Alaska Climate Change Strategy
Natural Systems Adaptation Technical Working Group

DRAFT Catalog of Adaptations and Policy Options for Discussion on October 27-28, 2008

At its September 29, 2008, meeting, the Natural Systems Technical Working Group (TWG) agreed to develop two major sections to the Natural Systems Adaptation Catalog:

I. **Changes to Habitats and Dependent Species** – This section will summarize the expected effects of climate change on Alaska's habitats and the fish and wildlife that depend upon those habitats. It will address potential changes in:
   - Marine habitats and dependent species
   - Terrestrial habitats and dependent species
   - Freshwater habitats and dependent species *(NOTE: This sub-section pending)*

   This section will set the context for the adaptation analysis by evaluating what changes are likely to occur in Alaska's natural habitats and dependent fish and wildlife species in response to climate change. The section will (1) inform what types of human adaptation will be needed to these changes (presented in Section II, below), and (2) indicate what research and monitoring is needed related to natural systems (to be forwarded to the Research Working Group).

II. **Adaptation of Human Uses of Alaska's Natural Systems** – This section will be the "catalog" of relevant actions that the State of Alaska could take to adapt to changes in Alaska's natural systems due to climate change (informed by the summary of natural system change provided in Section I, above). It will address the following topics, for which adaptation options will be recommended:
   - Agriculture
   - Forestry
   - Wildfire
   - Invasive Species (all habitats) and Disease (plant/animal)
   - Commercial Fishing
   - Subsistence Uses
   - Sport Hunting & Fishing
   - Water Conservation and Management
   - Education & Public Outreach (note that this likely spans all TWG areas)

The following Draft Catalog will be discussed and refined by the Natural Systems TWG at its meeting in Anchorage on October 27-28, 2008. The TWG will then evaluate the various adaptation options using criteria, to identify the options that should be evaluated further and considered for recommendation as priority options to the Adaptation Advisory Group.

Section I. Changes to Alaska's Habitats and Dependent Species

MARINE ENVIRONMENT: Anticipating Climate Change in Alaska's Seas: Prospects for the 21st Century

The seas around Alaska have responded dramatically to the warming trend of the last few decades, and are now on the brink of fundamental transitions that may substantially alter their productivity. The Bering Sea and the Arctic Ocean are strongly affected by changes in ice cover, which are amplified by multiple feedbacks in the associated ecosystems. Even in the Gulf of Alaska, where sea ice is not a crucial factor, the marine ecosystem will change considerably if current warming trends continue. Like predicting the weather, forecasts of how these seas will respond is necessarily imprecise, but consensus scientific projections provide the best guidance available for evaluating and prioritizing policy alternatives for adapting to these changes. These findings are summarized here, in the hope that the context they provide will constructively inform the difficult decisions that face Alaskans as we try to cope with the changes ahead.

The following summary begins with a basic account of how sub-polar and polar marine ecosystems function, how the three major marine ecosystems around Alaska (roughly associated with the Gulf of Alaska, the Bering Sea and the Arctic Ocean) are thought to interact with the physical environment and a description of the ecosystem changes that have occurred to date. The range of likely warming trajectories is presented next, along with a sense of the reliability of these projections. Forecasts of changes in the effective sizes of these ecosystems and their biological productivity follow, together with an indication of how these ecosystems may reorganize in response. The concluding section addresses the acidifying effects of rising carbon dioxide levels in the atmosphere, and how these interact with the effects from warming.

Marine Productivity around Alaska

As on land, marine productivity is fundamentally determined by the amount of plant growth over the course of the year. Microscopic plants called phytoplankton account for nearly all of this growth in the ocean, and require light and inorganic nutrients (especially nitrogen) to flourish. Processes that affect growth are important because phytoplankton productivity sets a limit on the productivity of everything else, including economically valued resources such as fish.

Little phytoplankton productivity occurs in the winter in sub-polar and polar seas because of low light levels and because of generally stormy weather that mixes the seawater column to depths of hundreds of meters, so the plants do not spend much time exposed to what little light is available at the surface. Calmer weather, increased light and addition of fresh water from rainfall, ice melt or terrestrial runoff create a buoyant layer of water on the sea surface during spring, and phytoplankton in this layer are continuously exposed to increasing light and to relatively high nutrient levels brought to the surface by the winter mixing. These conditions trigger a period of rapid plant growth that lasts until nutrients are exhausted or light levels diminish during fall. Strong storms during spring and summer may interrupt this growth, but if followed by calm weather may increase productivity by re-supplying nutrients.

The presence of sea ice usually affects marine productivity strongly. Because sea ice reflects ~80% of the sunlight reaching it, the productivity beneath continuous ice sheets is generally quite low. But near the margins during spring productivity can be quite high. This is because the underside of the ice provides a surface for algae to grow on that is irradiated by light scattered within nearby open water, and because the melting ice adds relatively fresh water to surrounding sea surface, lowering its buoyancy.

Warming climate affects Alaskan marine productivity processes in three fundamental ways. Shrinking the size and displacing the location of seasonal sea ice is the most important effect, and may have substantial impacts in the Bering Sea and the Arctic Ocean. By increasing the buoyancy and thickness of the sea surface during spring, increased warming suppresses re-supply of nutrients from the deeper waters beneath during summer and fall. And finally, the warmer temperatures increase the phytoplankton growing season, which tends to increase annual productivity. These warming effects have markedly different consequences in the Gulf of Alaska, the Bering Sea and the Arctic Ocean.

Response to Climate Warming in Alaskan Seas

Gulf of Alaska

The Gulf of Alaska is widely suspected of providing one of the first large-scale marine ecosystem transitions in response to climate warming. Following several unusually warm and wet winters, a major "regime shift" in the organization of the marine food web occurred beginning in 1977. Over the course of this transition, the shellfish fishery crashed but the productivity of salmonids and many other finfish soared[1]. Other biological responses include a general decline in abundances of oil-rich forage fish species that prefer cold waters, and a more than doubling of the zooplankton biomass, which are small animals that graze on phytoplankton[2]. These and associated changes in sea surface temperature and other physical factors strongly suggest that the warmer temperatures increased the growing season of the phytoplankton and especially the zooplankton, which reduced the supply of un-grazed phytoplankton falling to the seafloor where it supported a food web favorable for shellfish. The increased biomass of the zooplankton sustained a different food web in the water column that is more favorable for fish. Climate-ecosystem models suggest that these changes have if anything caused modest increases in the overall biological productivity of the Gulf of Alaska[3].

