response of crop species important to our region (including commercial timber tree species) to biotic and abiotic stresses, and developing crop models for them, would be of great value immediately in integrated pest management (IPM) and other management programs, as well as be useful in projecting climate change impacts;
2. strengthening the diversity of the forest products industry and developing a more flexible marketing strategy less reliant on specific species would be of benefit in the present as well as within the context of climate change;
3. improving our techniques for preserving and improving soil quality in managed forests and farm land will lead to more sustainable production systems regardless of climate change scenario, and will tend to maximize carbon sequestration in the future.

THE FOUR QUESTIONS ADDRESSED

1. What are the current concerns and stresses facing regional stakeholders in the natural resources sector?

There are serious near-term problems, stresses, and concerns that completely occupy the attention of natural resource-based industries in the region. Climate change, because of the long-term nature of the problem, uncertainty and skepticism regarding climate predictions, and lack of information, is not

currently “on the radar screens” of most stakeholders in this group. In Question 3 we identify some research, information, and education needs which, if met, would stimulate more interest and concern in the climate change issue.

Below are the current issues of concern identified for each component of the natural resources sector.

Forests

- Plant and animal species composition change (e.g., habitat change, crop tree change, invasion by exotic species)
- Atmospheric deposition (e.g., acid deposition, nitrogen deposition, ozone)
- Public policy / regulation

Other issues included: water quality; water supply; insect pests and pathogens; loss of biodiversity; introduction of new invasive plant species and exotics; forest sustainable productivity; reducing production in this region stresses other regions; rising deer (browser) populations; rising beaver populations; New England forests are old, aging and therefore more sensitive to adverse climate; renewed and increased clear-cutting because forests are aging; non-point source pollution; negative impact of poorly managed recreational use of natural ecosystems; erosion; and weak competitive position of timber industry because of high input costs relative to some other regions.

Agriculture

- Control of insect pests, diseases, and weeds
- Policy / regulation (especially regarding environmental impact of farming such as use of pesticides)
- Soil quality (e.g., loss of organic matter, compaction) and sustainable production
- In some regions of New England, the size of the agriculture industry is not sufficient to support infrastructure such as chemical suppliers, land banks, trucking services, marketing and promotion, etc.

Other issues included: regional competition (e.g., Canadian farmers); loss of good available farm land; loss of small family farms in some areas; weak competitive position of some food processing industries because of tax structure, costs of production; water availability; ozone damage; utility costs; and consumer concerns regarding environmental impact of farming, food safety, use of biotechnology (e.g., animal hormones, genetically engineered plants).

Fisheries/Aquatic Ecosystems

- Overfishing
- Loss of habitat (e.g., riparian zones; aquaculture displacing natural fisheries)
- Invasion of exotics

Other issues included: maintaining fish migratory passageways; toxic contaminants in fish; government regulations on commercial fishing; loss of estuary water quality; non-point source pollution; toxic algal blooms; anoxia-fish kills; and unemployment in commercial fishing industry.

Wetlands

- Loss of habitat
- Toxic contaminants
- Invasive (exotic) plants

Other issues included: eutrophication; atmospheric deposition; motor boat oil contamination; and septic runoff into waterways.

2. How will climate variability and climate change modify the current concerns and stresses of the natural resources sector in the region?

Climate change will likely amplify many current stresses, but could possibly also partially mitigate others. It could raise the priority level of some stresses, and bring new issues onto the agenda.

Forests

- Stresses associated with changes in plant species composition, loss of habitat and invasion by exotic species are likely to become worse with a rapidly changing climate.
- In many cases atmospheric deposition impacts will be negative and make plants more sensitive to climate change. However, in some cases, such as nitrogen deposition on nitrogen-deficient soils, atmospheric deposition may partially compensate for negative climate change impacts.
- Public policy issues are likely to become more complex with climate change, as there may be increased threat to endangered species, and increased pressure for other land uses (e.g., expansion of agriculture).
- New issues or issues that may rise in priority when considering climate change are:
 - + timber productivity,
 - + water supply and quality problems,

- + pest and disease problems,
- + possible change in fire frequency, and
- + negative impacts on soil biological factors such as beneficial mycorrhizal fungi associations with plant roots.

Agriculture

- Pest, disease, and weed problems are likely to significantly increase with rising CO₂ and increasing temperatures.
- Policy and regulations could constrain farmer adaptation options.
- Climate change could decrease soil quality (loss of organic matter with warmer temperatures; more soil compaction with wetter springs when farm equipment enters the fields). Climate change and increasing CO₂ could, on the other hand, improve soil quality by increasing productivity, including below-ground biomass, and thus increase organic matter and carbon sequestration.
- Issues that could become more severe problems with climate change are:
 - + water availability,
 - + environmental impacts of agriculture (increased use of pesticides, herbicides, resources, expansion of agriculture into natural ecosystems), and
 - + lack of sufficient infrastructure (extension personnel, agricultural support businesses, land suitable for agriculture) for farmer adaptation in some regions of New England and upstate New York, where the agriculture industry has lost critical mass.

The New England agricultural competitive position could become better or worse. For example, if the Canadian climate becomes more suitable for some of our important crops, we could lose market share. On the other hand, we may be more competitive with regions south of us for production of other crop species. This is particularly important since this could lead to a shift in the importance of agriculture in the region, reversing the trend of the past century.

Fisheries/Aquatic Ecosystems

- All of original stressors (overfishing, loss of habitat, invading species) could become worse with a climate change and warmer water temperatures with estuaries being the most vulnerable of the water bodies (marine cold water, interior waterways, estuaries).

