# MAINE STATE LEGISLATURE



**Summary and Recommendations from the Environmental and Energy Resources Working Group**

# Monitoring, Mapping, Modeling, Mitigation and Messaging: Maine Prepares for Climate Change

***September 2014***

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on behalf of

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MAINE DEPARTMENT OF ENVIRONMENTAL PROTECTION

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# Executive Summary

Governor Paul R. LePage established the Environmental and Energy Resources Working Group (the Working Group) to identify administrative and strategic opportunities to improve Maine's ability to respond and adapt to changing physical conditions in the environment due to climatic influence. The Working Group was led by Commissioner Aho of the Department of Environmental Protection (DEP), and included the Director of the Governor's Energy Office (GEO), and the Commissioners of the Department of Transportation (MDOT); the Department of Marine Resources (DMR); the Department of Agriculture Conservation and Forestry (DACF); and the Department of Inland Fisheries and Wildlife (MDIFW). The Working Group met several times to discuss ongoing projects, programs and activities at each agency that address changes in the environment; mapping of natural resources; or that study impacts to industry consequent of climate factors; and identified existing partnerships in both the natural environment and the built environment.

The Working Group held three public listening sessions, soliciting input from stakeholders regarding potential agency actions and approaches to ensure the availability of unified and consistent information regarding climate adaptation issues, and opportunities to simplify the incorporation of appropriate climate adaptation measures into current and future work. Public input in the form of written comments and suggestions was also solicited. Participants and respondents suggested ways to improve accessibility and utility of existing programs and services; provided ideas for proactive measures to monitor, plan for, and mitigate the effects of climate change on diverse segments of Maine's natural and built environments; and gave examples of difficulties experienced in implementation of climate adaptation projects.

Numerous ideas and suggestions were received, including ways to better utilize the state's GIS system and other mapping tools; incorporation of climate science in planning for wildlife, fisheries, silvicultural and agricultural management; conducting risk assessment studies for infrastructure, agriculture and wildlife; updating rainfall tables to account for more frequent and more severe storms; resolving conflicts between state and federal rules and standards; and creation of a state "climate clearinghouse" for individuals with environmental and energy concerns related to climate adaptation.

This summary presents current programs and activities, along with ideas and recommendations in five separate categories: Monitoring, Mapping, Modeling, Mitigation, and Messaging. This is intended to reflect the state's overall approach to the problems presented by a changing climate. As a state, we must know as much as we can about the current situation on the local scale; compare local-scale knowledge and information at regional and statewide scales; consider possible future conditions and consequences; act to minimize negative outcomes and consequences; and educate and inform the public, as well as maintain open communication between state agencies regarding all the potential effects of climate change on our state.

As a result of the meetings and public input received, the Working Group recognizes that commitment to identifying and implementing cost-effective adaptation practices is an essential part of the State's response to changes in Maine's climate. The Working Group recommends that its function be continued in the long term, to provide a forum for interdepartmental collaboration on matters relating to climate. The Working Group also recommends the state create a web-based climate adaptation resource to assist municipalities in planning for resiliency with input and advice from stakeholders and user groups. The Working Group agrees with many of the ideas presented, and will continue to be receptive and mindful of public input as it approaches its ongoing collaborative work. The Working Group's specific recommendations are presented at the end of each section of this document.

# Background

Natural resources form the cornerstone of the economies of many of our coastal and inland communities, and our built environment provides the framework in which these economies operate. Recognizing that changes in our climate can result in vulnerabilities to both our natural resources and our built environment, in late 2013 Governor LePage saw the need for the State to develop and coordinate strategies that address these complex issues. With this in mind, Governor LePage established the 'Environmental and Energy Resources Working Group' (See Appendix A), tasking the Group with developing strategies to provide specific and identifiable tools to assist decision-makers in responding to the challenges of a changing climate.

The Environmental and Energy Resources Working Group, which the Governor directed the Commissioner of the Department of Environmental Protection (DEP) to convene and chair, was comprised of the Commissioner of the DEP, the Commissioner of the Department of Transportation (MDOT), the Director of the Governor's Energy Office, the Commissioner of the Department of Marine Resources (DMR), the Commissioner of the Department of Agriculture Conservation and Forestry (DACF), and the Commissioner of the Department of Inland Fisheries and Wildlife (MDIFW), or their designee (Appendix B).

The Working Group was directed to focus its attention on two major areas:

A) Create a complete summary of ongoing projects, programs or activities taking place within the respective Departments or Offices that address or respond to observed climate changes in the environment, mapping of natural resources or the study of impacts to industry consequent of environmental change factors. Then, using that summary, discuss mechanisms for cross agency partnerships, information sharing, efficiencies, and streamlining that can be accomplished.
B) Convene at least two meetings during which input would be solicited from stakeholder groups in the areas of engineering, water and wastewater infrastructure operations, and other natural resource industry organizations. Invite input from stakeholders on how the Departments might create approaches to cross-cutting and multi-agency issues to ensure that unified and consistent information is available to decision-makers. Following these meetings, summarize the findings and recommend strategic approaches to developing tools to better collaborate among the agencies.

The Working Group members provided a summary of their projects, programs or activities to the DEP, which organized monthly meetings of all Working Group members to discuss related topics of concern; how to move forward with sharing of information; possible cooperative projects; and possible cross

agency sharing. The Working Group members also planned the listening sessions, which were widely promoted throughout the state, and which were held in Portland, Bangor and Houlton. In order to make the listening sessions readily accessible to all interested parties, the listening sessions in Portland and Bangor were held during both the afternoon and evening of the same day, while in Houlton, an extended afternoon session was offered. Various municipalities, public organizations, businesses and residents attended and presented their thoughts at these sessions, and many others sent emails to the DEP that conveyed their ideas and suggestions. The recommendations of the Working Group for actions in response to suggestions from the public and resulting from the discussions at the monthly meetings are presented at the end of each section of this document.

# Introduction

This document identifies ongoing projects, programs and activities within the natural resource and energy agencies in Maine state government, which address or respond to observed changes in the state's climate; which involve mapping of natural resources; or which study impacts to industry in consequence of changing environmental factors.

The activities are grouped in five major categories: Monitoring, Mapping, Modeling, Mitigation and Messaging. Activities in each category are listed according to their relevance to either the Natural Environment or the Built Environment. Some activities cross both categories, such as the installation of culverts that are sized to appropriately handle larger flows of water, and which also have natural bottoms to provide for improved aquatic habitat.

Some current projects involve shared responsibilities and oversight between multiple Departments, such as the project identified as 'Modeling the Effects of Sea-level Rise on Coastal Habitats', which is a collaborative effort between MDIFW and DACF; and the Aquatic Resources Management Strategy, in which DACF and DEP are working to minimize the impacts of road crossings on Maine's aquatic systems, which are becoming stressed by more frequent and severe storms.

Each section concludes with the Working Group's recommendations for actions related to the particular activity category, based on the discussions at the Working Group's monthly meetings and on the input received from the public at the listening sessions and via electronic mail.

# Monitoring Activities

The first step in responding to climate change is to understand current conditions as completely as possible. In Maine, the Departments of Inland Fisheries and Wildlife, Marine Resources, Agriculture, Conservation and Forestry, Environmental Protection, and Transportation, along with the Governor's Energy Office, all have ongoing programs that monitor various parts of the natural and built environments, some with data extending back many years. This information is critical to understanding what conditions are historically normal for Maine, and careful analysis of new data collected can show the effects of climate change before they become obvious to the casual observer. Monitoring wildlife activity at a particular observation station can show a change in species presence or domination; monitoring of stream flow or lake levels can show the effects of increased stormwater runoff from rain events; and monitoring of industrial activities can show changes in the amounts of pollutants entering the environment or changes in economically-driven priorities that may then change the part of the environment affected by a particular activity. Monitoring is also a necessary component of any climate adaptation project, to determine the effectiveness of the project and to discover any unanticipated consequences.

## NATURAL ENVIRONMENT

Current monitoring activities relating to the Natural Environment include:

### Vulnerability Analysis of Maine's Species of Conservation Concern (MDIFW)

Maine's ecosystems and species will be affected by climate change in many ways, and are projected to experience a larger temperature change than other regions in the U.S. outside of the Northeast. While populations and habitats of some species will increase, climate change could lead to extirpation of other species and significant losses of natural habitat. In an effort to understand which of Maine's species and habitats are most vulnerable to climate change impacts, MDIFW recently collaborated with the Manomet Center for Conservation Science and other partners on a climate change vulnerability assessment, an approach recommended by national groups such as the Association of Fish and Wildlife Agencies. The project involved over 100 professional biologists assessing the vulnerability of 442 Maine species, and multiple habitat types. The assessment concluded that climate change greatly increases the vulnerability of more than one-third of Maine's species of conservation concern: 168 species (37%) were ranked as highly vulnerable and another 171 species (38%) as moderately vulnerable. Ecosystems in Maine hosting a disproportionate number of these vulnerable species include alpine tundra, montane forest, and peatlands (bogs and fens). The results of this assessment will be used by MDIFW during revisions of the State's Wildlife Action Plan in 2014 to formulate adaptive strategies for conserving climate-sensitive species. The final vulnerability assessment report, entitled "Climate Change and

Biodiversity in Maine: Vulnerability of Habitats and Priority Species", can be viewed here: https://www.manomet.org/publications-tools/climate-change

## Priority Species Research (MDIFW)

MDIFW is actively conducting research on habitat relationships and limiting factors for several priority fish and wildlife species. Much of this research will help the Department anticipate the potential effects of climate change and adapt its management practices appropriately. Six examples of MDIFW's many ongoing priority species research projects are highlighted here.