Other responses to warming surface waters in the Gulf of Alaska include northward range incursions of fish that prefer warmer waters such as hake and mackerel, of invasive species and of more widespread occurrences of warmer-water fish diseases and other pests such as paralytic shellfish poisoning.

Bering Sea

The conjunction of the seasonal sea ice edge during spring with the edge of the continental shelf makes the Bering Sea one of the most productive on earth. Tidally-driven currents induce nearly continuous upwelling of nutrients along the shelf edge, and the ice provides a substrate for algae and source of meltwater that stabilizes adjacent surface waters, both of which allow plants to be well-supplied with both nutrients and light. Unfortunately this very favorable production regime is at risk. In recent decades the Bering Sea has supported enormous shellfish and finfish (mainly pollock) fisheries, the relative productivity of each being modulated by the weather during spring[4]. During cold springs, the phytoplankton bloom is closely associated with the sea ice edge, and the cooler temperatures suppress zooplankton population growth that would otherwise graze on the phytoplankton. The result is that most of the un-grazed phytoplankton production eventually sinks to the bottom, supporting a food web favorable for shellfish. During warm springs, the ice melts before the phytoplankton bloom starts, delaying the onset of the bloom until zooplankton abundances are increasing more rapidly. More of the phytoplankton production is consumed by the zooplankton, which are consumed in turn by finfish.

As in the Gulf of Alaska, the surface waters of the Bering Sea have been steadily warming over the last few decades, resulting in marked ecosystem changes. Whereas finfish have flourished, shellfish and cold water adapted forage fish have moved steadily north seeking cooler waters[5]. The edge of maximum sea ice extent has tended to move northwards as well, decreasing the coupling between the ice-melt processes during spring with the nutrient upwelling associated with the continental shelf edge. These responses have likely caused a small reduction in the overall productivity of the Bering Sea.

Arctic Ocean

The most dramatic marine ecosystem changes are underway now in the Arctic Ocean, including Alaska’s Arctic coast. In 2007 and again in 2008, the extent of seasonal ice retreat resulted in a minimum ice cap area some 40% smaller than the average from 1979 – 2000[6]. In addition, most of the ice now consists of 1-year ice (ice that is 1 year old or less), compared with predominantly multi-year ice just a decade ago, and nearly half the summertime Arctic ice cap volume has now melted[6]. These sea ice losses will likely increase the productivity of the Alaskan continental shelf in the Arctic substantially, although from such a low base it is unclear whether this will result in commercially viable fishing opportunities. Ice loss in spring and summer allows much more light to penetrate the water column. The shallow seawater depth of the continental shelf insures that phytoplankton are always illuminated, so phytoplankton growth can increase no matter how stormy the weather conditions are. However, except in the westernmost portion of Alaska’s Arctic continental shelf, most of the shelf will still likely suffer from nutrient limitation. This is because the coastal waters of Alaska’s Arctic are diluted by freshwater discharge from the Mackenzie River, which is nutrient poor. But just north of the Bering Strait lies the most productive patch of marine water anywhere on earth. This region is supplied by the nutrients upwelled from the continental shelf in the Bering Sea and carried northward by surface currents, and fuels a particularly rich benthic food web that supports walrus, gray whales and a variety of seabirds.

Future Trends

Consensus forecasts of the effects of warming trends on the seas around Alaska are based on models that couple atmospheric and oceanic processes and are driven by changes in the atmospheric concentrations of carbon dioxide and other greenhouse gases[3]. Although some members of the general public are skeptical of such models, they have found widespread acceptance within the scientific community for at least the following three reasons. First, no alternative explanation for all the myriad physical details associated with the warming trend of the last two centuries has been proposed that does not have serious defects, whereas the carbon dioxide hypothesis provides a tidy and elegant explanation of them, and has predicted specific effects that turned out to be true[7]. Second, the models based on the carbon dioxide hypothesis perform reasonably well in their ability to replicate the record of past climate observations, including the results from the geological record that extend well past the instrumental record from which the models are derived[7]. Third and perhaps most compellingly, these models have correctly forecast general climate trends with increasing precision over the last two decades, but have shown an enduring tendency to underestimate the magnitude of these trends, especially in the Arctic. Hence, to the extent skepticism is warranted, most should be in the direction of allowing for more drastic effects than these models predict.

The short-term accuracy of model-based forecasts is limited by uncertainties in the behavior of natural factors that have transient effects on climate. Foremost among these are El Niño-La niña, Pacific decadal and Arctic oscillations, sunspot activity and volcanic eruptions. For example, the last three years have been slightly cooler than the long-term warming trend because the current La niña phase brings cold water to the surface of the tropical Pacific that has a slight cooling effect on the whole planet, and because the sun is in a quiescent period of sunspot activity that temporarily diminished its output. The return of the next El Niño event will tend to warm the planet above the long-term trend. It is conceivable that the sun may remain in its quiescent phase for centuries, as occurred during the "Little Ice Age" during the Middle Ages, but this effect will be overwhelmed by about 5 years of continued increases of emissions of carbon dioxide and other greenhouse gases by humans. As for volcanoes, the particulates injected into the upper atmosphere may lead to planet wide cooling for a couple of years, but the carbon dioxide added is usually negligible in comparison with human emissions (as, for example, the 1992 Mt. Pinatubo eruption that was barely discernable in records of atmospheric carbon dioxide monitoring stations). While these natural perturbations may cause significant discrepancies from climate forecasts on time scales of a few years, they will not likely do so on time scales of decades or longer.

Applied to Alaskan seas, forecasting models based on "business as usual" emissions scenarios[3] indicate that the ecological functioning characteristic of the Gulf of Alaska will expand, whereas that of the Bering Sea will shrink. By about 2050, the subpolar ecosystem of the Gulf of Alaska and southern Bering Sea is forecast to increase modestly by ~14% in area, whereas the highly productive marginal sea ice ecosystem of the rest of the Bering Sea will shrink by ~45%. The productivity per unit seasurface area of these two regions are forecast to increase by 21% and 15% respectively, for an overall increase of total productivity of 31 – 37% in the subpolar ecosystem, but a decrease of 36 – 41% in the marginal sea ice ecosystem. Because the marginal sea ice ecosystem of the Bering Sea is so much more productive than the subpolar ecosystem of the Gulf of Alaska, these changes imply a net loss of productivity overall.