3. What information and data are needed by the natural resources sector to fully understand and address climate-related issues?

Addressing our highest priority information and research needs in a region-specific manner, will be essential to engaging this stakeholder group and the general public in climate change issues.

Highest Priority

- Developing more accurate climate and atmospheric deposition predictions (i.e., better models) for our region in particular.
- More research on crops important to our region (e.g., cool season vegetable crops, apples, grapes, impact on dairy) to be used in simulation models for projecting climate change impacts. Most current information on crop response to CO₂ and climate is based on research for major world food crops such as wheat, rice, and soybeans that are not important to our region.
- Develop forest and wetland models focused more particularly to species and conditions of our region.
- Identify environmental thresholds (i.e., critical changes in temperature, precipitation, etc.) for climate change impacts on species, communities, habitats within the New England context.

Research dollar values (or other quantitative or semi-quantitative values) for impacts to natural resources and agriculture for our region for various climate scenarios (e.g., loss of revenue to state parks, economic losses to specific components of agricultural industry such as dairy, cabbage, or apple). This will be essential to increasing the interest of the New England population in the climate change issue.

Other Important Needs

- Develop detailed historical landcover types and landuse maps for New England (our region is unique in complex history of landuse patterns).
- More research on interactions of multiple stresses is needed (e.g., acid deposition x climate change; CO₂ x environmental stresses on plants).
- Identify components of natural resources that will be most vulnerable to climate change (e.g., estuaries, endangered species, specific agricultural industries such as dairy).
- Conduct region specific policy analysis.

- Re-examine monitoring efforts and modify them to be more useful for climate change impact assessment (e.g., more long-term, focused on particular ecosystems, scales).
- Quantify the level of uncertainty in our models for public education outreach.
- Better characterize potential for sea-level rise and identify coastal areas which are the most vulnerable.
- Assess the vulnerability of ornamental and horticultural landscape components.

4. What types of strategies and approaches are available for coping with, or mitigating, climate change stresses for this sector?

Forests

Factors affecting forest adaptation to climate change include: age of forests, fragmentation of habitat, rate of land development for other uses (e.g., urbanization, conversion to agriculture), trends in competing regions, rate of climate change, exposure to extremes, and sustainability. Mitigation strategies to be considered:

- More protection for riparian zones
- Protection of coastal areas
- Encouragement of species diversity and age class diversity
- Encourage business diversity
- Reduce fragmentation
- Create ecosystem reservations
- Manage to maintain stand vigor
- Education of land managers
- Implement sequestration strategies

Agriculture

Factors affecting farmer adaptation include: agriculture research and extension support, available capital for new investments and to buffer costs during transition, land and other resource availability, and rate of climate change. Mitigation strategies include:

- Identify availability of new varieties or crops and cultural practices for climate change scenarios.
- More flexible government policies and regulations that will assist farmers in rapid adaptation are needed.

- Increased emphasis on developing regional markets for local agriculture commodities should be considered.

Fisheries/Aquatic Ecosystems

Aquatic mitigation strategies include, but are not limited to:

- Low flow maintenance
- More fish passages
- Better inventory of standing stock and production
- Improved water quality

Examples of Win-win Strategies

- Strengthen the diversity of the forestry industry and develop a more flexible marketing strategy which is less reliant on specific species. This will be of benefit in the present as well as within the context of climate change.
- Improve our understanding of the response of crop species important to our region to biotic and abiotic stresses, and develop crop models. This will be useful immediately in integrated pest management (IPM) programs which reduce pesticide loads, as well as be useful in projecting climate change impacts.
- Improve our techniques for preserving and improving soil quality in managed forests and farming systems. This will be of benefit to the industry by helping to sustain productivity and may improve carbon sequestration by managed and natural ecosystems in the future.

NATURAL RESOURCES—APPENDIX I

Selected Economic Data for Natural Resources Sector

Table 1. Sales value (in \$1000) for selected agricultural crops/enterprises (1992 USDA Census of Agriculture)

State	Grains	Silage	Vegetables	Fruit	Nursery	Dairy	Livestock
CT	872	6350	13313	12138	126581	71079	153863
MA	907	9771	26984	118339	88018	60430	95500
ME	4525	9683	12737	49888	20832	89875	214329
NH	16	5591	5249	10399	24069	46861	68346
NY	116924	69261	180861	179251	218241	1428850	1812710
RI	—	1010	2461	2322	19501	5024	12082
VT	635	11360	4080	9515	9461	328717	37977

Table 2. Selected forest statistics for ME, NH, NY, and VT combined (Northeast Forest Alliance (NEFA) 1990 Report)

Forest-based recreation/tourism jobs:	40,580
Forest-based manufacturing jobs:	86,050
<i>[NOTE: this represents 12%, 11%, 7% and 2% of total employment for ME, VT, NH, and NY, respectively]</i>	
Forest-based recreation/tourism payroll dollars:	\$1.241 billion
Forest-based manufacturing payroll dollars:	\$2.071 billion
Total forested area for NEFA region:	45.982 million acres
Total timberland area for NEFA region:	42.200 million acres

	<u>\$ per forested acre</u>			
	<u>NY</u>	<u>ME</u>	<u>NH</u>	<u>VT</u>
Manufacturing shipments	416	260	302	166
Gross state product	129	90	116	67
Manufacturing payroll	56	34	41	21
Delivered roundwood	24	26	19	21
Tourism spending	180	97	241	213