### Moose

Maine is home to the densest population of moose in the lower 48 states. Maine's private forestlands provide large tracts of habitat that produce a substantial forage base essential to moose productivity. Other jurisdictions in the lower 48 including Minnesota, Wyoming and New Hampshire have concerns regarding the interactions of moderating climate, parasites, habitat and predation as their moose populations have declined. Shorter-duration winters linked to a warming climate may increase the densities of parasites such as the winter tick, lungworm, and meningeal worm. In addition, mild winters and moderating climate benefit deer populations that serve as "reservoirs" for many of these parasites; thus, increases in deer populations may impact moose populations.

While Maine's moose population remains strong, it is still important to understand adult female and calf survival rates in light of these factors and population declines in other jurisdictions. Therefore MDIFW has embarked on a multi-year project to assess adult female and calf survival rates and examine potential causes of mortalities, by radio collaring moose in two study areas in western and northern Maine (Winter 2014 and 2015). Using GPS "survival" collars that transmit locations of each moose twice a day, biologists will monitor these moose in real time to track daily survival. Results from this work will enable MDIFW to gain a clearer picture of adult female and calf survival rates, rates of population increase/decrease, sources of mortality, influences of various disease vectors, and how parasites may influence moose population dynamics. This information will be vital for MDIFW's efforts to manage moose at a level that provides hunting and viewing opportunities for the people of Maine.

### Canada Lynx

Over the last 14 years, MDIFW, the U.S. Fish and Wildlife Service, and the University of Maine have been studying lynx habitat use and population status in Maine. Canada lynx are a northern boreal species adapted to living in areas with deep snow and abundant snowshoe hare. Lynx numbers thus fluctuate in delayed synchrony with snowshoe hares. Lynx in northern New England (Maine, New Hampshire and Vermont) live at the southern extent of their range. In 2000, in response to forest management on Federal land, lynx were listed as Threatened in Maine and 13 other northern-tier

states. Interestingly, at the time of listing, young spruce-fir forest that supports high hare densities was becoming abundant in northern Maine following a record spruce-budworm outbreak. As a result, Maine's lynx population has expanded to record high numbers, and now lynx occupy western, eastern, and northern regions. Habitat models suggest that lynx populations could begin to decline in Maine sometime after 2022 in response to a maturing spruce-fir forest that is expected to support lower snowshoe hare densities. A warmer climate could change the composition of Maine's northern forest from one dominated by spruce and fir to more southern temperate species. An even more immediate concern for lynx is a warmer climate that leads to less snow. If snow depths diminish in Maine, lynx range is expected to retract. MDIFW's on-going research on Canada lynx will help position State and Federal wildlife biologists to better conserve and manage lynx in a changing climate.

**Brook Trout**

Maine remains the last stronghold for wild Eastern Brook Trout in the United States, although the Eastern Brook Trout Joint Venture (EBTJV) has documented a significant range wide population decline. As a committed partner to the EBTJV, MDIFW collaborates on multiple research and assessment efforts with the goal of maintaining and restoring wild eastern brook trout throughout their historic range wherever possible. Hence, Maine is often the 'bellwether' for comparing conservation strategies elsewhere in the range for guidance or predicting outcomes. Since completing the landmark status assessment in 2005, MDIFW has greatly increased wild brook trout population assessment efforts in all habitat types (ponds, streams, coastal habitats) for a robust benchmark useful to all EBTJV partners as a variety of conservation measures are implemented range wide. For brook trout, climate change mitigation strategies center around reducing peak water temperatures during the summer season, and reconnecting fragmented hydrologic networks so fish can actively seek adequate conditions during stressful periods. MDIFW shares physical habitat and population monitoring information with EBTJV partners to assess and gauge success of a variety of habitat mitigation strategies to better refine restoration recommendations in light of changing climate.

In addition, MDIFW is collaborating with a variety of Maine partners to develop DNA detection techniques to track competing non-native fish species as a strategy for mitigating the effects of exotic species in wild brook trout habitats. As climate changes, habitat conditions tend to improve for certain non-native fishes to the detriment of Maine's native Salmonids. Hence, early detection of new non-native species occurrences in Salmonid habitats is paramount to mitigating their competitive effects on wild Brook Trout. Environmental DNA techniques allow for the detection of target species while their numbers are quite low, often at lower abundances than can typically be detected through standard fishery techniques.

**Saltmarsh Birds**

With even moderate sea-level rise, habitat for these species is predicted to be greatly reduced. As

most species nest just a few inches above the surface of the marsh, they are inherently vulnerable to tidal flooding. Obligate saltmarsh nesting species, such as Saltmarsh Sparrow, have been the focus of research by Department staff since the late 1990's. In recent years, MDIFW has partnered with researchers at three universities (U. of Delaware, U. of Connecticut, and U. of Maine) for a range-wide (Maine to Virginia) survey of abundance and distribution as well as focused research on survival, fecundity, and population viability. Currently, Maine data are serving as a control for the effects of Hurricane Sandy on populations of saltmarsh birds in southern New England and along the mid-Atlantic coast. This research will inform managers and researchers about the constraints on saltmarsh species in Maine and throughout the Northeast, and help inform management options given impending climate change.

**Rusty Blackbird**

Rusty Blackbirds are the northernmost ranging of the blackbird species, reaching the southern edge of their boreal breeding range in Maine. With a warmer climate and retreating spruce-fir forests, Rusty Blackbirds too are predicted to retract their breeding range to the north. Efforts by Department staff, the University of Maine and SUNY College of Environmental Sciences and Forestry have already demonstrated a range contraction in Maine, and begun to unravel what drives populations of this rapidly declining species. MDIFW has been active in a continent-wide cooperative Working Group seeking to understand threats to this unique species while we still can.

**Dragonflies and Damselflies**

Insects in the Order Odonata, damselflies and dragonflies, are a conspicuous component of Maine's wildlife diversity and serve an important role in both aquatic and terrestrial ecosystems. Presently, 155 species have been documented in Maine and ~230 species across the Northeast. Many of the region's odonates are considered of national and global conservation concern, including several species listed as Endangered or Threatened in Maine. Because of the sensitivity of some odonates to freshwater and riparian habitat degradation, including potential climate change impacts on water temperature and hydrology, MDIFW is cooperating with biologists from New York and New Hampshire to conduct the first comprehensive conservation assessment of Odonata in the Northeast. Odonata are well suited to an assessment of this sort because their distributions and habitat affinities are relatively well known and the number of species is manageable, especially compared to other insect groups. At present, nearly 200 species are listed as Species of Greatest Conservation Need (SGCN) by at least one northeastern State. This two year assessment will serve to identify which of these species are most critical to consider for regional conservation actions, thereby helping Maine and other states strategically focus limited conservation resources on the most imperiled species.

## An Assessment of Maine's Endangered and Threatened Species (MDIFW)

One of the tools employed by MDIFW to achieve its mandate for conserving all species of fish and wildlife found in the State is to periodically review state listings of Endangered and Threatened Species. Changes must comply with the Administrative Procedures Act, which includes a public comment period, public hearing(s), and review by the MDIFW Advisory Council. Adding or removing species listed under the Maine Endangered Species Act then requires legislation based upon a MDIFW proposal. Review guidelines are adopted in MDIFW regulations and focus on scientific criteria for species vulnerability -- mainly abundance, distribution, trend, habitat fragmentation, and endemism. Novel risk factors, including climate change, are also considered. If climate change significantly compounds the risks for species that are already deemed vulnerable, then the concept can indeed form part of the justification for listing species as Endangered or Threatened in Maine. In short, MDIFW is considering species vulnerability to climate change as one of many potential threat factors in its proposed revisions to the State Endangered and Threatened Species list. In 2014, three species of bats and three species of insects are proposed to be added to Maine's list of Endangered and Threatened Species. Final changes would be promulgated in 2015. These changes may present challenges to other aspects of climate mitigation, such as increasing available wind energy generation to reduce GHG emissions at power plants, since wind turbines can present risks to bats.

## Lobster Sea Sampling (DMR)

Lobster sea sampling – three samples from each of the seven lobster zones monthly from May through November, provides us with changes in size at maturity, molting timing and frequency, and disease monitoring, in addition to size composition and biological composition of the catch. This information is also collected from the ventless trap survey that is conducted monthly from June to August.

## Maine-New Hampshire Inshore Trawl Survey (DMR)

Annual spring and fall sampling (2000-present) of marine resources and associated temperature/salinity conditions from the Massachusetts/New Hampshire border to the Maine/Canadian border provides information on temporal and spatial distribution patterns and abundance of species out to 60 fathoms, along with information on size, age, sex, and reproductive condition. In addition to usefulness for stock assessments, the time series will be useful for understanding changing environmental conditions.

## Sea Urchin Survey (DMR)

Annual dive survey of sea urchin size and abundance along the Maine coast (2001 to present) provides information on recruitment/reproductive success, population size, size composition, and distribution of the green sea urchin.

## Scallop Surveys (DMR)

Periodic fishery-independent survey of sea scallop distribution and abundance along the Maine coast since 2001.

## Lobster Settlement Survey (DMR)

DMR has compiled and maintained a coast-wide dataset since the early 2000's, that measures juvenile lobster settlement success at various locations on the coast and that can be compared with data from Massachusetts, New Hampshire, Rhode Island and Canada.

