

Natural Systems Technical Working Group
Recommended Adaptation Options – May 27, 2009

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Introduction

Alaskans (as well as humans across the globe) benefit from a multitude of resources and processes that are supplied by natural ecosystems. Collectively, these benefits are known as **ecosystem services** and include products like clean drinking water, timber, habitat for fisheries, and pollination of native and agricultural plants. Ecosystems provide “services” that moderate weather extremes and their impacts, mitigate drought and floods, cycle and move nutrients, maintain biodiversity, and contribute to climate stability. These services are distinct from other ecosystem products and functions because there is human demand for these natural assets. Ecosystem services can be *provisioning* such as the production of food and water; *regulating*, such as the control of climate and disease; *supporting*, such as nutrient cycles and crop pollination; *cultural*, such as spiritual and recreational benefits; and *preserving*, which includes guarding against uncertainty through the maintenance of diversity. Decisions on land use (Foley et al. 2005) and water use have important consequences on provisioning of ecosystem services for human needs.¹ (See also Daily, 1997.)²

Changing climate is having broad impacts on many ecosystems in Alaska. The potential changes to habitats within marine, freshwater, and terrestrial ecosystems and their dependent species were highlighted by the Natural Systems Technical Working Group in Section I of the *Catalog of Adaptations and Policy Options* presented to the Adaptation Advisory Group for Alaska’s Climate Change Strategy, December 17, 2008.³

Climate change could alter many essential ecosystem services that provide life requisites and cultural well being in Alaska, including clean air and water, wild foods, renewable resources, and timber and agricultural systems. The seven adaptation options recommended by the Natural Systems Technical Working Group for approval by the Adaptation Advisory Group and the Governor’s Climate Change Sub-Cabinet are intended to sustain the ecosystem services that meet society’s needs.

¹ Foley JA, R. Defries, G.P. Asner, C. Barford, G. Bonan, S.R. Carpenter, F.S. Chapin, M.T. Coe, G.C. Daily, H.K. Gibbs, J.H. Helkowski, T. Holloway, H.A. Howard, C.J. Kucharik, C. Monfreda, J.A. Patz, I.C. Prentice, N. Ramankutty, and P.K. Snyder. 2005. Global consequences of land use. *Science* 309:570-574.

² Daily, G. C. 1997. *Nature's Services: Societal Dependence on Natural Ecosystems*. Island Press, Washington.

³ www.climatechange.alaska.gov/aag/docs/AAG4a_NSTWG_DftOptnsCtlg_17dec08.pdf

NS-1 Incorporate Climate Change into Fisheries Management and Assist Fishing Communities and Users in Adaptation

Recommended Adaptation Option

The State of Alaska will take into account climate change impacts when developing fisheries policy and management options for the state's commercial, recreational, subsistence and personal use fisheries. In addition, because of its contribution to Alaska's economy and jobs, the State will develop a program to assist the commercial fishing industry, including the communities and user groups reliant on the industry, in adapting to the impacts from climate change.

Option Description

Recent scientific evidence indicates the seas and rivers in and around Alaska are responding to warming trends in the last few decades in ways that may substantially influence circulation patterns, food webs and productivity regimes. In addition, carbon dioxide from human emissions that is independent of the effects on warming is causing about a 30% increase in the acidity of the oceans worldwide, and is projected to increase substantially by the end of this century. Some of these changes could have major impacts on Alaska's bountiful fisheries with potentially different consequences in the Gulf of Alaska, the Bering Sea and the Arctic Ocean. These impacts include:

- Changes in fish distribution, abundance, catch composition, and run timing;
- The northern migration of species such as pollock (in some cases outside of U.S. waters);
- Movement of some fish farther away from on-shore processors, harbors, and communities, requiring further travel;
- The transient appearance of new species such as tuna;
- Establishment of invasive marine species (see NS-4); and
- Declines in the Bering Sea in the catch of crab, shrimp, and in some locations, halibut, with a corresponding increase in some species such as cod.

Increased ocean acidification could also result in the elimination of important components of the food web in the Gulf of Alaska, deleterious effects on cold water corals in the Bering Sea, and adverse impacts on ecologically and economically important shellfish such as krill, crabs, and shrimp.

Although scientists and managers may not know the exact cause or the precise nature of the changes currently being observed, nor those projected for the future, we do know they could have significant ecological consequences, as well as potential economic impacts on businesses, fishing reliant communities, and individual Alaskans. Some changes and impacts could be positive, others negative. There is sufficient information to begin to act in response to the changes being observed and predicted.

Alaska's system of abundance based fisheries management is designed to be broadly responsive to changing species and abundance distributions. However, climate change, ocean acidification, and other unpredictable environmental impacts are not explicitly considered in current Alaska fishery policies and management plans and practices, likely due to their uncertainty and complexity. This option would enable the State of Alaska to consider climate change impacts on species abundance and distribution when developing fisheries policy and management plans, including a continued precautionary approach to the opening and management of new fisheries, and taking climate change into account when considering the rationalization of various commercial fisheries.

It is essential that the State of Alaska and federal government coordinate closely on adaptation of fisheries management in response to climate change. The State could urge NOAA Fisheries and the North Pacific Fishery Management Council to continue to consider climate change impacts when making decisions affecting federally managed fisheries. The proposed 10-year moratorium on commercial fishing in the Arctic EEZ is one example. Because environmental impacts on commercial fisheries can be extremely difficult to predict, the success of these options would be greatly enhanced with a robust system of monitoring and stock assessment and the design of policies that are flexible enough to respond to unexpected changes in conditions.