Forecasts for the Arctic Ocean are not available owing to the lack of data for the region, exacerbated by the unforeseen large sea ice losses over the last two years, but it seems likely that most of the Alaskan Arctic shelf will shift from a light- to a nutrient-limited system, with modest increases in productivity except north of the Bering Strait, where increases may be substantial.

These ecosystem changes will continue to put pressure on organisms such as shellfish dependent on food webs associated with the seafloor, and favor mid-water fishes such as pollock in the Gulf of Alaska and the Bering Sea, and Arctic cod in the Arctic Ocean. They will also put pressure on cold-adapted species such as lipid-rich forage fish, because their habitat will continue to contract both in extent and in productivity. Such declines would in turn limit populations of several species of marine mammals and birds that rely in energy-rich prey to provision their young. Ice-dependent marine mammals, including polar bears, walrus and several seal species, face substantial habitat loss as the ice disappears, making them especially vulnerable to the effects of continued warming.

The pace of these anticipated changes in Alaskan seas will be modulated by two intermediate-term climate patterns, the Pacific Decadal Oscillation (PDO) and the Arctic Oscillation (AO). The PDO refers to a distribution pattern of cool and warm surface waters in the North Pacific Ocean, and operates on a time scale of 1 – 3 decades. It has been in a warm phase for about the last 30 years, making the Gulf of Alaska stormier, warmer and wetter than usual, conditions that are conducive to high marine survival of salmon in the region. It now appears to be reverting to a cold phase, which will tend to obscure the effects of global warming in the Gulf of Alaska and the Bering Sea. Hence, sea ice loss in the Bering Sea will decelerate and winter ice cover may even increase for a few years until overwhelmed by continued global warming, but when the PDO changes again to its warm phase after a couple of decades ice loss will be rapid. The AO refers to variations in the intensity of atmospheric pressure in the Arctic basin, and operates on a time scale of several years to over a decade. During periods of low pressure such as have prevailed during the last few years, Pacific storms are brought further north making southern Alaska warmer and wetter during winter, and more warm Atlantic seawater is drawn in to the Arctic which exacerbates ice loss. During high pressure periods, winters are colder in Alaska and most of the rest of North America, and ice loss in the Arctic decelerates. The AO is expected to change from the warm phase to the cold phase sometime during the next few years, which will temporarily suppress the effects of global warming in Alaska even more. But this respite will quickly disappear when the AO reverts to the warm phase again after another few years.

Ocean Acidification

Ocean acidification refers to another consequence of adding carbon dioxide to the atmosphere that is independent of the effects on warming. Some of the carbon dioxide added from human emissions dissolves into the surface layer of the ocean where it reacts with water to form carbonic acid. Enough has dissolved since the advent of the industrial revolution to cause about a 30% increase in the acidity of the oceanic surface waters worldwide, and are projected to triple by the end of this century under "business as usual" emissions scenarios. Increases of this magnitude will likely eliminate important components of the food web in the Gulf of Alaska, threaten some cold water corals in the Bering Sea, and may adversely impact commercially and economically important shellfish such as euphausids, crabs and shrimp.

References

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6. See: http://www.nsidc.org/news/press/20081002_seaice_pressrelease.html

7. See: http://www.aip.org/history/climate/index.html

TERRESTRIAL ENVIRONMENT

The Arctic Climate Impact Assessment in 2004 (http://www.acia.uaf.edu/) reviewed effects of climate change on arctic tundra (Chapter 7) and forest (Chapter 14) biomes and selected species. It included several authors and research case studies from Alaska. A more detailed account of the status of wildlife species status in Alaska including the context of climate change was given in the Comprehensive Wildlife Conservation Strategy in 2005 (http://www.sf.adfg.state.ak.us/statewide/ngplan/NG_outline.cfm).

Recent trends in warmer and drier conditions in parts of mainland Alaska have influenced plant growth rates and the expansion of tree line and shrub line northward and to higher elevation. A continued decrease in growth rate of white spruce and Alaska paper birch coincident with warmer, drier conditions could eventually lead to possibly rapid change in species diversity (forest transition to grassland savanna) and the supply of fiber or biomass fuel. Changing bioclimate can also affect the supply of wild foods (e.g., berries) as species distributions change. Lower fitness or growth rate of trees could decrease reforestation success or prolong the harvest rotation period of wood supply.

For the short term (10-25 years), the recent trend toward warmer conditions may be moderated by a cooler phase of the Pacific Decadal Oscillation (http://kenai.fws.gov/overview/notebook/2008/august/29august2008.htm), which could moderate ecological changes or rates of change recently documented as coincident with warmer temperatures. Adaptation during this period should focus on convening scientists and resource managers to forecast changes in biomes, habitats, and species as the basis for recommending revision of resource management policy. Monitoring protocols should be established and implemented to calibrate ecological forecast models. As evidence for change becomes clearer in species distribution or the supply of food or commodities, revision of policy will become more informed. Experimentation in adaptive management (e.g., introduced trees from nearby ranges, such as lodgepole pine; conducting moose hunts during the rut to test effect on subsequent breeding success) should also begin, to understand system performance under new bioclimatic conditions.

Currently there are three projects led by U.S. Department of Interior agencies (U.S. Geological Survey and U.S. Fish and Wildlife Service) in Alaska is attempting to use prediction from global climate models to forecast changes in biome distribution and potential effects on plants and animals (e.g., creation or disruption of migration corridors or range extension pathways) over defined periods. Outcomes may be used to prioritize mitigation (e.g., transplanting of alpine-dependent species to remaining alpine areas to maintain genetic diversity) or suggest adaptive strategies (e.g., major changes in caribou migration routes may require focus on new transportation options or alternative game species by subsistence hunters). Continued warmer and drier conditions are predicted to increase the area or frequency of wildland fire, cause retreat of inland glaciers, and decrease the area of continuous and discontinuous permafrost and lakes.

FRESHWATER ENVIRONMENT

(Note: This section is pending.)

Section II. Adaptations in Human Uses of Alaska's Natural Systems

NS-1: Agriculture

SITUATION - AGRICULTURAL IMPACTS DUE TO CLIMATE CHANGE (and proposed adaptation actions)
Current impacts – increased growing degree days (gdd) (e.g., Fairbanks increased from 1,100 to over 1,250 since 1950); longer growing season for current crops (e.g., hay); introduction of new crops and fruit trees (e.g., apples, pears); changes in growing zones and hardiness zones; increase in invasive species, pests, and diseases in agriculture (e.g., potato late blight, Canada thistle, hawkweeds); less water available in certain areas of the state (e.g., interior) suitable for agriculture.
Future projections – continued increase in gdd (e.g., in Fairbanks, under high emissions scenario, gdd double by 2071); agriculture becomes possible in more northerly locations; greater increase in invasive species, pests, and diseases; more water deficits (in Fairbanks, under low emissions scenario, almost a doubling by 2071); potential for increased animal husbandry.