## The Boothbay Harbor Sea Water Temperature Record (DMR)

This record extends over more than a century, and constitutes one of the longest running, continuous series of sea temperature observations for any point on the North American Atlantic Coast. Observations began in March 1905 and have continued, with minimal interruption, to the present day. Currently, observations of air temperature, barometric pressure, sea surface temperature, relative humidity, wind speed and wind direction are recorded at daily intervals.

## Summer survey for Northern Shrimp (DMR)

Cooperative survey among National Marine Fisheries Service, Massachusetts, New Hampshire and Maine to monitor the condition of the northern shrimp resource (ongoing since the 1980s).

## National Marine Fisheries Service/National Oceanographic and Atmospheric Administration Fisheries Albatross-Bigelow surveys (DMR)

Marine resource surveys conducted spring and fall in the Gulf of Maine since 1968 to assess the distribution and abundance of marine resources and environmental conditions. Recent analyses of changes in distribution of species and ecosystem conditions can be found at:
http://www.nefsc.noaa.gov/epd/ocean/MainPage/ioos.html and
http://www.nefsc.noaa.gov/publications/crd/crd1207/crd1207.pdf

## Northeast Regional Association of Coastal Ocean Observing Systems (DMR)

Through participation in the Northeast Regional Association of Coastal Ocean Observing Systems (NERACOOS), DMR monitors environmental conditions at buoys throughout the Gulf of Maine.

## Atlantic States Marine Fisheries Commission (DMR)

Maine is a signatory to the Atlantic States Marine Fisheries Commission (ASMFC), an interstate compact for the management of fisheries across state waters. The ASMFC's Management and Science Committee has been studying the impact of climate change on the distribution of species under ASMFC management, and associated allocation issues. Some species, such as black sea bass, are managed under quotas that are allocated on a state by state basis. A survey of state directors is being developed to assess reactions to a variety of reallocation schemes.

## Northeast Regional Ocean Council (DMR, DACF)

The Northeast Regional Ocean Council (NROC) and the Northeast Regional Association of Coastal and Ocean Observing Systems (NERACOOS) are developing a plan for integrated sentinel monitoring for climate change in the northeast. This effort involves reviewing existing data, and developing criteria for indicators and sentinel sites to monitor estuarine, benthic and pelagic organisms. Planning and science staff from DMR and DACF participate.

## Forest Inventory Program (DACF)

The Forest Inventory Program monitors current and changing forest landscapes and demonstrates changes at a landscape scale across time. The systematic survey of all Maine's forests allows comparison with surrounding jurisdictions. The data sets extend back to 1959 and to allow the long-term monitoring of changing abundance and relative growth rates of various species. Representative subsets of plots are used to track insect and disease syndromes/evidence of expansion of invasive and/or exotic plants.

## Insect & Disease Management Program (DACF)

The Insect & Disease Management Program monitors frequency, intensity and extent of various pests in Maine. The monitoring tracks the expansion and intensification of climate-ameliorated native and exotic invasive species.

## Cooperative Agricultural Pest Survey (DACF)

The Cooperative Agricultural Pest Survey (CAPS) program conducts science-based national and state surveys targeted at specific exotic plant pests, diseases, and weeds identified as threats to U.S. agriculture and/or the environment. These surveys represent a second line of defense against the entry of harmful plant pests and weeds. The number of exotic pests threatening the state has increased partly as a result of climate variability. New pests that have been introduced into the country, and into the state of Maine, e.g. hemlock woolly adelgid, are easily expanding their ranges due to favorable climate

conditions allowing faster development times and reduced temperature-related mortality. The CAPS Program aids in tracking invasive species, and provides early detection of harmful exotic plant pests to minimize impacts on our agricultural and natural resources.

## BUILT ENVIRONMENT

Current monitoring activities relating to the Built Environment include:

### Biennial Greenhouse Gas Emissions Inventory (DEP)

The DEP is required to report annually on Greenhouse Gas emissions from larger licensed facilities (approximately 200 facilities statewide). Progress in reducing emissions is evaluated in the Biennial Greenhouse Gas Emissions Inventory. The report reflects all sources statewide.

### Annual Reporting of Greenhouse Gas Reductions (GEO)

The GEO, through its participation on the Efficiency Maine Trust Board of Directors, guides the development and implementation of energy efficiency strategies across all sectors (residential, commercial, industrial), which reduce Greenhouse Gases (GHG). Specific GHG reductions are measured in many of these programs. Efficiency Maine Trust and the Public Utilities Commission also issue an annual report on GHG reductions.

### Transportation Infrastructure Monitoring (MDOT)

MDOT conducts a number of infrastructure monitoring activities, which is vital to ensure infrastructure safety and integrity, and helps guide the department's priorities. In conjunction with the U.S. Geological Survey (USGS), MDOT measures and documents annual peak flows and rainfall amounts. All bridges are inspected at a maximum interval of 24 months. Underwater inspections for scour and structural integrity are conducted every 60 months. (Unless a finding determines that more frequent inspection is required in either case.) The MDOT Bridge Maintenance Division Scour Report was completed in 2009. The bridge-specific scour plans are currently under development. With DEP, MDOT conducts pipe and culvert assessments. With federal partners USGS, NOAA, and EPA, MDOT anticipates participating in the East Coast Climate Change Risk Assessment with the federal Safe, Accountable, Flexible, Efficient Transportation Equity Act: A Legacy for Users (SAFETEA-LU) reauthorization.

### Environmental Leader Program (DEP)

The DEP encourages various energy efficiency projects throughout its work. For example, technical assistance provided to facilities on an on-going basis as well as through the permitting and licensing programs. The Office of Innovation and Assistance administers the Environmental Leader Program,

which recognizes voluntary efforts of lodging establishments, restaurants, and grocers in reducing their environmental footprint.

### Enhanced Motor Vehicle Inspection Program (DEP)

The DEP administers the enhanced motor vehicles inspection program that went into effect January 1, 1999. The program requires that all gasoline-powered motor vehicles registered in Cumberland County be subjected to an enhanced inspection, which includes a gas cap pressure test and an Onboard Diagnostics (OBD) inspection.

## PUBLIC INPUT

Ideas and suggestions from the public regarding monitoring activities included installation and monitoring of stream and tide gauges at all appropriately located state facilities, and correlation of the data collected, as an aid in tracking the effects of climate change on the intensity of weather events and associated runoff. Fish and wildlife populations should be monitored to track the effects of climate change on habitat extent and to document any encroachment of new or invasive species as their habitats expand. The state should monitor vegetation changes in watersheds; monitor surface water conditions; monitor flood events and drivers; monitor current weather conditions; and monitor and inspect the integrity of existing infrastructure.

## RECOMMENDATIONS

The Working Group recommends that all ongoing monitoring activities be continued. DMR and DACF should establish a team to establish common goals and conduct all activities related to The Northeast Regional Ocean Council (NROC) and the Northeast Regional Association of Coastal and Ocean Observing Systems (NERACOOS), to minimize any duplication of effort. By June of 2015, all state facilities located adjacent to a river, stream or brook, or adjacent to the ocean, should have an appropriate stream or tide gauge installed, and tide or water level data from the gauge recorded at appropriate intervals. Data collected should be reported to DEP on a monthly basis for assimilation and analysis.

# Mapping Activities

The logical second step in climate change adaptation and response is mapping relevant monitoring data at large enough scales to show regional and statewide trends. Changes in the extent of protected resources affect developers' ability to site projects, and without current maps of those resources, project planning can be very difficult and expensive. Good maps make it easier to communicate, and public availability assures that parties from different areas will have access to the same information.

MDIFW, DACF, DEP and MDOT manage several ongoing mapping projects for various resource types and infrastructure elements. Other mapping projects, including such projects as DMR's eelgrass mapping project and Molluscan Shellfish Resource mapping project, have been completed, with no provision for future updating.

## NATURAL ENVIRONMENT

Current mapping activities relating to the Natural Environment include:

### Improving Aquatic Connectivity (MDIFW, DEP, MDOT, MDIFW, DACF)

The Stream Connectivity Working Group is a multi-agency project with the goal of encouraging statewide identification of priority aquatic resources for conservation and restoration activities that will benefit brook trout and other fish and aquatic wildlife. One product of this effort has been the field identification and mapping of in-stream barriers to aquatic animal passage due to poorly designed and/or malfunctioning road culverts and impoundments.

### Identifying Priority Amphibian and Reptile Conservation Areas (MDIFW)

The Priority Amphibian and Reptile Conservation Area (PARCA) project is a national initiative to develop a network of focus areas that contain the specialized habitats required by these groups and that are also resilient to anticipated climate change impacts. As a member of a northeastern research team (including the University of Maine), MDIFW has helped to identify scientific criteria for identifying PARCAs, drawing on the concepts of species rarity, richness, and landscape integrity. PARCAs are a nonregulatory designation whose purpose is to raise public awareness and spark voluntary protection by local partners. PARCAs are not designed to compete with existing landscape biodiversity initiatives, but to complement them - providing an additional spatially explicit layer for conservation consideration.