Most fisheries-reliant communities and many components of the fishing industry itself do not have sufficient information to respond to these potential changes. They don't know how imminent those changes might be, and if they are of sufficient significance to warrant infrastructure development such as retooling of fish processing plants, the development of new harbors and industry support facilities. This option would facilitate development of a program to provide information about current and projected changes in commercial fishing due to climate change, and work with communities and the fishing industry to develop the capacity and the infrastructure needed to adapt to those changes.

The challenge will be to provide information about extremely uncertain impacts due to mechanisms we do not fully understand. A robust monitoring program covering both physical and chemical ocean conditions and biological populations would however, allow us to document the important changes in ocean and river conditions, including ocean acidification, and fish abundance and distribution that are likely by-products of climate change. As such, we could respond, even without full understanding.

Without this option, fishing-reliant communities, industries and individuals will be less certain about how to respond to current and projected environmental changes that will affect Alaska's fisheries. Fishing has always been an uncertain endeavor and history shows tremendous fluctuations in stock abundance, particularly for salmon; yet the changes we face under various projected climate change scenarios will alter the scale of past experience. To support fisheries conservation and avoid substantial economic losses, the State of Alaska must coordinate with the federal government, local communities and industry to develop and implement appropriate fisheries policy and management responses to these changing conditions.

Option Design

Structure/design: The option is divided into four major components that meet short-term, intermediate, and long-term needs.

1. The first component is a review of the State of Alaska's fishing-related statutes, policies, management actions, and programs to determine if and how climate change considerations might be included in these. This review could begin immediately and be completed within one year, with possible changes to state laws and regulations requiring additional time. It could be implemented by state agencies (including the Alaska Departments of Fish and Game, Law, Environmental Conservation, Natural Resources, and Commerce, Community and Economic Development) or by an independent commission that would include climate change experts, stakeholders (including fisheries-reliant communities and fishing industry representatives), and agency representatives.
2. The second component is a comprehensive assessment of existing habitat, fish species and stock monitoring programs to determine their current effectiveness and to recommend changes to improve the State's ability to predict and adapt to the effects of climate change on fish resources. This assessment would include an analysis of which geographic regions, habitats and species in Alaska waters are particularly sensitive or vulnerable to ocean acidification and temperature change and recommendations on potential actions to ensure their future protection. A panel of agency scientists and independent scientific experts could provide this analysis. This assessment must go hand-in-hand with development of a comprehensive long-term monitoring program that builds upon existing federal and state agency programs. Monitoring must address physical and

biological components to monitor ecosystem changes; fisheries abundance and distribution (including keeping the State’s catalog of anadromous fish streams current); monitoring of ocean, coastal and riverine habitats, including ocean currents, temperature, salinity, and acidification; and an assessment of species and habitat values and vulnerability. Associated with this is the need for monitoring of human activities, their potential effects on the ecosystem, and monitoring of community and industry socioeconomic data to track trends. Improved monitoring would provide policy and decision makers greater confidence when allocating resources and managing fisheries, by distinguishing human-caused changes due to climate change from natural variability.

3. The third component is development of a centralized source of information regarding climate projections on the fishing-dependent environment, adaptation tools, technical assistance, and support for communities and businesses to enhance their capacity to plan for and adapt to climate change. This need can be addressed through implementation of the *Alaska Climate Change Knowledge Network* that is proposed as a separate Overarching Option #1.
4. The fourth component is a long-term strategy to work with fishing-reliant communities and businesses to identify the needs for modified or new infrastructure to meet the changing needs of the industry and fishermen, including possible construction, loans, etc. These actions would depend on how short- or long-term projected changes occur and would need involvement of communities, fishing businesses, climate change scientists, and state and federal agencies. (Note: This recommendation focuses on fisheries-related infrastructure, such as ports, docks and/or processing facilities. The Public Infrastructure Technical Working Group is recommending responses to climate change impacts on a wider range of public infrastructure.)

Participants/Parties involved: Described above.

Evaluation:

- Review of existing statutes, regulations and policies will determine the efficacy of including climate change considerations and a possible framework for doing so.
- A periodic assessment of existing research and monitoring programs should occur, with identification of continuing gaps, and development of a plan for providing essential information.

Research and Data Needs:

1. Research what other countries, U.S. federal agencies and other states are doing to incorporate climate change considerations into commercial fishing policies and management. Assess what is appropriate to Alaska and North Pacific conditions. Identify inconsistencies and/or gaps in regulations, statutes and policies that affect our ability to effectively address and manage climate change impacts on natural resources. Assess policies for prioritizing survey work, and include climate change impacts as a consideration. **High Priority for near-term.**
2. Develop a comprehensive long-term monitoring program, building upon existing federal and state agency programs, and including physical and biological components, to inform the fishing community about ecosystem changes. See details under Option Design #2, above. **High Priority.**
3. Research potential impacts/ramifications of climate changes to ocean, coastal, cryosphere (sea ice and glaciers), estuarine, and freshwater ecosystems, the ecosystem services that they provide, and the wildlife, fisheries, and societal impacts of these changes. Consider developing a set of reliable physical and biological indicators of climate change and related community impacts to identify the most effective ways to implement short-, mid-, and long-term status and trend monitoring across broad areas and multiple land management units. Consider low-tech monitoring techniques to cover broad geographic regions. **Medium priority.**
4. Synthesize current information about climate change impacts on fisheries and assess its reliability and degree of uncertainty. Understand how productivity of coastal and estuarine systems may change. **Lower priority.**

5. Possible research is needed on new infrastructure to meeting engineering requirements of a changing climate. **Lower priority for commercial fishing sector.**

Implementation Mechanisms

1. The review of existing statutes, regulations, and policies could be done either by existing state staff, or by establishing an independent expert panel. Proposed changes could require legislative or regulatory changes.
2. Ensuring a robust research and monitoring program cannot be accomplished with state funds alone, and requires significant federal, university, non-governmental organizations (NGO) and other sources of funding. The state should work with these entities to develop a long-term funding approach that makes use of multiple funding sources.