Option No.	Adaptation Action / Policy Option (includes regulatory and management options)	Expected Outcome(s) or Extended Actions	Parties involved in implementation	Notes/Comments	Ballot re: Priority (completed later)
NS 1.1 Ag and Food Security	TSA and other related food security issues reviewed for Alaska rural and urban communities relative to agricultural products and do the following: • Identify local supply linkages • Determine local demand issues • List out communities/issues of high critical concern	Identify likely problem areas due to increased TSA regulations due to climate change related concerns. Indentify or build local food storage areas (root cellars etc, especially in rural communities Increased awareness and listing of local suppliers of shellfish, livestock and produce Processing of local produce for long term storage Increased usage of local suppliers	State of Alaska; Alaska Municipal League; AFN, University of Alaska, Soil and Water Conservation Districts, Farm Service Agency, Farm Bureau, Master Gardeners, Alaska Shellfish Growers and others	From TWG (Technical Working Group)	

Option No.	Adaptation Action / Policy Option (includes regulatory and management options)	Expected Outcome(s) or Extended Actions	Parties involved in implementation	Notes/Comments	Ballot re: Priority (completed later)
NS 1.1 (continued)		Identification of local food supplies in home gardeners and master gardeners, storing produce. Strengthen the link between producers and consumers Strategic plan for sustainable agriculture including indigenous foods.			
NS1.2 Ag Production	Invest in the production of food and the expansion of markets for those products that can be produced economically in Alaska under conditions of longer warmer growing seasons.	This might include grants or start-up funding for garden tractors/rotor-tillers or greenhouses in rural communities that were formerly too cold for gardening; fencing or improved processing facilities for red meat production or game ranching on grasslands, tundra, or recently burned forests; improved food storage facilities; or production of weed-free seed sources for export to organic farmers in the lower 48. Building of root cellars and processing kitchens in rural communities	State of Alaska, University of Alaska, AFN, Alaska Shellfish Growers Farm Bureau and Master Gardeners, Municipalities	This is crucial to provide food security for Alaskans and to explore markets for new Alaskan agricultural products.	

Option No.	**Adaptation Action / Policy Option (includes regulatory and management options)**	**Expected Outcome(s) or Extended Actions**	**Parties involved in implementation**	**Notes/Comments**	**Ballot re: Priority (completed later)**
NS 1.3 Ag Working Lands vs. Conservation Lands	Investigate the creation of agricultural protection zones (e.g., land trusts), where tax incentives support long-term agricultural use of private lands near communities and taking into consideration the impact of Ag on sensitive conservation areas.	*There is a need to look at the affect of increased agriculture on conservation or wildlife or about trying to steer agriculture away from biologically important or sensitive areas. Mapping should be completed to identify the best new potential areas for agriculture under different climate change scenarios and mapping should also be completed to identify conservation focal areas - those areas that are most critical to protect and provide stewardship for natural resources and wildlife. If applicable, then new agricultural development could be steered away from these sensitive areas.*	State of Alaska, Local borough governments	Item suggested through public comment Additional public comment on this suggestion (from another party): *Concern that agriculture must be located in areas that are economically accessible (must consider this in siting decisions; may conflict with direction to steer away from environmentally sensitive areas). Notes also that agriculture can increase wildlife.)*	
NS 1.4 USDA/FAO	Review USDA definitions impacting Alaska Ag	Request alteration of USDA definitions of food production systems so that Alaskan agriculture (e.g., vegetables) are considered food rather than horticulture and would therefore be eligible for USDA agricultural subsidies USDA now considers aquaculture and fish farming agriculture	State of Alaska	From Ag Strategic Planning Working Group	

Option No.	Adaptation Action / Policy Option (includes regulatory and management options)	Expected Outcome(s) or Extended Actions	Parties involved in implementation	Notes/Comments	Ballot re: Priority (completed later)
NS 1.5 AK ag and University Engagement towards an International View	AK Div of Ag (ADOA) will look at the feasibility of placing Fairbanks based ADOA staff at the Cold Climate Housing Research Center (CCHRC) as per the DOT model where DOT personnel are collocated with engineering faculty and other faculty on the UAF campus. This will help jump start a broader "international" view of Alaska's Ag situation relative to climate change issues.	This would lead to an International Alaska Agriculture Commission (or expand the current Board of Ag) coordinated and staffed by ADOA, with membership including Alaska, U.S. and international experts in the cold climate agriculture and adaptations to climate change in these regions. From the standpoint of economic development, entry into foreign markets using Northwest passage, east and west. Cost of fuel.	ADOA, CCHRC, UAF, AISWG Alaska Invasive Species Working Group, Federal agencies, USDA	From Ag Strategic Planning Working Group (Note, public comment on this option: *Some products may benefit from an international focus, name seed potatoes. However, focus should be on new markets and increased market share to feed Alaskans with local foods.)*	
NS 1.6 Ag Technology Transfer	Through active research and development, apply the latest technologies to support the sustainability and expansion of agriculture in Alaska under changing climatic conditions. This would include review of laws, policies, technology and practices applied in Alaska and other regions that would contribute to future agricultural sustainability.	The expansion of Ag in Alaska will require the awareness and ability to implement the latest technology and research applicable to Alaskan Ag. The ADOA will work with the Ag industry, state and federal agencies, the UAF to ensure this process. Review Ag related tech and practices in US and other countries to see what common practices prevail and contribute to Ag sustainability.	State of Alaska, University of Alaska Cooperative Extension Service Cold Climate Housing Research Center (CES and CCHRC, Municipal Economic Dev Offices	From Ag Strategic Planning Working Group, and *public comment* Climate change will expand hardiness zones and open the opportunity for additional agriculture products. Organizations like cooperative extension service will transfer the research results on economic opportunities.	