### Beginning With Habitat Program (MDIFW, DACF, MDOT)

Beginning with Habitat (BwH), a collaborative program of federal, state and local agencies and non-governmental organizations, is a habitat-based approach to conserving wildlife and plant habitat on a landscape scale. The program provides towns and land trusts with the best available information on rare plants and animals, important habitats, riparian areas, and undeveloped habitat blocks. The goal of the program is to maintain sufficient habitat to support all native plant and animal species currently breeding in Maine. BwH compiles habitat information from multiple sources, integrates it into one package, and makes it accessible to towns, land trusts, conservation organizations and others to use proactively.

## Coastal Hazard Resiliency Tools Project (DACF)

Science and planning staff worked with numerous regional and local partners to continue the fourth and fifth years of the Coastal Hazard Resiliency Tools (CHRT) project. The CHRT project, part of Maine's approved Coastal Program work plan funded by the National Oceanic and Atmospheric Administration (NOAA), is pursuing coastal hazard resiliency at local and regional levels. The project focuses on developing vulnerability assessment datasets, engaging directly with interested communities through education and outreach, and aiding local partners in developing locally acceptable adaptation strategies for dealing with the potential impacts of storms and future sea-level rise. Part of these efforts included developing the required GIS datasets for assessing the potential impacts of various sea-level rise scenarios on both natural and built environments in each partner community. These sea-level rise scenarios were superimposed onto the highest annual tide and the 100-year storm water elevation to assess potential impacts.

## Online Coastal Sand Dune Geology Maps (DACF)

The Maine Geological Survey maintains an online catalog of maps of the state's dunes based on air photography, LiDAR imagery, and field surveys. The maps delineate Erosion Hazard Areas (EHA) as well as existing extents of front and back dune areas. EHA designation includes consideration of climate related sea level rise and potential for inundation. These maps were most recently updated in 2011.

## Coastal Resilience and Restoration (DACF)

The Bureau of Ocean Energy Management (BOEM) and the State of Maine have begun efforts under a two-year cooperative agreement to evaluate sand resources for coastal resilience and restoration planning. Under this agreement, (DACF) will develop seafloor maps using new and pre-existing data to expand the Maine Geological Survey map series, and use the information to estimate the resource needs and evaluate the potential for Outer Continental Shelf sand and gravel resources. The geographic information system data layers will be available to the public online through the Maine Coastal Atlas. The maps will identify and locate potential areas of sand resources, as well as benthic habitat. The overall goal is to have available geologic and benthic habitat resources data accessible for planners and managers.

BOEM scientists will assist Maine in identifying areas to study for future geophysical and geological surveys, with the purpose of confirming previously identified resources and locating new potential areas of sand resources. BOEM will also help Maine develop tools to more readily share sand resource data with other agencies involved in coastal resilience planning. Such activities are essential for reducing potential storm damage to the residents, economies, and infrastructure of Maine's coastal areas. Research funded under this agreement will help ensure that activities including offshore dredging and beach nourishment are conducted in a sustainable manner that is compatible with natural sediment transport and biological processes, as well as stakeholder interests.

### Coastal Zone Data Acquisition (DACF, MDOT)

The Bureau of Resource Information and Land Use Planning is part of a consortium with the Maine Office of GIS, MDOT, other state agencies, and federal agencies to acquire detailed elevation data in southern Maine coastal areas. The acquired LiDAR data facilitates modeling of sea-level rise, storm surge, tsunami impacts, and riverine flooding. While the intent is to acquire such detailed elevation datasets statewide, currently most coastal counties are completed.

### Environmental Mapping Projects (DEP)

DEP provides regular updates to GIS map layers; using new and existing data to more correctly delineate resource protection areas and to reflect changes in resource extent caused by climate change and other factors. Data is updated at large scales and at local scales based on collaboration with MDIFW, DMR, DACF, and other agencies.

DEP identifies and maps the locations and impacts of the deposition of air pollutants such as acid rain and mercury, to enable monitoring of effects on activities and the environment. The distribution of these pollutants can also be used to inform modeling of other airborne pollution, such as ozone.

## BUILT ENVIRONMENT

Current mapping activities relating to the Built Environment include:

### Transportation Infrastructure Mapping (MDOT)

MDOT uses maps of existing infrastructure to assess the existing infrastructure's ability to handle worst-case climate change scenarios to identify potential threats associated with those impacts and determine where these weaknesses overlap (e.g., is there a bridge that is vulnerable to a rise in sea-level, coastal flooding and severe storms?).

MDOT collaborates with MDIFW's Beginning with Habitat Program to identify, retain and restore prime habitat for threatened and endangered species to make them less susceptible to climate change.

MDOT's numerous field staff are able to verify mapped elements in the field on an almost daily basis, providing a stream of up-to-date assessment of needs for maintaining and improving GIS mapping, which makes for more cost-effective project and candidate screening, and helps accurately target information gathering efforts.

## PUBLIC INPUT

Ideas and suggestions from the public regarding mapping activities included the expansion of LiDAR mapping data to include coverage of the entire state to enable more accurate flood modeling and more accurate updates to FEMA flood maps. Bathymetric mapping data needs to be more robust statewide, and mapped data should be available at the same scales in the different regions of the state. The state should develop a "clearinghouse" where interested parties can access information regarding climate adaptation and learn about the various agencies' capabilities to offer assistance and solutions to problems related to climate change. The state should coordinate culvert inventory activities statewide and prioritize and initiate proactive measures at vulnerable infrastructure components.

## RECOMMENDATIONS

The Working Group recommends that all ongoing mapping activities be continued, and that as monitoring efforts reveal anomalous or changing circumstances regarding climate-related effects on specific resources or infrastructure elements, the data reflecting those changes should be forwarded to the Maine Office of GIS for evaluation regarding its inclusion in an existing GIS map layer, or potentially creation of a new layer. The Working Group recommends that all GIS data be coordinated through the Maine Office of GIS or the Maine Library of Geographic Information (Geolibrary) for assemblage into statewide datasets. MDOT should work with MDIFW, DEP and the Maine Emergency Management Agency (MEMA) to identify critical points of vulnerability along supply and evacuation routes, where increases in runoff or changes in sea level may increase the risk of infrastructure failure, and initiate mitigation efforts to minimize those risks. The Working Group agrees with the public comments regarding the expansion of the LiDAR mapping data, and recommends that the coverage be expanded to include the whole state, with the results publically available. The Working Group recommends that the multiple issues raised regarding data mapping and geographic information be considered a priority for resolution.

# Modeling Activities

Modeling enables us to look at possible futures based on current conditions and the effects of specific changes to specific parameters. Modeling is a tool that, when properly applied, can expose system weaknesses without the need to experience actual system failure and the resultant repair costs. Using current monitoring data, coordinated by accurate and up-to-date maps, models can be used to examine the effects of small or large changes in one or more climate-related parameters. Effects can be predicted for the natural environment and for the built environment, and compound effects can also be examined. Models can be designed to show short-term effects or long-term effects, and parameters can be adjusted to reflect continuing changes in climate over the time period being examined, to more

accurately reflect the effects of a climate that is changing more each year. DACF, MDIFW, MDOT and DEP conduct various ongoing modeling projects that can be used to help predict, understand and prepare for the effects of climate change.

## NATURAL ENVIRONMENT

Current modeling activities relating to the Natural Environment include:

### Modeling the Effects of Sea-level Rise on Coastal Habitats (DACF, MDIFW, MDOT)

Maine's tidal marshes are important to commercial fishery interests and to a wide diversity of wildlife species, and are predicted to be negatively impacted by sea-level rise. Science and planning staff from DACF worked with MDIFW, using funding from NOAA to develop a LiDAR-based coast-wide dataset depicting the impacts of various sea-level rise scenarios on high and low coastal marshes. The towns of Bath, Bowdoinham, Georgetown, Phippsburg, Scarborough and Topsham are participating in the project. MDOT received funding from the Federal Highway Administration to conduct a vulnerability and criticality assessment of the public transportation assets in the six communities. That effort will be integrated into the overall project and MDOT will be using the local relationships and network developed through the DACF project to deliver the municipal outreach component of their grant. Project partners at the local level include farmers, fishermen, municipal officials, schools, and other interested citizens.

### Climate Change and Biodiversity in Maine (DACF, MDIFW)

Scientific staff from DACF has collaborated with several partners to produce a report, *Climate Change and Biodiversity in Maine,* which identifies the state's plants, animals, and habitats that may be most vulnerable to climate changes. The report was written by a team from MDIFW, DACF, conservation groups, land trusts, and U.S. Fish and Wildlife Service. Researchers looked at 442 vulnerable species in Maine and found that climate variations could significantly impact 168 species. The report concludes that native plant and animal species will be affected by changes in temperature, rainfall and snowfall patterns; invasive pests and plants species, sea-level rise, and other naturally occurring factors. The report authors theorize that mountain, coastal, and wetland habitats are most likely to be at significant risk.

### Sea Lake and Overland Surge from Hurricanes Modeling (DACF)

With funding from FEMA, marine geologists completed new coastal inundation mapping using the Sea Lake and Overland Surge from Hurricanes (SLOSH) model for Category 1 and 2 hurricanes at two tide stages. Staff developed a GIS tool that uses the latest LiDAR elevation data for the Maine coast. Maps were produced that show areas of potential inundation for both Category 1 and 2 hurricanes at mean

tide and mean high tide. Preliminary results were shared with the Maine Emergency Management Agency and emergency directors from Lincoln County in order to develop a plan for local and regional data utility. The maps were well received.