Related Policies/Programs and Resources

Related Policies/Programs/Actions: Related programs include those of federal agencies such as NOAA, USGS, US Fish and Wildlife Service, National Park Service, EPA, and National Science Foundation. A state-federal integrative initiative – the Alaska Ocean Observing System – is working with stakeholder groups to assess existing monitoring needs and develop an overall approach for filling in observing gaps.

Key stakeholders include the various commercial fishing industry sectors (fishers, processing, value-added, vessel support such as harbors and pilots, etc.), coastal communities that rely on commercial fishing, relevant state and federal agencies, and others.

Available Resources: Resources currently exist, but funding is not sufficient to implement the four components of this recommendation. A new funding mechanism, such as an Ocean Trust Fund, if implemented at the federal level could be used to fund these efforts.

Feasibility

Feasibility and Constraints: The State could realistically implement these actions, although funding for a robust monitoring program would require substantial federal funding. The Alaska Ocean Observing System provides a mechanism for coordinating the various monitoring efforts.

A review of existing statutes, regulations and policies is feasible. The end result may be that existing institutions have sufficient flexibility to consider climate change impacts. However, if changes are recommended, adding the additional uncertainties of climate change could add new constraints to decision-making and raise concerns about more decisions ending up in the court system.

Adaptation Benefits and Costs

Significant documentation exists in the peer-reviewed literature to show that increased monitoring of fish and wildlife populations and habitat (including ocean conditions) leads to improved resource management. With less precise forecasts and trends, fisheries resources are either over- or under-harvested, both resulting in significant economic losses.

The Alaska Fisheries Science Center budget for federal research in Alaska is about \$40 million a year. The Alaska Department of Fish and Game's commercial fisheries budget for 2009 is about \$80 million from state, federal and other funds. Given Alaska's huge geographic scope, remoteness, and logistical challenges, these budgets could easily double in order to provide for a more robust research and monitoring program. However, given their value, in the billions, and their job creation, this investment could have huge payoffs.

TWG Approval and Deliberations

During the ranking and evaluation by TWG members, this option was the highest ranked option with no

minority views. It ranked high for all criteria, particularly significance, effectiveness and cost considerations. The TWG is in concurrence about the ranking of this option.

NS-2 Review and Modify Alaska's Wildland Fire Policies and Programs

Recommended Adaptation Option

The State will thoroughly review and modify as appropriate, Alaska's wildland fire policy and programs to address potential climate-induced increases in wildland fire frequency, size and geographic location.

Option Description

Wildland fires occur commonly throughout much of Alaska and have a wide range of effects on social, health, economic and biological conditions. Historically, about 96% of all acreage burned in Alaska occurs in the Interior portions of the state and thus most of the greenhouse gas (GHG) emissions associated with wildland fire also occur in this region.⁴ However, in recent years fire agencies have observed the occurrence of lightening caused fires in Southcentral Alaska, a relatively rare ignition source for this region, and in 2007 one of the largest fires on record in the far north occurred in the tundra region. While this is just anecdotal information, monitoring of these phenomena should occur to identify trends in location, cause and burn intensity.

This option would address these concerns through a variety of actions including changes to current policy, increased planning and education at the community and individual homeowner levels, increased active management of high-risk fuel types, and increased active management of wildland fires.

This option addresses several goals:

- Maintain a healthy ecosystem that provides habitat for a variety of species, many of which are important to subsistence life styles.
- Reduce risks to human health (respiratory) and to human improvements.
- Utilize woody material removed from fuels management activities in bioenergy applications to offset fossil fuel used in home and community heating applications.
- Minimize the emissions of GHGs in tundra ecosystems by managing the extent of severe wildland fires to retain the large stores of organic material and extensive lichen cover (food for caribou) characteristic of this ecosystem.
- Engage local communities in planning and implementation of fire management in the lands that directly affect them.

These goals will be addressed by actively managing high-risk fuel types through fuel-reduction programs for individual homes and communities, proactive management of wildland fires on adjacent lands and increased education and planning efforts. These plans are called Community Wildfire Protection Plans (CWPP), while the individual outreach would be via an education program called Firewise. The interagency community that provides wildfire protection and education services in Alaska already uses these tools, but the programs would be expanded and updated to address changing conditions, perhaps in collaboration with the proposed *Alaska Climate Change Knowledge Network*.

Additionally, the Wildland Fire Management Options that were selected for the North Slope portions of the state under the Alaska Interagency Wildland Fire Management Plan (AIWMP) will be reviewed in the context of a policy discussion on the changing role of fire in tundra ecosystems. Currently and historically, tundra fires are relatively rare events and most tundra regions are planned for a "limited" response. In layman's terms, this means no initial attack on fire starts except in very specific circumstances. Some call this the "let burn" policy, but this terminology over-simplifies the option. The

⁴ Kasischke, Williams and Barry 2002: International Journal. of Wildland Fire 11 pp. 131-144.

interagency community that manages wildland fires in Alaska uses this tool to respond to changing conditions and needs of the ecosystem and the wildlife and humans that depend on it. However, there is a need for greater involvement by the public in these basic decisions.