Option No.	**Adaptation Action / Policy Option (includes regulatory and management options)**	**Expected Outcome(s) or Extended Actions**	**Parties involved in implementation**	**Notes/Comments**	**Ballot re: Priority (completed later)**
NS 1.6 (continued)		*Focus (of entities such as Plant Materials Center) should be on developing and improving food crops suitable for Alaska's climate. Examples include varieties of short-maturing grain (barley, wheat, oats), fall-planted barley able to winter over, shorter season canola and other oilseeds.*			
NS 1.7 Ag Best Practices	Incorporate Best Practices for future Alaska Ag and develop a strategic plan for Alaska Ag that looks to the next 50 years	Foster an approach for Alaska Ag that incorporates a best practices model for "future" Alaskan Ag in a changing climate environment. Expand sustainable agriculture awareness and practices ie, profit over long term, protecting land and water and people and communities.	State of Alaska, Alaska Farm Bureau, Alaska Farmers Union, NRCS, SWCD, University of Alaska	Refer also to #6	
NS 1.8 Ag legislation	Review Ag related legislation	Review Ag legislation in Alaska and in US and other countries to see what common practices prevail and contribute to Ag sustainability.	State of Alaska	Refer also to #6	

NS-2: Forestry

Option No.	Adaptation Action / Policy Option (includes regulatory and management options)	Expected Outcome(s) or Extended Actions	Parties involved in implementation	Notes/Comments	Ballot re: Priority (completed later)
NS 2.1 Use of climate-damaged forests	Invest in economic development and infrastructure to attract and build industrial capacity at appropriate scales to use insect- or fire-damaged timber.	Develop capacity to produce wood pellets, wood chips, or fuel wood from damaged timber near urban and rural communities. Provide incentives to support installation of wood heat/power systems for public buildings.	Alaska Division of Forestry	Electrical generation could be considered by stand-alone wood systems, or co-firing with coal at utilities, but this is more complex than relatively simple space heating wood systems. This will require Alaska-based training to develop technologies that are appropriate for Alaska, for example the capacity to efficiently harvest small-diameter woody biomass.	
NS 2.2 Development of wood fuels	Invest in economic development and infrastructure to attract and build industrial capacity at appropriate scales to use under-utilized and new sources of wood biomass.	Use biomass generated from hazard fuel treatment projects to reduce fire risk to communities. Use small and low quality trees from current commercial harvest operations for saw-timber logs. Use hardwood species, birch, aspen, willow that have a large under-utilized allowable cut or no current commercial use for biomass fuels. Explore alternative harvest strategies such as bringing firewood to access points that are easily accessed by the public.		Offers an element of mitigation via use of carbon neutral wood fuels, from carbon dioxide perspective. Other beneficial spin-offfs, addresses high cost of energy and economic opportunities.	

Option No.	Adaptation Action / Policy Option (includes regulatory and management options)	Expected Outcome(s) or Extended Actions	Parties involved in implementation	Notes/Comments	Ballot re: Priority (completed later)
NS 2.3 Timber harvest	Research available types of harvesting equipment for small diameter timber and biomass to facilitate acceptance and use by local commercial contractors. Demonstrate equipment; establish lease program.			Will directly support several adaptation objectives for increased use of dead or damaged timber and underutilized species in development of biomass projects.	
NS 2.4 Replace or reduce use of fossil fuels with wood biomass fuels	Invest in economic development and infrastructure to attract and build industrial capacity at appropriate scales to use under-utilized and new sources of wood biomass	Examples of extended actions: - Utilize biomass generated from hazard fuel treatment projects to reduce fire risk to communities. - Utilize small and low quality trees from current commercial harvest operations for sawtimber logs. - Utilize hardwood species, birch, aspen, willow that have a large under-utilized allowable cut or no current commercial use for biomass fuels. - Explore alternative harvest strategies such as bringing firewood to access points that are easily accessed by the public.		Would help make a variety of wood fuels available that are more economical, less-polluting and are a sustainable alternative to fossil fuels for space heating, electrical generation and liquid fuel. The first example is a result of the need to practice more aggressive fuels management in the rural and urban interface as a result of climate change and increased risk The later two examples are not directly related to climate change, but are required components to ensure sufficient wood supply Also an element of mitigation via use of carbon neutral wood fuels from CO_2 perspective. Other beneficial spin offs, addresses high cost of energy and economic opportunities.	

NS-3: Wildfire

Option No.	Adaptation Action / Policy Option (includes regulatory and management options)	Expected Outcome(s) or Extended Actions	Parties involved in implementation	Notes/Comments	Ballot re: Priority (completed later)
NS 3.1 Community Wildfire Protection Plans	Provide information and funding to enable communities to develop and implement wildfire protection plans.	Outcome – Reduced risks to life and property, and reduced health risks and economic costs related to smoke events. Spinoff benefits include habitat improvement for moose and other wildlife.	Alaska Wildland Fire Coordinating Group, Alaska Division of Forestry		
NS 3.2 North Slope Wildland Fire	Change policy for response to North Slope wildland fire in tundra areas from limited protection to full protection		State of Alaska Division of Forestry, Bureau of Land Management, Alaska Fire Service, North Slope Borough, regional communities	Historically, fire has not occurred frequently north of the Brooks Range and the tundra ecosystem is not fire dependent or perhaps even fire adapted. The Anaktuvuk Pass fire of 2007 was one of the largest and latest fire events recorded on the north slope. Research by BLM and UADF on fire intensity, history, vegetative response and CO_2 emissions may have implications for fire management policy in this region.	

Option No.	**Adaptation Action / Policy Option (includes regulatory and management options)**	**Expected Outcome(s) or Extended Actions**	**Parties involved in implementation**	**Notes/Comments**	**Ballot re: Priority (completed later)**
NS 3.3 Wildland Fire Management	Establish a task force of agency, rural, and urban community stakeholders to assess wildland fire management issues. To assess: (1) how to fund and implement changes in wildland fire management that will be required in a warmer climate, and (2) engage the public in more effective fire prevention and protection programs.	Scope: Statewide, Alaska Interagency Wildfire Management Plan and corresponding map atlas. Scope: Individual communities, local government, Community Wildfire Protection Plans (CWPPs). Scope: Individual homeowners, Firewise Program. *Readers may benefit from a footnote that explains in detail each of these plans and/or programs.* One potential policy solution would be more strategic application of wildland fire use to break up extensive areas of fire-prone black spruce forest by creating fuel breaks of less flammable early successional post-fire vegetation that connects to other natural fuel breaks such as wetlands. Another potential policy solution would be more active involvement of rural communities in deciding and implementing fire management and fuel management activities near their communities. Encourage		Alaska Wildland Fire Coordinating Group (AWFCG) may be an appropriate group to organize a task force. Stakeholders: Local governments, structure and volunteer fire departments, insurance carriers, Native organizations, various State and Federal agencies, others…. Spinoff benefits: habitat improvement for moose and other wildlife, food security via hunting, reduced CO_2 emissions from wildland fire should the treated area burn, biomass fuels from fuel management activities.	