### Water Resource Investigations (DACF)

In collaboration with the Maine Department of Health and Human Services Drinking Water Program, the U.S. Geological Survey, and the Kennebunk-Kennebunkport-Wells Water District, hydrogeologists from the Bureau have been investigating water resources in the Branch Brook watershed of southern Maine, which is a primary water supply for the Water District. The goal of this project is to develop a groundwater model that more realistically represents the supply of and demands on groundwater within the watershed. The model will have the ability to assess the impacts of changes in water supply, due to climate change or other factors, and changes in demand due to increased pumping, thus providing an important planning tool for the Water District.

### Insect & Disease Management Program (DACF)

The Insect and Disease Management Program allows prediction of probable pest impacts beyond historic range; provides Maine's forest landowners and residents information for timely response to threats; and works with researchers at the University of Maine and the United States Forest Service to conduct research on new or intensifying pest problems, many of which have been exacerbated by changing weather patterns, such as warmer winter minimum temperatures and wetter spring weather

## BUILT ENVIRONMENT

Current modeling activities relating to the Built Environment include:

### Air and Water Quality Modeling (DEP)

DEP is currently modifying models used in air quality planning to incorporate updated meteorological parameters, such as increased average temps to better predict ozone levels in model projections.

DEP is reviewing wastewater treatment facilities' capacities and outfalls, in anticipation of increased rainfall and rising sea-levels. Model results will evaluate facility capacities, including their ability to handle storm events and stormwater, and aid in assessing the vulnerability of associated infrastructure, such as pipes in proximity to water bodies.

In response to predictions of increasing frequency and intensity of storm events, DEP is considering the impacts of more frequent rainfalls (soils may be more moist/saturated more often prior to a storm event), as well as increased rainfall amounts and durations (increasing surface water flow), in its

Stormwater management program. Results of this modeling will inform more appropriate criteria for designs, systems and options for stormwater and erosion control measures at various types of development, including land development projects; operating facilities; road crossings; and hazardous and solid waste storage areas.

DEP considers the potential impacts of changes in the climate on surface water bodies and sea levels when assisting with the siting of fuel storage facilities and associated services, including above ground storage tanks and terminals (ASTs); underground storage tank (UST) facilities near surface waters; and piping to dispensers on docks (e.g. marinas).

Through participation in the Regional Greenhouse Gas Initiative (RGGI), DEP models the results of reductions in carbon emissions from power generating facilities, and shares the results with other state agencies to enable more informed decisions regarding power planning and development needs.

DEP modeling of nutrients in land and water environments enables better understanding of such phenomena as algae blooms in lakes, "red tide" contamination of clam beds in the coastal wetland, and growth patterns in working forests across the state.

DEP models are used to help municipalities understand the implications of climate change as they plan management programs for local water supply and for wastewater treatment.

DEP's modeling efforts also inform planning for and the identification of temporary 'holding sites' within which to better manage debris from increased frequency and intensity of storm events, and establishing avenues for reuse and recycling of those materials. The Department has collaborated with the Maine Emergency Management Agency on this issue.

With the changing climate, the DEP is anticipating and preparing for an increase in the number of emergency response requests related to hazardous material releases, including smaller-scale incidents such as spring blizzard damage to residential aboveground storage tanks, and larger-scale incidents involving material storage and transportation, either related to vessels in transit, or at terminal facilities.

## Aquatic Resource Management Strategies (DEP, DACF)

DEP has been participating in this project with DACF to review and determine improved methods for facilitating improvements to infrastructure that simultaneously support and encourage natural ecosystems. A report has been released on this project.

**Probabilistic Risk Assessment (DOT)**

Conduct cost/benefit analyses to identify and prioritize the most vulnerable infrastructure for retrofit now to avoid future direct and collateral damage from impacts. The Transportation Research Board (TRB) (2008) cites Probabilistic Risk Assessment (PRA) as a methodology that could be potentially utilized to assess climate change impacts on infrastructure components. PRA can be summarized as follows: Total Risk = Prob(hazard) X Prob(consequence). As the TRB report explains:

The central idea behind PRA is to define risk as the product of the magnitude of adverse consequences and the probability that those consequences will occur. For instance, the risk of the loss of a coastal road due to a storm surge would be the likelihood of a storm surge rising high enough to inundate the road, multiplied by both the dollar cost of replacing the flooded road and the costs of the economic disruption during the time the road was disabled.

## PUBLIC INPUT

Ideas and suggestions from the public regarding modeling activities included modeling forest fires, groundwater conditions and sewer system infiltration, storm surges, sea level rise, and flood potential. Concerns were expressed regarding the integrity and reliability of freshwater supplies under the influence of potentially extreme conditions brought about by changes in the climate. Regulations that inhibit or prevent disaster response activities such as debris removal or other cleanup in protected resources after major storm events need to be modified to allow sensible measures to be taken in a timely fashion. The state should create a "planning tool kit" for municipal planners and developers to use in project design, which enables and enhances consideration of climate-related factors that may affect developments in the future. This should include tools to evaluate a range of scenarios including varying rainfall amounts, water levels and temperature ranges. The tool kit should also help users to understand the significance of differences in the results given by use of alternative parameters in multiple model runs and should be flexible to allow municipalities to design stormwater management projects based on characteristics of individual watersheds rather than a one-size-fits-all approach. The guidance provided in the DEP's Rules, Chapter 387, for calculating Aquatic Base Flows (minimum flows) for impounded waters yields results that are dramatically different from the results calculated using the USGS method. The state should provide guidance on resolving the conflicts between the USGS method and the Chapter 387 method for determining base aquatic flows. State agencies should aggressively seek resolution of conflicts between state building codes and FEMA rules. State agencies should aggressively seek resolution of conflicts between state Shoreland Zoning rules and federal wildlife/ wetland protection rules.

## RECOMMENDATIONS

The Working Group recommends that all ongoing modeling activities be continued. The Working Group

recommends that a model be developed, as a joint effort of MDIFW, DMR, MDOT, and DEP, to predict local consequences of changes in sea level to both the natural and built environments, with the understanding that these consequences may be either detrimental or beneficial in nature. The Working Group also recommends investigating the possibility of developing a comprehensive water model for the state, to model the response of groundwater and aquifers as well as surface waters and stormwater flows to various changing climatic influences. This effort should be conducted jointly by the members of the Working Group as part of their ongoing mission. The Working Group recommends that existing regulations be examined for impediments to emergency and nonemergency response to the types of damage that are predicted to arise under a more energetic climate, and that any such impediments be corrected as soon as possible.

# Mitigation Activities

The ultimate goal of climate adaptation strategy is to effectively mitigate the potential detrimental effects of a changing climate. The results of predictive modeling are invaluable in guiding the selection of appropriate and cost-effective targets for mitigation efforts. Mitigation projects are generally physical constructions that preserve or protect existing infrastructure or natural features. Mitigation projects can also be designed to take advantage of a local change in conditions, for example by selecting a crop to plant based on its affinity for a new climatic condition that may exclude a previously favored crop. Similarly, mitigation may take the form of adaptive fisheries or wildlife management strategies that allow for increased sustainable harvesting of species that may not have been historically abundant in sufficient quantities, but due to climatic changes have supplanted previously abundant species. MDOT, DACF, MDOT, DEP, DMR and the GEO are all involved in activities which mitigate the causes and/or effects of climate change.

## NATURAL ENVIRONMENT

Current mitigation activities relating to the Natural Environment include:

### Aquatic Resource Management Strategy (DEP, MDIFW, DMR, MDOT)

The Aquatic Resource Management Strategy (ARMS) is a joint effort between DEP, MDIFW, DMR, and MDOT to develop a statewide aquatic conservation and restoration strategy that aims to maintain and restore the ecological health of aquatic ecosystems. The program has resulted in development of a draft pocket guide that contains best management practices (BMPs) and guidance for those installing new and replacement crossings where culverts are 6 feet or less in diameter; the initial stages of a master reference manual that incorporates the best of existing BMP documents and Stream Smart crossing principles; the identification of existing opportunities for partnerships and/or project funding sources and potential new initiatives that would better enable local actions that benefit statewide aquatic

resource priorities; and the identification of further refinements and objectives for the Maine Stream Habitat Viewer, which is an on-line tool for data sharing and planning and assessing stream restoration projects that was developed by the Maine Stream Connectivity Working Group.

## Coastal State Parks – Adaptation to Climate Change (MDOT)

Coastal state parks and public lands in Maine are managed by the DACF Bureau of Parks and Public Lands. These parks are subject to erosion, land loss, flooding from hurricanes and winter storms, and other hazards. This project is collaboration among the programs of the Bureau of Resource Information and Land Use Planning and the Bureau of Parks and Public Lands to assess state park vulnerabilities, provide technical guidance on coastal hazards affecting park infrastructure and natural resources, and develop risk assessments. The project will prioritize sites for improving public safety, mitigating hazards, siting future development, and making lasting investments in park improvements. Results will also have secondary benefits for parks through development of "new media" visitor educational materials. In-state contractors and at least one NOAA-funding partner (Wells Reserve) will also participate in the project. This project is funded by a competitive grant from NOAA.

## Climate Mitigation through Forestry Management (DACF)

The Bureau of Forestry provides guidance and technical assistance to landowners and encourages them to actively manage their woodlands to maintain them in a healthy, resilient condition through a series of initiatives and ongoing programs. The Maine's Healthy Forests Program promotes active forest management by family woodland owners in southern Maine; the Woodswise Incentives Program helps woodland owners practice long term stewardship of their forest land, primarily by cost sharing woodland management plans, but also through other means; and Project Canopy supports healthy, well-managed urban and community forests by planting and maintaining trees in public spaces; managing town-owned woodlands; planting trees to mitigate storm-water overflow and retention; and encouraging installation of low impact development projects to increase green infrastructure as a viable alternative to grey infrastructure. The Bureau also assists woodland property owners in navigating the Tree Growth Tax Law, a current use taxation program which encourages long term forest ownership and active management.