Option Design

Sub-Option 1: Community Wildfire Protection Plans

Structure/design: Increase the capacity of communities to initiate, complete and implement a Community Wildfire Protection Plan (CWPP). This program is already well established and has a template for developing a planning effort. Communities will need technical assistance in developing plans and maps that show fuel types and community improvements. This could be accomplished through close collaboration with the proposed *Alaska Climate Change Knowledge Network*. Once risk maps are completed, projects for treating hazard fuels can be designed and ranked.

Targets/goals:

- Complete five new CWPPs each year for the next ten years.
- Keep all current plans updated.
- Establish a statewide CWPP coordinator as part of the Division of Forestry or the Alaska Wildland Fire Coordinating Group (AWFCG).

Timing:

- Can begin immediately, but need to increase the number of plans being prepared or updated.
- Within ten years complete 50 new plans and within 20 years have plans completed for all communities with fire risk.
- Benefits will accrue indefinitely into the future so long as plans are updated and implemented.

Participants/Parties involved: Numerous individual communities and federal and state agencies involved in wildland fire management activities and national, state and local governments. Specific agencies would include: State of Alaska, DNR, Division of Forestry, ADF&G, Wildlife Conservation, Habitat Divisions, Bureau of Land Management, Alaska Fire Service, U.S. Fish and Wildlife Service, Bureau of Indian Affairs, National Park Service, and the proposed *Alaska Climate Change Knowledge Network*.

Evaluation: Periodic review of the CWPPs would be required to determine if community goals and projects are being implemented on the ground. Reviews should be made at the community level annually and a more comprehensive update made every five years if conditions warrant.

Research and Data Needs: There are no specific research needs for this sub-option but, as noted in the design section, there would be needs for data in the form of vegetation (fuel) maps that are usually compiled from satellite imagery. Ortho rectified imagery would show human improvements and culturally important areas. A vegetation base map is needed for the state. Currently this information is available for only portions of the state. In addition, fine-scale projections of future fire regime, prepared by Scenarios Network for Alaska Planning (SNAP) at the University of Alaska, would benefit communities in preparing their Community Wildfire Protection Plans.

Sub-Option 2: Policy Change (Review) to Wildland Fire Management Options Identified for Tundra Regions in the Alaska Interagency Wildland Fire Management Plan

Structure/design: Reviews of the selected wildland fire management options are part of the current process provided for in the Alaska Interagency Wildland Fire Management Plan (AIWFMP) and occur on an annual basis. The interagency community that oversees the plan would need to engage communities, landowners, and managers in a formal review process of the fire management options for the lands they manage. A discussion of the merits of higher fire protection for tundra areas would be undertaken as part

of the annual review. It may be necessary to update sections of the plan to better reflect climate-change issues and concerns as they relate to wildland fire and its management in the state.

Targets/goals:

- Complete a review of the selected wildland fire management options for tundra lands within two years to identify resources at risk (including air quality in communities) and appropriate management responses for future wildland fires.
- Identify components of a CWPP (see sub-option 1) appropriate to communities in tundra-dominated regions.
- Update plan to reflect climate-change issues and strategies as they relate to management of wildland fires.
- Reduce or avoid GHG emissions from tundra fires by setting prescriptions and carefully monitoring environmental conditions to pre-empt extreme tundra fire events, such as occurred in 2007. Plan and document these effects in ways that allow the State to claim carbon credits in the context of whatever national carbon-trading legislation is developed.

Timing:

- Begin review in 2010 and have any adjusted protection levels in place for the 2012 fire season.
- Results will accrue over time, depending on the level of success of the increased protection policy.

Participants/Parties involved: Individual land owners and managers on the North Slope of Alaska, North Slope Borough fire department and science staff, Nuniamuit corporation, possibly leaseholders such as BP and Conoco/Phillips, other native corporations and the fire management agencies, mainly the Alaska Fire Service (AFS) and the Division of Forestry. In addition, local government and researchers at the University of Alaska and other institutions and agencies should be involved in discussing the nature and feasibility of potential policy changes.

Evaluation: There should be monitoring of fire occurrence and burn intensity to calculate CO₂ emissions, on an as-needed basis, to determine if objectives and goals of the policy change are being met. Agency or university researchers could do this monitoring. Concurrent monitoring of lightning strikes and climate trends would allow inference on whether there is an increasing trend in potential area burned in tundra on the North Slope.

Research and Data Needs:

- Further work on burn severity mapping and quantification of GHG emissions from recent fires should be continued to complete work that has been initiated. Studies should look at both the long- and short-term emissions from fire in tundra and changes in the dynamics of permafrost response in boreal forest and tundra. Research on the relative contribution of GHG emissions from tundra ecosystems that are independent of fire is also needed to put fire release of GHGs in context (e.g., release of methane CH₄ from melting permafrost; it has >20 times the effect on climate warming than release of CO₂).
- Evaluate mitigation strategies for communities in tundra-dominated ecosystems to create fuel breaks at the wildland interface (e.g., gravel perimeter road around community) to reduce risk of wildland fire spreading among structures, as well as spread of fire from communities into wildlands (e.g., escaped trash fires at dumps).
- Additional research should be conducted on the impacts of fire on winter caribou range and changes in vegetation patterns and succession caused by fire.
- Modeling work to help quantify what would happen under an increased fire-protection strategy scenario and the current management action. (This could help quantify the third goal bullet

above). Modeling is also needed to assess future fire dynamics under a suite of potential future climate scenarios. Scenarios Network for Alaska Planning (SNAP) at the University of Alaska has these modeling capabilities.

Sub-Option 3: Develop a comprehensive fuels management program to treat high-risk areas to minimize negative impacts of wildland fire on humans and to increase beneficial aspects, especially wildlife habitat.

Structure/design: Examine ways to use wildland fire and mechanical fuel treatments to break up extensive areas of fire-prone black spruce forests, in part by creating fuel breaks of less flammable early successional post-fire vegetation that connect to other natural fuel breaks such as wetlands.