		development of biomass heating opportunities.			
NS 3.4 Demonstration Wood Biomass	Demonstration wood biomass projects by UAF and State agencies	Outcomes - Reduced CO_2 emissions - Generation of sellable carbon credits - University and State agencies take the lead in show-casing technology to address energy and CO_2 issues	State of Alaska, Division of Forestry; other State agencies; University of Alaska	UAF has an opportunity to replace a percentage of its coal use with wood when they construct a new power plant for campus. Co-firing wood chips with coal is a feasible and acceptable practice. State agencies can demonstrate chip, pellet and other wood biomass boilers and stoves for space hearing needs in buildings.	
NS 3.5 Carbon Registry	Establish rules and process for listing forestry carbon sequestration projects in Alaska for potential purchase.	.	Board of Forestry; State agencies (DEC, DNR); Native Corporations	May have overlap with other sectors and could be combined with a larger policy effort to address this topic	
NS 3.6 Offset Carbon Credits	Provide a mechanism for aggregation of fuel offset credits from wood biomass or other alternative energy projects in order to sell credits on the CCX		State agencies (DEC, DNR, DCCED)	Small biomass heating projects will generate fuel offset credits and thus reduce CO_2 emissions. Carbon is traded in tons and minimum sale units are __ tons. The aggregator will collect offsets from a number of small projects and accumulate enough tonnage to sell. Produce revenue for project owners, school districts, local government, private entities.	

NS-4: Invasive Species					
Option No.	**Adaptation Action / Policy Option (includes regulatory and management options)**	**Expected Outcome(s) or Extended Actions**	**Parties involved in implementation**	**Notes/Comments**	**Ballot re: Priority (completed later)**
Cross Spectrum					
NS 4.1 State commitment to invasive species control	Promote active and committed involvement in invasive species issues from State agencies and employees at all levels.	Provide agencies with new and adequate funding for these efforts. Conduct training for natural resource and DOT/PF employees in recognizing invasive marine organisms, plants, insects and pathogen outbreaks.			
NS 4.2 Alaska Invasive Species Council (bill)	Support the Alaska Invasive Species Council bill about to be submitted to the Alaska legislature (spon. Rep. Craig Johnson).			Council will be a mechanism for cooperation, communication, and collaboration, and will develop a statewide strategic plan of action. State representatives will include ADF&G, DNR, DEC, DOT/PF, and University of Alaska. Council will review current funding mechanisms/ levels for state agencies to manage noxious weeds and aquatic nuisance species on lands and waters under their authority. Will establish criteria for prioritization of invasive species response actions, and must prepare an annual report to the governor and to the relevant policy committees of the Senate and House of Representatives.	

Option No.	Adaptation Action / Policy Option (includes regulatory and management options)	Expected Outcome(s) or Extended Actions	Parties involved in implementation	Notes/Comments	Ballot re: Priority (completed later)
NS 4.3 Alaska Weed & Pest Coordinator / Strategic Plan	Support Alaska Weed and Pest Coordinator Position in Alaska Division of Agriculture, and preparation of a strategic plan to address weeds and pests.			Position is responsible for coordinating State response to invasive plans in all settings and insects in agricultural settings. Need active participation of all affected state agencies (e.g., DOT/PF, DNR) in weed and pest strategic planning process. Support and advance the policy recommendations of the plan.	
NS 4.4 Coordination with Canada	Work with Canada through appropriate diplomatic channels to encourage the control and eradication of a variety of weeds, insects, aquatic nuisance species, and marine invasives (e.g. spotted knapweed, *Spartina*, green crab) in British Columbia, the Yukon, and NWT to reduce their spread towards Alaska.				

Invasive Insects and Pathogens in Shipments					
Option No.	**Adaptation Action / Policy Option (includes regulatory and management options)**	**Expected Outcome(s) or Extended Actions**	**Parties involved in implementation**	**Notes/Comments**	**Ballot re: Priority (completed later)**
NS 4.5 Quarantine inspection	Establish a dedicated plant/wood products quarantine inspector with regulatory authority.			Currently, the only plant/agricultural materials entering the state that are inspected in any way are potatoes and tomatoes. The inspection program should include all nursery materials and Christmas trees entering the state as well as inspection of wood shipping containers, pallets and wood products for exotic wood-borers.	
Invasive Plants					
NS 4.6 ADOT&PF vegetation management	Refill the integrated vegetation management position at the Alaska Dept. of Transportation and Public Facilities (vacant since Jan. 08)			Expect position to work closely with Division of Agriculture Weed and Pest Coordinator, particularly in arena of road maintenance operations.	
NS 4.7 Weed-free gravel pits	Support Alaska Division of Mining, Land and Water in developing a weed-free gravel pit certification program.			Encourage that gravel used by ADOT&PF and in other state construction projects come from certified pits only.	
NS 4.8 Noxious weed regulations	Support ADNR in developing modern and comprehensive noxious weed regulations.		State if Alaska, collaborate with APHIS and USDA	Current regulations are inadequate, serving only to limit the amount of contamination by 12 species in seed sold in state. Model legislation on that in western US.	

Option No.	Adaptation Action / Policy Option (includes regulatory and management options)	Expected Outcome(s) or Extended Actions	Parties involved in implementation	Notes/Comments	Ballot re: Priority (completed later)
NS 4.9 Cooperative Weed Management Area	Provide consistent State support for local Cooperative Weed Management Area (CWMA) efforts.	Establish small-grants program to assist in funding grass-roots, volunteer-run organizations.			
NS 4.10 UAF Invasives contol	Recognize University of Alaska Fairbanks for its Weed Task Force's management plan for significant invasive plan infestations on UAF campus.			Use these projects as a starting point from which to address and manage invasive plant infestations around all state-owned administrative sites, buildings, storage areas, parking lots and other public facilities.	
NS 4.11 Increase native plant suppliers	Encourage Alaskan agricultural producers, greenhouses and nurseries to enter the native-plants-as-revegetation-materials market.	Initiate a small grants program to support and expand such production.		Currently, there is more demand for native plan seed and containerized native plans for use in revegetation projects than can be met by the few existing growers.	
NS 4.12 Invasives eradition	Active participation by State of Alaska (Division of Ag and DOT/PF) in eradication of highly invasive plant species.		State of Alaska, in cooperation	Alaska still has the opportunity to eradicate a number of highly invasive plant species with very limited distributions in the state (e.g., garlic mustard, spotted knapweed, purple loosestrife).	
Invasive Insects and Pathogens in Forests					
NS 4.13 Forest insect EDRR	Establish a dedicated position and consistent dedicated funding to focus on forest insect EDRR (early detection, rapid response.)			Currently, there is no dedicated state funding for detection of either exotic or native-outbreaking insects in Alaska's forests.	