## Invasive Pest Mitigation Strategies (DACF)

DACF staff provides training for landowners in appropriate methods to address invasive species; and provides support for invasive pest preparedness and response efforts. A number of other programs and areas of assistance are offered, including participating in advisory groups developing guidelines for town and land trust woodland management plans that are "climate smart."

### Water Resources Programs (DACF)

DACF staff provides trainings and assists in remediating water crossings on forest roads to handle predicted increases in storm flow and improve fish passage; oversees the chop and drop program, designed to improve cold-water fisheries habitat; conducts frequent workshops on Forestry Best Management Practices to protect water quality; and administers the Direct Link Loan Program, which provides reduced interest loans to loggers to purchase water quality-friendly harvesting equipment.

### Forest Climate Working Group (DACF)

The Forest Climate Working Group is a consortium of various parties involved in forest management/landownership and climate response/remediation. DACF participates to help steer FCWG initiatives so that they benefit Maine landowners and businesses.

### Vector Borne Working Group (DACF, Maine Center for Disease Control)

DACF staff have worked collaboratively with the Maine Center for Disease Control and Prevention (Maine CDC) to address the northward advance of diseases carried by ticks and mosquitoes. Climate variability has allowed the deer tick to flourish through most of the southern half of the state, and Lyme disease has followed. Department staff have participated in the multi-agency Vector Borne Working Group to develop and promote strategies to reduce the incidence of Lyme Disease. The Department has also developed a plan in collaboration with the Maine CDC to protect the public from mosquito-borne diseases which have also been migrating northward.

### Shoreland Zoning Management Program (DEP)

The DEP administers the Shoreland Zoning Management program to protect, conserve and promote environmentally wise use of sensitive areas adjacent to the state's natural water resources. Updates to the shoreland zoning rules have recently been proposed to address potential impacts of a changing climate on these areas.

## BUILT ENVIRONMENT

### Climate Mitigation in Transportation Infrastructure Maintenance (MDOT)

MDOT actively incorporates climate change considerations into current decision-making and planning. For example, when maintenance requires culvert replacement, old culverts are replaced with new ones that are adequately sized to handle more frequent/severe floods and that maintain or restore hydrologic connectivity and functional habitat connectivity to the extent practicable, especially in areas important to species for which Maine constitutes their northern or southern fringe range.

To the extent practicable, MDOT's goal is to design and build infrastructure to withstand a warmer and wetter climate. In this vein, bridges may need to be built with larger capacities to compensate for sea-level rise or increased flood events; highways may need to be designed to reduce the volume of standing water on the travel surface associated with frequent heavy rain events; and highways and roads in coastal areas (especially those in York County) may need to be relocated further inland to compensate for rising sea-levels, beach erosion and increased coastal flooding.

MDOT is able to more readily implement appropriate and cost-effective stormwater management practices through a Memorandum of Agreement with DEP, to maintain and restore surface water quality.

MDOT is working through the Surface Water Quality Unit with Project Development and Maintenance & Operations to minimize surface water impacts from all construction projects.

Where applicable, MDOT projects are designed to minimize and mitigate impacts on endangered species, such as Canada lynx and Atlantic salmon.

Where applicable, MDOT projects are designed to maintain and restore natural buffers to sea-level rise and increased stormwater run-off, such as wetlands and coastal salt marshes (e.g. Sherman Marsh).

In anticipation of increased frequency and intensity of storm events predicted as a result of climate change, MDOT project planning includes an upgrade of design standards that requires a project to be able to withstand a 100-year storm event rather than a 50-year event.

## Reducing Carbon Emissions from Licensed Sources (DEP)

DEP has several initiatives underway related to reducing Greenhouse Gas (GHG) emissions from licensed activities, including participation in the Regional Greenhouse Gas Initiative (RGGI) with eight other Northeast states, as well as in-state GHG reduction goals, and its work with the New England Governors/Eastern Canadian Premiers (NEG/ECP).

DEP actively promotes and supports the development of alternative fueled freight for Maine's trucking industry, especially through its work with NEG/ECP. In 2013 NEG/ECP tasked the Transportation Air Quality Committee to facilitate widespread adoption of alternative fuel vehicles (AFV) as a way to reduce greenhouse gasses. DEP supports NEG/ECP's work including to continue toward the 2020 goal of 5 percent AFV penetration; propose a framework that will facilitate interoperability of AFV refueling and recharging; identify corridors in the region that would facilitate AFV travel; and compile a regional profile of the light duty fleet.

Offset categories in RGGI currently include landfill methane capture and destruction; reduction in emissions of sulfur hexafluoride ($SF_6$); sequestration of carbon due to reforestation; improved forest management or avoided conversion; reduction or avoidance of $CO_2$ emissions from natural gas, oil, or propane end-use combustion due to end-use energy efficiency; and avoided methane emissions from agricultural manure management operations.

These categories have not changed with the exception of the original afforestation category being expanded to include reforestation, improved forest management, and avoided conversion of forest lands. Presently, due to the low demand for offset allowances within the RGGI program, no offset projects have completed the application process in any of the RGGI participating states.

DEP is investigating the process to potentially revise the end-use energy efficiency offset category to include fuel switching projects that reduce carbon dioxide emissions.

## Low Impact Development (DEP)

Low Impact Development (LID) practices are a set of site development strategies designed to mimic natural hydrologic function by reducing stormwater runoff and increasing groundwater recharge and pollutant treatment. LID practices are almost always small in scale and diffuse across a project site; they are generally surface vegetative systems that are integrated with the site development infrastructure. DEP encourages the use of LID practices on new developments.

## Comprehensive State Energy Plan (GEO, DEP)

Biennial updates of the Comprehensive State Energy Plan include strategies for: reducing oil dependence; wind energy development; and the interaction between energy planning and GHG reduction goals. DEP and the GEO work together to assemble plan updates in the areas of wind energy development and GHG reductions.

## State Energy Assurance and Emergency Management Plan (GEO)

The GEO identifies potential vulnerabilities in energy infrastructure due to a number of factors, including damage due to climatic events. The Plan documents all the agencies responsible for responding to energy emergencies, and explains each agency's role in addressing fuel supply disruptions and damage to critical infrastructure.

The GEO also works with the Efficiency Maine Trust (EMT) and the Public Utilities Commission (PUC) on programs which include climate change mitigation activities, such as renewable energy and energy efficiency projects at EMT; and the community renewable energy pilot program at the PUC. The GEO

also worked with the PUC to initiate a requirement to seek non-transmission alternatives on certain projects; and to secure long term contracts for offshore wind energy and tidal energy pilot programs.

### PUBLIC INPUT

Ideas and suggestions from the public regarding mitigation activities addressed the effects of climate change, as well as the perceived causes of climate change. Ideas and suggestions received included increasing renewable energy production, establishing and preserving wildlife migration corridors, adopting agricultural management practices more appropriate to the changing climate; proactive upgrades to critical elements of existing infrastructure; increasing the use of green-building technologies, such as green roofs and efficient insulating materials; encouraging carpooling and bicycle commuting where possible; building flood barriers to protect infrastructure; and building infrastructure needed for aquifer storage and recovery.

### RECOMMENDATIONS

The Working Group recommends that all ongoing mitigation activities be continued. The Working Group recommends that crossings identified as critical to evacuation and supply routes and vulnerable to the effects of climate change be prioritized for proactive upgrading as part of planned and future MDOT projects wherever practicable, and that MDOT identify critical infrastructure elements worthy of proactive upgrading as stand-alone projects. The Working Group recommends that MDOT and DEP continue to promote opportunities for alternative fuel vehicles especially for freight. The Working Group recommends that DEP develop additional offset categories in RGGI. The Working Group recommends that state agencies develop more awareness of opportunities to build LID or resiliency into infrastructure funding, for example, changes should be made to the State Revolving Funds for wastewater and drinking water plants.

## Messaging Activities

In order for the state's response to climate change to have any effect in the real world, it is essential that the information gathered and the tools and methods created be made available to the widest possible audience. Conversely, in order for the state to be most effective in the use of its resources, comments and suggestions from the members of the public who are most closely exposed to the effects of climate change must always be taken seriously and evaluated for potential applicability. Education and outreach programs are a critical part of any messaging effort, and the state has several such programs in place. Incorporating information into these programs about techniques and standards that address the potential effects of climate change is a very effective way to introduce new material to an existing audience that is accustomed to receiving valid information from these sources. Climate change

will affect virtually every aspect of the state's operations, and therefore information about climate change and its potential effects is relevant in virtually every educational forum.

## NATURAL ENVIRONMENT

Current messaging activities relating to the Natural Environment include:

### Keeping the Public Trust and Informing Voluntary Habitat Conservation (MDIFW)

MDIFW works with private landowners, businesses, local, state, and federal agencies, and other parties representing multiple interests on a wide variety of land and water use proposals. MDIFW works to provide fair, scientifically valid, and consistent recommendations to enable state regulatory agencies to render permitting decisions on these myriad development proposals within the parameters of various environmental laws and rules.