Targets/goals:

- Work in conjunction with CWPPs at the community level to identify fuel-reduction projects.
- Reduce GHG emissions and lessen health impacts from wildland fire events.
- In fire-dependent ecosystems, allow wildland fire to continue to play an important role in maintaining healthy ecosystems, while meeting the needs of communities that utilize these ecosystems.
- Find opportunities to actively manage wildland fires to break up and reduce high-risk forest fuels.
- Utilize woody fuels from hazard fuel treatment, if feasible, in wood biomass applications.

Timing:

- Fund and implement fuel reduction projects identified in current CWPPs from 2010 forward.
- Take advantage of wildland fire starts to remove hazard fuels during late fire season or during other strategic times during the fire season. The time frame will be variable, depending on fire season activity, but wildland fire use strategies should be considered during each fire season. Use of aerial ignition can help direct burning to the locations where fuels management is most needed, at times appropriate for the conditions.⁵

Participants/Parties involved: Primarily the wildland fire management agencies in the state: Division of Forestry, Alaska Fire Service and the U.S. Forest Service. These agencies would need to work with communities, land managers, Alaska Native Corporations and other entities to fully implement this option.

Evaluation: Utilize a statewide Fire Plan Coordinator to develop metrics to track and monitor the accomplishments of the stated strategies. Acres treated by both fire use and mechanical methods on an annual basis could be one metric. Acres of fuel types in a condition class⁶ above normal to gauge level of risk and thus risk reduction by these treatments.

Establish baseline conditions across geographic regions and track via modeling expected outcomes under different treatment scenarios.

Research and Data Needs:

- Determine if mechanical fuel treatments are achieving the desired condition class change in the fuel type.

⁵ Note: If prescribed fire is used in permafrost areas, it should be scheduled for the spring season to provide maximum protection for the permafrost layer.

⁶ There is a formal definition of "Condition Class" and its components. <http://www.nwcg.gov/teams/wfewt/message/FrccDefinitions.pdf>

Implementation Mechanisms

Sub-Option 1: Provide funding for a statewide CWPP (Community Wildfire Protection Program) coordinator as part of the Division of Forestry or the Alaska Wildland Fire Coordinating Group (AWFCG) and annual funding to complete the number of plans identified in the target and goal sections of the Option Design, above.

The CWPP coordinator would interface with communities and the interagency community to access technical and professional assistance to develop and complete new plans, maintain a database of current plans and status, assist with updates of current plans and provide overall leadership on a statewide basis to ensure the program is coordinated between agencies. No new authorities would be required. The key implementation item is funding. Without additional funds a low level program will continue where individual agencies work in a relatively uncoordinated manner with communities that fall within their jurisdictions. Plans may not follow a standard format and will be completed in an ad hoc manner based on agency funding levels and support for this program.

Sub-Option 2: Task the Alaska Fire Service (AFS) and Division of Forestry (DOF) with a comprehensive review of the current fire management options in the AIWFMP. Ensure that monitoring and research is taking place to help identify changing conditions and trends and work with UAF and other research institutions to address items identified in the research needs section of this paper. This initial review entails no additional costs.

If a more aggressive fire management option is adopted, there will be additional costs incurred for the pre-suppression budget for the AFS and DOF.

Sub-Option 3: Much of this option can be implemented by ongoing work in several agencies, notably the DOF and several Department of Interior agencies. While the state has no dedicated general fund monies directed at fuels management, funding from the federal government, mainly via the U.S. Forest Service (USFS), State & Private Forestry program has allowed communities and the DOF to undertake a number of fuel mitigation projects across the state. Funding under the American Recovery and Reinvestment Act (ARRA) of 2009 may enable additional projects to be initiated and the DOF has submitted a number of projects for consideration in the USFS competitive ARRA process. (Note, most ARRA funding is formula driven, but a competitive process allocates USFS funds.)

The U.S. Fish and Wildlife Service, Bureau of Indian Affairs, and the National Park Service have all provided some funding toward agency specific fuel mitigation projects in the past and are likely to continue this effort.

Increasingly, fire managers are moving toward a “fire is fire” concept. Management actions on a wildland fire to purposely manipulate forest fuels can reduce future protection expenditures. Directing a wildland fire with aerial ignition to achieve a fuels management objective can be a cost-effective use of resources already assigned to the fire, under the right conditions, and should not be considered an inappropriate use of suppression funds.

Projects to demonstrate the costs and potential to utilize woody biomass generated from these fuel mitigation projects are also underway, most notably in the community of Tok where a wood biomass facility will make use of material from a fuels treatment project.

Related Policies/Programs and Resources

The proposed changes are relatively modest changes that can be implemented by the Alaska Division of Forestry through its participation with the Alaska Fire Service in the AWFCG. These options would build on the basic programs and policies that are currently in place in the interagency fire management community; although sub-option 2 would require a review of current policy in regard to fire management levels in the northern portions of the state (tundra regions).

Active management of wildland fires to modify forest fuels may require discussion and agreement among agency heads that fire management is more than suppression. Managers would need to become more

proactive on wildland fires and use fire resources in new roles if they are to meet the protection needs of communities in a safe and cost effective manner.

Community Wildfire Protection Plans and the Firewise education and homeowner assistance program are well established, but not always well-funded programs.