Option No.	Adaptation Action / Policy Option (includes regulatory and management options)	Expected Outcome(s) or Extended Actions	Parties involved in implementation	Notes/Comments	Ballot re: Priority (completed later)
NS 4.14 Forest pathogens	Establish a new position in the Division of Forestry focused on introduced forest pathogens.			There is no forest pathology expertise in the Alaska Division of Forestry or elsewhere in state government.	
Marine Invasives					
NS 4.15 Ballast water	Work with and encourage shipping industry to adopt treatment technologies now available to reduce impacts of ballast water in Alaska. Consider state regulation (such as in WA and OR) to protect Alaskan waters from ballast water release.			Has potential to transfer pathogens (e.g., Vibrio outbreak). Implications to health of shellfish industry and human health.	
NS 4.16 Tunicate/fouling organisms	Support statewide tunicate/fouling organism monitoring. Develop tunicate/fouling organisms response plan, to address potential for a highly invasive species be found in state marine waters.		State, in collaboration with Smithsonian Institution.		
NS 4.17 Green crab	Support outcomes of an ADF&G funded green crab response plan (funding already dedicated.)	Monitor green crab statewide. Work with mariculture industry to educate and monitor for occurrence. Use habitat suitability modeling to identify potential invasion hot spots.			

Option No.	Adaptation Action / Policy Option (includes regulatory and management options)	Expected Outcome(s) or Extended Actions	Parties involved in implementation	Notes/Comments	Ballot re: Priority (completed later)
NS 4.18 Atlantic salmon pathogens	Fund research to determine salmon pathogens that could be transported to Alaska by Atlantic salmon; develop an anticipatory action plan.				
NS 4.19 Spartina response plan	Support outcomes of a NMFS-funded Spartina response plan (funding already dedicated.)				
NS 4.20 Hull fouling – invasives vector	Determine if State action should be taken to address hull fouling as a vector to Alaska.			Evaluate results of research funded by Prince William Sound Regional Citizen's Advisory Council for possible followup on additional research, education or best management practices.	

NS-5: Commercial Fishing

Option No.	**Adaptation Action / Policy Option (includes regulatory and management options)**	**Expected Outcome(s) or Extended Actions**	**Parties involved in implementation**	**Notes/Comments**	**Ballot re: Priority (completed later)**
NS 5.1 NPFMC Arctic Fishery Management Plan	Support adoption & implementation of the NPFMC Arctic Fishery Management Plan; & take similar action for state waters	Adoption of a precautionary approach to establishment of new commercial fisheries in the Arctic	Coastal Arctic communities, ADF&G, AK Board of Fisheries, NMFS, & NPFMC, Fisheries enforcement officials	Need to monitor adaptively, Is enforcement capability available?	
NS 5.2 Ecosystem-based management	Adopt Ecosystem Based Management principles in fisheries management	Consideration of ecosystem impacts when making decisions on commercial fisheries; adoption of broad range of management options to respond to changing conditions	NOAA, ADF&G, UA researchers	EBM still in its infancy, need better ecosystem models. Essential to have monitoring of ocean conditions included, including ocean temp, salinity, winds, waves & currents, acidification, nutrients, contaminants.	
NS 5.3 Disease/invasives monitoring (NOTE- Put on research/monitoring list)	Develop a statewide monitoring program for diseases (and invasive species) that affect fish & shellfish, including PSP, vibrio, and Harmful Algal Blooms	Testing program, guidelines, & disease (& invasive species) monitoring & forecast program	ADEC, State public health dept., EPA, NOAA, FDA?	Research need: develop a HAB & Vibrio (& invasive species) forecasting program for AK waters.	

Option No.	**Adaptation Action / Policy Option (includes regulatory and management options)**	**Expected Outcome(s) or Extended Actions**	**Parties involved in implementation**	**Notes/Comments**	**Ballot re: Priority (completed later)**
NS 5.4 Socioeconomic impacts of changes in commercial fisheries	Provide socio-economic info to community planners on a regular basis, related to changes in commercial fisheries	Communities have the socio-economic info needed to make informed local decisions about changing commercial fisheries & its impacts on their communities (e.g., need for port expansion or relocation, loss of fishing boats and vessel rents in community, loss or increase of fisheries revenues & taxes; transfer of quotas & permits)	ADF&G, NMFS, ADCCED, UA ISER		
NS 5.5 New fishing gear	Develop new fishing gear to target new species and avoid bycatch species	Gear that can target new fisheries opportunities & reduce bycatch of non-targeted species	UAF FITC, NMFS, ADF&G, commercial fishers, other?		
NS 5.6 Preparation for new fishing opportunities	Develop new harbor capacity, improved weather & ocean condition forecasting, & more accessible & cost-effective processing & delivery options	More cost-effective & efficient fisheries, able to take advantage of new - or changing - fishing opportunities	ADOT, USACE, harbor managers, community planners, NWS,	Some fish farther away from on-shore processors, harbors, and communities, requiring further travel, need for larger vessels, and greater peril at sea	
NS 5.7 Fuel cost transition plan	Develop transition plan to assist commercial fishing industry cope w/ higher fuel costs	Adaptation plan for higher fuel costs	?	Could become more significant issue in light of efforts to limit combustion emissions	
NS 5.8 Education/outreach for new entrants into fishing	Education & outreach program for new entrants into commercial fishing industry	New entrants would have info needed to make informed decisions about future in commercial fishing	AK Sea Grant Marine Advisory Program, young fishermen		

Option No.	Adaptation Action / Policy Option (includes regulatory and management options)	Expected Outcome(s) or Extended Actions	Parties involved in implementation	Notes/Comments	Ballot re: Priority (completed later)
NS 5.9 State-federal commission	Establish a joint state-federal commission to allocate stocks of any fish species that has commercial potential in a fashion consistent with 1) international treaty obligations (e.g., salmon escapement to Canadian portions of Yukon River), 2) in-river subsistence needs, and 3) commercial demands for fish both within rivers and in oceans	State, national & international commercial & subsistence fisheries would be allocated in a comprehensive fashion	State, federal fish managers & US and Canadian State Depts.	Would require new state & federal legislation? How do existing treaties play into this?	
NS 5.10 No-Take reserves	Establish permanent no-take reserves for commercial species threatened by climate change or which have potential to develop into commercial fisheries as climate warms.	Permanent habitat protection for threatened species.	Legislation? NPFMC? State? NOAA?	Might be located adjacent to terrestrial conservation areas, due to tight linkage between terrestrial & marine ecosystems in Arctic. Too extreme an option? Promote precautionary management approaches as alternative?	
NS 5.11 Allocation policies responsive to changing conditions	Establish allocation policies that strengthen incentives to conserve viable fish stocks & promote fishing at times when weather is safe & market prices are high. Provide permits to communities that are likely to require a new subsistence resource as they lose opportunities to hunt marine mammals due to declining sea ice.				