A small proportion of the State's species are legally designated as Endangered or Threatened, and therefore afforded special protections under the Maine Endangered Species Act and associated jurisdictional legislation (e.g., Natural Resources Protection Act, Site Location of Development Law). Some State-listed species are iconic and important to Maine's identity, including the Atlantic Puffin, Peregrine Falcon, and Bald Eagle (recently recovered and no longer listed). Other lesser known State-listed species are equally important to our natural heritage and have been identified as vulnerable to climate change, including Bicknell's Thrush, Canada Lynx, and the Katahdin Arctic Butterfly, among others. MDIFW works in a cooperative fashion to accommodate both development and the needs of sensitive fish and wildlife resources, thereby helping to maintain resilient wildlife populations in the face of an uncertain climate.

The State Wildlife Action Plan includes a strategy of "conservation of a network of connected habitats that represent areas of high diversity and large intact habitat patches" for maintaining habitat resiliency in the face of climate change. This information is provided as a valuable planning tool for municipalities and land trusts - two key Department partners that affect conservation on the ground for Maine's public trust wildlife species. As a result, Maine is better positioned to conserve sensitive habitats that are vulnerable to climate change than many other states along the eastern seaboard.

### Integrated Pest Management Program (DACF)

DACF's Integrated Pest Management (IPM) Program supports sustainable and effective ways to safeguard people, our food and fiber supply, and Maine's valuable natural resources from pests. Climate variability effects such as species range shifts, introduction of new pests, increased pest incidence, altered plant-pest interactions, and increased threats of pest-vectored diseases will continue to present new challenges. The IPM Program provides training, outreach and technical expertise to help

farmers, land managers and citizens prepare for and successfully minimize risks posed by climate change effects on pests.

Through the Maine Board of Pesticides Control, DACF works with farmers, foresters and other pest managers to obtain state-specific pesticide labels to help address new pests that have been migrating into Maine.

### Technical Guidance for Water Crossing Construction (MDOT)

MDOT provides technical guidance to entities outside of MDOT on construction of crossings and risk reduction. MDOT also takes advantage of institutional knowledge by applying lessons learned from previous projects to increase adaptive capacities in the future.

## BUILT ENVIRONMENT

Current messaging activities relating to the Built Environment include:

### Bureau of Resource Information and Land Use Planning (DACF)

The Bureau of Resource Information and Land Use Planning includes programs that provide credible scientific information to decisions regarding critical land use and resource impact issues. A good understanding of the potential effects of climate change enables staff to provide guidance to property owners and developers in the Unorganized Territories regarding appropriate construction techniques and other considerations involved in rural development projects. DACF offers frequent education and training opportunities for landowners, loggers, foresters, students, and the general public in support of all the above efforts.

### Office of Innovation and Assistance (DEP)

The Office of Innovation and Assistance provides in-person and online technical assistance in response to telephone and email requests from landowners, businesses, developers and others, including consideration of potential effects of the changing climate. The Office provides trainings for a wide sector of the regulated community including wastewater treatment plant operators, planning boards, realtors, CEO code enforcement and other audiences. Within the Office, the Nonpoint Source Training Center reaches out to contractors, landscapers, foresters and code enforcement officers to bring technical assistance, certification, and new training for erosion control practices. Over 2,600 contractors have received their erosion control certification.

The permitting and licensing programs administered by the Department also involve direct communications of technical advice regarding climate impacts and their potential effects on proposed development.

### Sustainability Division (DEP)

DEP's Sustainability Division provides a comprehensive and coordinated approach to environmental stewardship and management of the materials we utilize. The Division merges a number of existing cross-media DEP programs and strategies related to greenhouse gas and climate adaptation concerns.

The Sustainability Division manages DEP's climate change web page.

### Governor's Energy Office Policies

The GEO is very involved in information sharing and advocating for collaborative climate adaptation strategies on a regional scale. For example, the GEO led efforts to move a regional coalition to expand natural gas transmission and distribution infrastructure in Maine and New England, and the GEO has and continues to work with the NE Governor's Association on a regional energy infrastructure initiative to increase transmission for electricity generated from renewable sources, primarily from Canada.

## PUBLIC INPUT

Ideas and suggestions from the public related to messaging activities include that the state should provide a "clearinghouse" for environmental and energy concerns as they relate to climate adaptation. This should be a resource for the public to learn about information, services and capacities available through state environmental agencies and should be displayed prominently on Maine.gov. Additionally, suggestions included better cross program coordination of funding requirements that would allow more thorough and appropriate planning and a one-time solution that would address all issues during a single construction effort. The state should develop a Climate Action Plan addressing mitigation and adaptation. Members of the public also indicated that energy efficiency and conservation programs for homeowners should be well-funded and promoted.

## RECOMMENDATIONS

The Working Group recommends that all ongoing messaging activities be continued. DEP's Sustainability Division should continue to house and coordinate the state's climate change activities and keep the website updated with the ongoing work. All departments and agencies should work with infrastructure and municipal stakeholders to have consistent outreach messages. The Sustainability Division should have messaging as part of the toolkit.

# Working Group Findings and Recommendations

The Department and Agency representatives met regularly, beginning in January this year, and shared what their respective Departments were doing in the areas of ongoing projects, programs or activities which addressed or responded to observed climate-driven changes in the environment; the mapping of natural resources and related infrastructure; or the study of impacts to industry consequent of changing environmental factors.

During these meetings, and in discussions between meetings, a list of activities was compiled and reviewed by all participating Departments and Agencies. Areas of potential overlap or duplicative efforts between agencies were identified for possible consolidation of effort. Multi-Agency activities were also identified and catalogued.

The Working Group recognizes that a clear understanding of the value of identifying and addressing potential impacts of climate change, and opportunities to implement appropriate and cost-effective adaptation practices, is critical to the success of the State's efforts in this area. Without that understanding, and the commitment of the resources necessary to implement appropriate plans and practices, the State may find itself inadequately prepared for the challenges presented by the changing climate, and also may be unable to adequately support regional, county and municipal efforts in the area of climate adaptation.

In recognition of the programs and activities currently being conducted by the Departments and Office that comprise the Working Group, and in consideration of the comments, ideas and recommendations of the stakeholders and other members of the public who participated in the listening sessions or otherwise contributed their thoughts and concerns to this effort, the Working Group makes the following recommendations for approaches that should encourage improved communication and coordination of activities amongst and between agencies, as well as options for expanding state agency efforts in the area of climate change adaptation practices.

1) To strengthen the interdepartmental cooperation that the Working Group has initiated, the Working Group should continue. This would supplement discussions between and among agencies; building upon the relationships established in the Working Group, and provide a forum for discussion of shared needs related to climate adaptation activities.

   Representatives from the current member Departments and Office should participate in the continued Working Group, and develop working relationships with staff from other departments and agencies involved with climate adaptation work, which will facilitate and improve cross

agency information sharing and maximize efficiencies to the benefit of state and municipal programs.

Additionally, recognizing that the Environmental and Energy Resources Working Group was established with a selected group of Departments and Office, and given that efficient and effective implementation of climate change adaptation practices must include a more broad-based statewide approach to this issue, the Working Group recommends that the membership be expanded to include, at a minimum, the Maine Emergency Management Agency and the Maine Department of Health and Human Services.

2) The Working Group recommends that all current monitoring, mapping, modeling, mitigation, and messaging activities related to climate change adaptation be continued.

3) The Working Group recommends that DEP, DMR and DHHS work together to develop a bond proposal to provide funding for climate mitigation and adaptation projects for Wastewater, Septic, Overboard Discharge and Drinking Water infrastructure. Funding should be targeted for the Small Community Grant Program for the repair and replacement of failed septic systems; the Overboard Discharge Removal Program for residential and commercial systems; for Clean Water Matching Funds; and for Wastewater Infrastructure Grants, to provide a total of 26.9 million dollars in funding to address climate mitigation and adaptation projects in these areas.

4) The Working Group recommends that DEP and DACF work together with the Department of Economic and Community Development to develop a Beach Nourishment Program, targeting specific areas for nourishment and other forms of beach management. The program should present a systematic and planned approach that provides environmental and economic benefits for coastal communities; enhances public use and enjoyment of public beaches; protects private properties; and protects against beach erosion wherever possible.

5) The Working Group recommends that DEP, MDIFW, DACF and MEMA work together to review Debris Management Plans, focusing on provisions in existing rules and statutes that may currently impede emergency clean-up activities after damaging storm events. Recommendations for corrective actions should be presented to the Working Group by winter of 2014/2015.

6) The Working Group recommends that crossings identified as critical to evacuation and supply routes and vulnerable to the effects of climate change be prioritized for proactive upgrading as part of planned and future MDOT projects wherever practicable, and that MDOT identify critical infrastructure elements worthy of proactive upgrading as stand-alone projects.

7) The Working Group recommends that the GEO, MDOT and DEP continue to promote opportunities for alternative fuel vehicles, especially for freight. This effort should focus on

private/public partnerships to create infrastructure corridors, propane refueling locations, and/or LNG refueling locations, especially for tractor-trailer vehicles.

8) The Working Group recommends that DEP develop additional offset categories in RGGI.

9) The Working Group recommends that state agencies develop more awareness of opportunities to build LID or resiliency into infrastructure funding. For example, changes should be made to the State Revolving Funds for wastewater and drinking water plants to facilitate these strategies.

10) The Working Group recommends the state create a web-based climate adaptation resource to assist municipalities in planning for resiliency with input and advice from stakeholders and user groups. This resource should be managed by DEP's Sustainability Division.