There is work occurring on the statewide base map and National Land Cover Classification System (NLCCS) land cover mapping is available statewide at 30 meter resolution and can be accessed via mapping utility at AFS website. LANDFIRE should provide a value-added enhancement of this with finer vegetation classes and cross-walked fuel types within the year. Most of the layers are now done and being reviewed and the next version/update of the NLCCS are in progress from 2007 satellite data. Additionally, DNR and the University of Alaska are considering investment in 2.5-meter statewide satellite coverage via the Statewide Digital Mapping Initiative (SDMI). This would provide a good base map for fuels mapping and other resource management activities.

At the national level, the development of a comprehensive cap and trade policy on CO₂ could provide opportunities to market carbon credits. Revenue from these sales could offset or cover a portion of the expense associated with the implementation of sub-option 2 should a more aggressive initial attack strategy be adopted for the northern portion of the state.

Feasibility

This policy recommendation with its three sub-options is quite feasible to implement because most of the policy components are already in place. There is a need for establishment of a CWPP coordinator position and funding to ramp up completion of new CWPPs.

If a more aggressive approach is recommended for tundra fires, the methodology to provide a higher protection level is very feasible, but also dependent on funding. A more aggressive response for initial attack of fire starts would rely on aviation assets and an upgrade of the current CL-215 water scooper air tankers to CL-415 tankers. These aircraft are faster and could cover the longer distances between current home bases and fires on the North Slope. The current smoke jumper program would provide the needed ground presence to mop-up and fully contain a fire and can be expanded as needed based on fire activity via the normal resource ordering system in place nationally.

Adaptation Benefits and Costs

Benefits: There are large benefits to reducing the risk of increasing wildfire extent expected with climate warming. Increased public safety and ecological resilience are direct positive outcomes from the suite of options presented. Wildland fire is a natural process that managers can utilize as one of several strategies for reducing or minimizing CO₂ emissions by managing fuel loading, ignition timing and location of fire events.

Sub-option 2 examines the potential for preventing large releases of CO₂ in a region of the state that historically has not been prone to wildland fire occurrence. This option may be viewed as a strategic short-term (20 years) approach to preventing emissions in order to “buy time” for other adaptation or mitigation programs to mature and stabilize or reduce CO₂ levels. Over time if the fire regime is changing, it will become more difficult to minimize the impact of fire in this region. At some future point a large catastrophic event will occur similar to the 2004 and 2005 fire seasons. The challenge will be to manage fire to meet the objectives of this option while allowing the evolutionary process of the system to proceed.

Ancillary Benefits:

- Communities will have a more robust and proactive approach to fire management. Much of what we see today is reactive and can result in an inefficient use of resources
- Wildlife habitat and a variety of subsistence activities will continue to be important beneficiaries of these policies

- Potential to sell carbon credits for carbon stored in place as opposed to emitted for tundra regions
- Job training and employment for fuel mitigation crews (Type II village crews) which will enhance their employment opportunities during the regular fire season

Costs:

Sub-Option 1: Annual costs of \$100,000 per year for coordinator position and \$125,000 for five new plans per year for the next ten years.⁷

Sub-Option 2: The initial policy review entails no additional costs. If a more aggressive approach is adopted for initial attack on tundra fires, the cost would range from \$650,000 to \$2.0 million a year. The AFS currently pays \$7,800/day and \$5,000/flight hour for their CL-215 and they anticipate that their costs would double for a CL-415 platform. The first option would be to upgrade the current 90-day contract for two CL-215 aircraft to two CL-415 aircraft. (Cost of \$650,000 with \$50,000 of this cost being for extra general support costs.)

The second option would add two 90-day contracted CL-415 aircraft to the current fleet mix, thus having two CL-215 and two CL-415 aircraft in the AFS pool. (Cost of \$2.0 million with \$50,000 going to general support costs.) This would ensure availability of aircraft even during a busy fire season for use in implementing this option.⁸

Additional work on the cost effectiveness of sub-option 2 should be completed. Work on quantifying the carbon emissions from the Anaktuvuk Pass fire are in progress and it would be a straight forward process to calculate the value of CO₂ emitted and compare this figure to the prevention cost. While this would be only a snapshot of one incident, it could serve to illustrate some of the fiscal considerations and the magnitude of the monetary costs and benefits for changing response to fires in tundra regions.

Sub-Option 3: Depending on the fuel type, location and treatment method, the costs of fuel mitigation projects can vary widely. In general, the least expensive treatments use wildland fire or prescribed fire to treat large acreages, while more expensive methods involve mechanical treatments and hand crews. This last option is usually the most expensive method of treating fuels. A paper entitled “*Development of Wood Residue Markets From Fire Hazard Mitigation Projects and Analysis of Wood Residue Volume Available for Market Development*”⁹ and the companion document “*Summary of Cache Creek Hazardous Fuel Treatment Project*”¹⁰ outlines several common treatment scenarios and the associated costs. The costs discussed in these papers range from \$4,830 per acre to \$550,000 per acre.

Individual projects recommended by a community CWPP will vary significantly in cost because of the unique situations of each treatment, thus it is difficult to discuss specific project costs for sub-option 3.

TWG Approval and Deliberations

During the ranking and evaluation by TWG members, this option was the second-highest ranked option with no minority views. The option ranked particularly high in terms of feasibility, timing and adaptive capacity. The TWG is in concurrence about the ranking of this option.

⁷ Personal communication with Division of Forestry (DOF) staff and costs for individual CWPP plans from the Alaska Wildland Fire Coordination Group (AWFCG) database.

⁸ Personal communication with the Alaska Fire Service (AFS), Chip Houde, Aviation Manager.

⁹ Lee, Marc, *Development of Wood Residue Markets From Fire Hazard Mitigation Projects and Analysis of Wood Residue Volume Available for Market Development*, DOF, June 2008, pp.26.