Option No.	**Adaptation Action / Policy Option (includes regulatory and management options)**	**Expected Outcome(s) or Extended Actions**	**Parties involved in implementation**	**Notes/Comments**	**Ballot re: Priority (completed later)**
NS 5.12 Experimental fish-trap program	Initiate an experimental fish-trap program for salmon that could lead to carefully regulated harvest of high-quality wild fish near river mouths that could compete with farmed fish in terms of quality & price.				

NS-6: Fish and Wildlife Management / Subsistence

Option No.	Adaptation Action / Policy Option (includes regulatory and management options)	Expected Outcome(s) or Extended Actions	Parties involved in implementation	Notes/Comments	Ballot re: Priority (completed later)
NS 6.1 Fish and wildlife harvest regulations	Establish policies and practices, and make required changes in law, to allow for the timely and effective adjustment of state and federal fishing and hunting regulations to adapt to effects of climate change.	Establish a mechanism by which local observations of ecological change can be incorporated into promulgation of fish and wildlife management regulations. Revise state statute AS 44.62.270, which defines the situations under which "emergency" regulatory changes can be made by the Alaska Boards of Fish and Game to include "an unforeseen, unexpected weather of climate change effect that would otherwise restrict a reasonable opportunity for customary and traditional fish and wildlife uses, as defined in AS 16.05.258(1). Consider process that allows adjustments by trained wildlife biologists, rather than through Board process.	ADF&G Board of Fish Board of Game Federal Subsistence Board Federal agencies Alaska State Legislature	Important to be able to respond to a wide range of climate change effectson the use and users of fish and wildlife, such as: - need to adjust hunting seasons in response to changing migration timing or routes - respond to changes in species diversity, ranges, abundance and distribution - respond to species conversation issues - respond to hunting access and travel safety issues	
NS 6.2 Modify state subsistence law	Modify state subsistence laws so that a consistent subsistence policy and management regime can be developed on lands under state and federal jurisdiction.	Might include a combination of a state constitutional amendment providing a rural priority for customary and traditional uses in times of resources shortage and a needs-based and/or customarily and traditionally dependent-based process for providing urban Alaskan subsistence opportunities.	Alaska State Legislature		

Option No.	**Adaptation Action / Policy Option (includes regulatory and management options)**	**Expected Outcome(s) or Extended Actions**	**Parties involved in implementation**	**Notes/Comments**	**Ballot re: Priority (completed later)**
NS 6.3 Adaptive fish and wildlife management	Use adaptive management to minimize or slow loss of species, where mitigation of climate change effects is feasible.		Working group of agencies, NGOs, communities.		

NS-7: Water Conservation and Management

Option No.	Adaptation Action / Policy Option (includes regulatory and management options)	Expected Outcome(s) or Extended Actions	Parties involved in implementation	Notes/Comments	Ballot re: Priority (completed later)
NS 8.1 Instream flows	Establish policies regarding water rights, and reserve water in streams, to maintain essential fish habitat and productivity		ADFG ADNR		
NS 8.2 Community water supplies	Identify and protect watersheds needed to meet estimated future water needs of Alaskan communities		ADEC		

NS-8: Capacity-Building, Education & Outreach

Option No.	Adaptation Action / Policy Option (includes regulatory and management options)	Expected Outcome(s) or Extended Actions	Parties involved in implementation	Notes/Comments	Ballot re: Priority (completed later)
NS 8.1 Community climate change adaptation plans	Provide centralized source of information and funding for communities to apply to, to develop climate change adaptation plans that build their local capacity to respond to climate change.	Locally appropriate climate change adaptation plans that launch adaptation steps by individual communities. Information-sharing would provide mechanism for communities to learn from approaches that have proven successful in other communities.	Interagency climate change adaptation group	All Alaskan communities face climate change, but differ in the risks and opportunities that are of greatest local concern. Community adaptation plans that propose integrated solutions are most likely to meet these needs. The general goal is to build local capacity to engage in decision-making about how to adapt to climate change.	NS 6.3 Community climate change adaptation plans
NS 8.2 Climate Change Adaptation Training	Establish an Alaska Climate Change Action Center at the University of Alaska that serves to share information about climate change related expertise and user needs for this information.			There is currently no mechanism to efficiently share expertise in addressing climate change related issues between groups that have this expertise, and the businesses and agencies that need access to the expertise.	
NS 8.3 Support and coordinate existing outreach and education	Improve support for and coordination between existing programs and entities that are addressing climate change education in Alaska's schools			There are many existing programs that are addressing this issue, including University of Alaska Cooperative Extension Service, Alaska Sea Grant Marine Advisory Program, Alaska Center for Ocean Science Education Excellence, etc.	

Option No.	Adaptation Action / Policy Option (includes regulatory and management options)	Expected Outcome(s) or Extended Actions	Parties involved in implementation	Notes/Comments	Ballot re: Priority (completed later)
NS 8.4 Increase assistance to K-12 teachers	Hire a climate change specialist as a statewide resource for teachers	Possible outcomes to support teachers: Teaching material kits Curriculum modules Training workshops		By graduation, students who are ready to vote need a general understanding of climate change, so they can make informed decisions regarding related issues	
NS 8.5 Support University level	Increase support at University level for course development and delivery related to climate change				
NS 8.6 Public / adult outreach	Support and staff development of outreach materials effective with general public				
NS 9.4 Recreation and ecotourism planning	Fund information outreach to potential tourists about new opportunities associated with climate change			Build local capacity to engage in decision-making about how to manage tourism.	