11) DMR and DACF should form a team to establish common goals and conduct all activities related to The Northeast Regional Ocean Council (NROC) and the Northeast Regional Association of Coastal and Ocean Observing Systems (NERACOOS), to minimize any duplication of effort.

12) By June of 2015, all state facilities located adjacent to a river, stream or brook, or adjacent to the ocean, should have an appropriate stream or tide gauge installed, and tide or water level and/or flow data from the gauge recorded at appropriate intervals. Data collected should be reported to DEP on a quarterly basis for assimilation and analysis.

13) The Working Group recommends that as ongoing monitoring and mapping efforts reveal anomalous or changing circumstances regarding climate-related effects on specific resources or infrastructure elements, the data reflecting those changes should be forwarded to the Maine Office of GIS for evaluation regarding its potential for inclusion in an existing GIS map layer, or creation of a new layer. The Working Group recommends that all GIS data be coordinated through the Maine Office of GIS or the Maine Library of Geographic Information (Geolibrary) for assemblage into statewide datasets.

14) MDOT should work with MDIFW, DEP and the Maine Emergency Management Agency (MEMA) to identify critical points of vulnerability along supply and evacuation routes, where increases in runoff or changes in sea level may increase the risk of infrastructure failure, and initiate mitigation efforts to minimize those risks.

15) The Working Group recommends that LiDAR mapping coverage be expanded to include the whole state, with the results publically available. LiDAR mapping data should be updated regularly to accurately reflect local and regional changes.

16) The Working Group recommends that DMR investigate available resources for acquiring and assimilating bathymetric data for inclusion in the state's GIS database for areas near the coast as an aid to understanding potential effects of wave run-up and storm surge in sensitive areas.

17) The Working Group recommends that the multiple issues raised regarding data mapping and geographic information be considered a priority for resolution.

18) The Working Group recommends that a model be developed, as a joint effort of MDIFW, DMR, MDOT, and DEP, to predict local consequences of changes in sea level to both the natural and built environments, with the understanding that these consequences may be either detrimental or beneficial in nature.

19) The Working Group recommends investigating the possibility of developing a comprehensive water model for the state, to model the response of groundwater and aquifers as well as surface waters and stormwater flows to various changing climatic influences. This effort should be conducted jointly by the members of the Working Group as part of their ongoing mission.

20) The Working Group recommends that DEP and GEO develop a program to provide economic incentives to woodstove users to replace existing low-efficiency woodstoves with new high-efficiency units. Funding for this program should come from money generated by Maine's participation in the Regional Greenhouse Gas Initiative.

21) The Working Group recommends that DEP's Watershed Management Division should work with the Federal Environmental Protection Agency to develop standards and establish goals responsive to climate change as related to impacts on Maine's lakes and freshwater resources.

22) The Working Group recommends that existing regulations be examined for impediments to emergency and nonemergency response to the types of damage that are predicted to arise under a more energetic climate, and that any such impediments be corrected as soon as possible.

23) The Working Group recommends that DEP's Sustainability Division should develop a "clearinghouse" for environmental and energy concerns as they relate to climate adaptation. This should be a resource for the public to learn about information, services and capacities available through state environmental agencies. The clearinghouse should provide guidance for municipalities, companies and individuals to help them select the most appropriate GIS application or other tool for their situation. It should be in the form of a sortable/filterable resource guide for homeowners as well as municipal and business planners. GIS information must be kept current, in order to accurately reflect and track changes at the local level.

24) The Working Group recommends that, as part of the clearinghouse, the DEP's Sustainability Division should create a "planning tool kit" for municipal planners and developers to use in

project design. The tool kit should enable and enhance consideration of climate-related factors that may affect developments in the future. This should include tools to evaluate a range of scenarios including varying rainfall amounts, water levels and temperature ranges. The tool kit should also help users to understand the significance of differences in the results given by use of alternative parameters in multiple model runs and should be flexible to allow municipalities to design stormwater management projects based on characteristics of individual watersheds rather than a one-size-fits-all approach.

25) The Working Group recommends that DEP's Sustainability Division should continue to house and coordinate the state's climate change activities and keep the website updated to reflect ongoing work. All departments and agencies should work with infrastructure and municipal stakeholders to have consistent outreach messages. The Sustainability Division should have messaging as part of the toolkit.

26) The Working Group recommends that DEP should develop guidance for resolving the conflicts between the USGS method and the Chapter 387 method for determining base aquatic flows. State agencies should aggressively seek resolution of conflicts between state development standards and FEMA rules; conflicts between state Shoreland Zoning rules and federal wildlife/wetland protection rules; and other conflicts between state and federal requirements and standards, as they apply to climate change adaptation and mitigation projects requiring state licensing.

27) The Working Group recommends that DMR develop messaging and, if necessary, licensing programs to assist fishermen in adapting to changes in species distribution and abundance as a result of climate-induced environmental variations. Information regarding changes to fishing gear and changes to markets should be researched and made available.

28) The Working Group recommends that MDIFW develop management practices that incorporate mitigation techniques into working forest management plans to help maximize carbon uptake and to establish and maintain migration corridors.

29) The Working Group recommends that DEP revisit the rain event standards used for the design of stormwater control projects and redefine the standards in Chapter 500 to more accurately reflect the more frequent high-volume rain events associated with climate change.

30) The Working Group recommends that DEP develop application submission requirements to address sea level rise as a consideration in design and review for all projects within 250 feet of a coastal wetland, that are subject to DEP licensing under the Natural Resources Protection Act or the Site Location of Development Act.

31) The Working Group recommends that to the extent practicable, the area around privately-funded projects should be examined for opportunities to cost-effectively upgrade public

infrastructure to provide climate adaptation measures while minimizing repeat impacts due to multiple mobilizations in the same vicinity.

32) The Working Group recommends that the state should work with funding agencies to develop ways to coordinate funding and consolidate separately-funded project segments into one larger fund for a single larger project that addresses the totality of a problem, rather than having to approach a situation piecemeal.

# Appendix A

## Governor's Letter establishing the Working Group

STATE OF MAINE
OFFICE OF THE GOVERNOR
1 STATE HOUSE STATION
AUGUSTA, MAINE 04333-0001

Paul 19, LePage

GOVERNOR

5 November 2013

Patricia Aho, Commissioner
Department of Environmental Protection
17 State House Station
Augusta, ME 04333-0017

Dear Commissioner Aho:

Natural resources are the cornerstone of the economies of many of our coastal and inland communities and that changes in our climate may provide both opportunities and challenges for economic, cultural and natural resource communities.

At the same time, Maine's built environment sustains our economy by providing transportation opportunities, fishing and hunting traditions and livelihoods, clean drinking water, wastewater solutions, energy, and housing for our citizens and our businesses.

Changes in our climate raise potential vulnerabilities to our built and natural resource environment and create the need to develop and coordinate strategies that address these complex issues. These strategies must provide specific and identifiable tools to assist decision-makers.

With this in mind, I direct you to convene an "Environmental and Energy Resources Working Group" comprised of the Commissioner of the Department of Environmental Protection (DEP), the Commissioner of the Department of Transportation (MDOT), the Director of the Governor's Energy Office, the Commissioner of the Department of Marine Resources (DMR), the Commissioner of the Department of Agriculture Conservation and Forestry (DACF), and the Commissioner of Inland Fisheries and Wildlife (MDIFW), or their designee. With the Commissioner of the DEP serving as chair this group which shall undertake the following:

A) Consolidate in a white paper a complete summary of ongoing projects, programs or activities taking place within your respective Departments or Offices that address or respond to observed climate changes in the environment, mapping of natural resources or the study of impacts to industry consequent of environmental change factors;

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B) Once compiled and based on the above summary, discuss mechanisms for cross agency partnerships, information sharing, efficiencies, and streamlining that can be accomplished.

C) Convene at least two meetings during which you solicit input from stakeholder groups in the areas of engineering, water and wastewater infrastructure operations, and other natural resource industry organizations. Invite input from these stakeholders on how the Departments might create approaches to cross-cutting and multi-agency issues to ensure that unified and consistent information is available to decision-makers. Examples of such tools or strategies might include streamlined interagency review, interagency information sharing or consolidated or shared mapping capabilities;

D) Based on the above the working group will summarize the findings and recommend strategic approaches to developing tools to better collaborate among your agencies.

Thank you for your efforts in this initiative to ensure that our departments are collaborating on methods to manage the opportunities and challenges today and in the future.

Sincerely,

Paul R. LePage

Governor

Cc: Walt Whitcomb
Chandler Woodcock
Patrick Woodcock
Patrick Keliher
David Bernhardt
Tom Desjardin

# Appendix B

## Commissioner's Designees to the Working Group

Judy Camuso – Wildlife Division Director – Department of Inland Fisheries & Wildlife

Judy Gates – Director of Environmental Services – Department of Transportation

Charles Hebson – Civil Engineer III – Department of Transportation

Meredith Mendelson – Deputy Commissioner – Department of Marine Resources

Lisa Smith – Senior Planner – Governor's Energy Office

David Lavway - Deputy Commissioner – Department of Agriculture, Conservation & Forestry

Robert Marvinney – State Geologist - Department of Agriculture, Conservation & Forestry

Chris Swain – Director of the Office of Innovation – Department of Environmental Protection

George MacDonald – Director of Sustainability Division – Department of Environmental Protection