¹⁰ Lee, Marc and Pyne, Kathryn, *Summary of Cache Creek Hazardous Fuel Treatment Project*, DOF, June 2008, pp.116.

NS-3 Address the Effects of Climate Change on Alaska's Freshwater Resources through Adaptive Management Supported by Improved Hydrologic Data

Recommended Adaptation Option

The State of Alaska will improve the capacity of its freshwater management program to adapt to the impact of climate change to meet the diverse needs for freshwater in Alaska, through: (1) advocating for and coordinating with the federal government and others to fill the substantial need for essential data on stream flow and groundwater hydrology, (2) improved coordination among water resource agencies and the public, (3) reservations of water in rivers and lakes to protect fish and wildlife habitat, and (4) adjusting laws, policies and practices as necessary. Beneficial uses of water in Alaska include those of communities, industries, transportation/utility systems, and natural ecosystems and the fish and wildlife that depend on those ecosystems. It is critical that the State's water managers have scientifically sound water information in order to apply effective water management strategies in what could be a significantly altered future environment.

Option Description

This option is designed to ensure effective adaptive management of freshwater for users in Alaska, including, but not limited to, communities, industries, transportation/utility systems (including hydroelectric/hydrokinetic projects) and ecosystems (for fish, wildlife, recreation, aesthetics and other values), in the face of changing climatic and hydrologic conditions.

Future Trends: Climate change projections suggest that surface water abundance in Alaska could become more variable and might become seasonally limiting in more areas across the state. Changes in surface water hydrology will vary by region, but substantial changes in precipitation, water storage in the soil, surface water base and peak flow rates, and runoff timing are expected to occur. As permafrost degrades in Alaska's interior and northern regions, increasingly permeable soil could cause perched lakes and other surface water sources to disappear for much of the year. Surface water quality may also be impacted, with increases in water temperature, changes in precipitation, increased runoff and erosion contributing additional sedimentation and pollutants, and potential concentration of pollutants if there are decreases in water supply. Changes in groundwater quantity and quality must also be expected.

These and other changes will pose significant challenges to Alaska's ecosystems, as well as to communities and other users who may not find suitable alternate water sources. In addition to expected changes in water quantity and quality for human use, declines in stream flow, warmer water temperatures and degradation of water quality would threaten fish and wildlife habitat, and changes in surface water flow would affect navigability of watercourses essential for rural transportation.

Issues of Concern:

- 1) **Lack of Basic Hydrologic Data:** Water resource managers must have scientifically sound hydrologic data (both surface and groundwater) to use for modeling and to make informed decisions. Collection of hydrologic data, predominantly a federal government function, has been historically under-funded in Alaska. In most parts of Alaska data are insufficient to adequately describe seasonal or long-term hydrologic characteristics or support modeling of future conditions without a large range of uncertainty.

Stream gaging of surface water flow in Alaska is woefully inadequate. Fifty or more years ago, the federal U.S. Geological Survey (USGS) established networks of stream gages throughout the western United States; they have never provided comparable coverage in Alaska, even in the most developed regions of the state. In the western Lower 48 states, there is approximately one stream gage for every

400 square miles and the density in eastern states is even higher. In Alaska, there is approximately one USGS stream gage for every 7,500 square miles.¹¹ Less than one percent of Alaska's rivers or lakes have historic flow or water-level data. Without adequate data, there can be little confidence in the hydrologic models upon which managers rely.

While in the past the USGS matched State funding 1:1 to install and operate stream gages, the agency has now significantly reduced these federal fund contributions. Data from stream gages is essential for many uses including modeling, permitting, planning, engineering designs, flood prediction and control, and water appropriations. The existing stream gaging network must be maintained and additional gages with expanded data collection capabilities (including water quality parameters) established in strategic locations, to provide Alaska with the information needed to effectively manage its water resources under changing climatic conditions.

Groundwater hydrologic data is even sparser. The USGS has one groundwater monitoring well in the entire state, in Anchorage. The state is currently unable to determine how much groundwater is available, even in regions that are of key importance to communities and to industry; it is likely that groundwater is being "mined" in key areas (that is, more groundwater consumed than replenished) and climate change may worsen that situation.

- 2) **Need for Policy-Level Emphasis and Coordination:** The Alaska Water Resources Board (authorized in 1966 by AS 46.15.190-240) has been unfunded and inactive since 1994. Since that time, the State has lacked a forum for communication and coordination between State water management agencies, and between State managers, federal agencies that have a role in hydrologic data collection and management, and the public. It is essential to reestablish this agency/public body to advise the Governor on matters related to water management. The Board can help ensure that the State adapts its water resource programs to Alaska's changing climate and environmental needs, and can also help the state combine and leverage funds and other resources.
- 3) **Need to Increase Pace of Adjudications for Instream Flow Reservations:** Alaska's policy for freshwater management must ensure that water resources are adaptively managed to retain sufficient instream flow quantity and quality to meet fish and wildlife needs. The State Department of Natural Resources (DNR) and Department of Fish and Game (ADF&G) have been working collaboratively to secure water appropriations for instream flows for major fish streams in Alaska, for streams that have adequate gaging data (at least five years). As a near-term target for adaptive water management, it would be very beneficial to increase the pace at which adjudications are completed to provide protection on the numerous fish-bearing water bodies throughout Alaska¹².
- 4) **Need to Review and Adapt Alaska's Water Management Laws, Policies and Practices:** The State of Alaska's Water Use Act (AS 46.15) and State Water Policy (Administrative Order No. 130) provide the structure for water appropriation and management in Alaska, following the prior appropriation doctrine (First in Time-First in Right). Alaska's water management statutes, regulations, policies and practices generally have the flexibility and adaptability to take into account potential impacts of a changing climate. However, as changes occur, it will be essential to review and adapt the administrative structure for water management to ensure it is responsive to changes in water resource availability, beneficial uses and demands. The Alaska Water Resources Board would serve as a coordinating body for this ongoing effort.

Recommendations to address these issues of concern are discussed in the Option Design section below.

¹¹ The best surface water hydrology data available in the State is from a gaging network on the North Slope, maintained by the University of Alaska. However, this data is not transferable to other regions.

¹² Conservatively, it has been estimated there are over 15,000 fish bearing streams and millions of fish bearing lakes in Alaska. Many water bodies have never been surveyed for fish so it is assumed that actual numbers are much higher.

Option Design

Structure/Design:

- 1) Obtain necessary data regarding surface and groundwater hydrology (through a strategic action plan that prioritizes needs) and its effect on surrounding ecosystems to improve the State’s capacity to incorporate climate scenarios into its water management risk assessments, policies and decisions.

It is recommended that the State of Alaska advocate for the USGS to retain and strategically expand the stream gaging network that exists in the state to provide the data necessary to be able to confidently model and manage Alaska’s water resources under changing climatic conditions. Ideally, effective coverage for Alaska would mean continuation of existing gaging stations, and installation and operation of approximately 400-500 additional stream gages with expanded data collection capabilities (including key water quality parameters). A network of 50-75 groundwater-monitoring wells should also be established in areas of the state where groundwater is heavily used (e.g., Anchorage, Mat Su Valley, portions of Fairbanks and Kenai).

Installation of stream gages and groundwater monitoring wells should be done strategically, with initial emphasis on areas where pressure on diminishing water resources would be felt first (e.g., population centers, areas where industrial uses are occurring or expected); secondly, in areas where changes in water volume and quality may be reaching minimum threshold levels for support of important fish and wildlife resources; and third, in consideration of improving USGS regional prediction models. Cost effectiveness and feasibility of installations must also be considered.

Implementation steps could include:

- Coordination of a round-table discussion with the many entities that have a role in water quantity and quality management, modeling and data in Alaska, including state agencies, federal agencies, the University and industry. The purpose of this discussion would be to identify existing sources of information and data gaps that should be addressed through strategic, coordinated efforts.
 - Specifically related to the stream gage network, DNR should work with the USGS, the University and other water management agencies to revisit and update the 1996 study, “Evaluation of the Streamflow-Gauging Network of Alaska in Providing Regional Streamflow Information” (USGS Water-Resources Investigations Report 96-4001). The review should also include a strategic evaluation of the need for water quality data that could be gathered at gaging locations. This would result in an updated strategic plan for allocation of financial resources to meet the most pressing surface water hydrology and water quality data needs.
 - For groundwater monitoring wells, DNR should coordinate with USGS, University and affected communities on development of a strategic plan for establishing a network of wells in areas where groundwater is, or is projected to be, heavily used.¹³
 - The State should work with Congress, the USGS and others to support and obtain additional federal funding for baseline hydrologic (including water quality) monitoring in Alaska. The State should also consider the need to increase State appropriations for cooperative funding for this essential hydrologic data collection.
- 2) Reestablish the Alaska Water Resources Board, to improve coordination regarding water management among state agencies, and between the state, other water management entities and the public. Reestablishment of the Alaska Water Resources Board would provide needed policy-level emphasis to water resource management issues and programs, including the potential need to adapt

¹³ Note that the Alaska Department of Environmental Conservation receives groundwater well logs that could possibly serve as a source of data for groundwater resources.

the water right adjudication process, and statutes and regulations related to the allocation of water and its uses.

The Board includes representation from DNR, ADF&G and the Department of Environmental Conservation (DEC), as well as seven public representatives appointed by the Governor. The Board's duties are to inform and advise the Governor on all matters relating to the use and appropriation of water in the State of Alaska, including "... studies of the state's water supplies and plans for future requirements" (AS 46.15.210(4)), which is particularly relevant to meeting the challenge of adapting to climate change.

- 3) Increase State efforts to appropriate reservations of water for fish and wildlife habitat to provide protection for fish and wildlife resources.

Alaska's freshwater resources should be managed adaptively to retain sufficient instream flow and water quality to meet fish and wildlife needs. DNR and ADF&G have been working collaboratively to secure appropriations for reservations of water for major fish-bearing streams in Alaska that have adequate gaging data (at least five years). As a specific near-term target, it would be highly beneficial to increase the pace at which adjudications are completed, particularly for the approximately 150 fish-bearing streams in Southcentral and Interior Alaska for which there are adequate data for assessment of instream flow needs and water right adjudication. There are also adjudications for instream flow for fish pending on federally managed lands in Alaska.

- 4) Continue to assess the water right adjudication process, and where necessary revise the statutes and regulations related to the allocation of water and its uses, to provide additional flexibility when needed to adapt to climate change.

DNR and the reestablished Alaska Water Resources Board should work together and with other entities to ensure that Alaska's water resource management laws, policies, and practices allow the State to adapt to the effects of climate change. Incorporating climate change considerations in water management is critical to the sustainability of Alaska's communities, industries and ecosystems. This may include using available data and assessment tools to identify areas where there is risk that future water needs will not be met, and development of long-term water management strategies for these regions, including strategies and assessments conducted at the watershed-level. (It is important, however, to note that confidence in the results of risk assessments is directly related to the availability of useful hydrologic data. For example, the Arctic Water Resources Vulnerability Index [AWRVI] is a promising tool for the North Slope of Alaska, where there is better data coverage; however, the lack of data in many other areas of Alaska would be a significant constraint to conducting risk assessments.)

Targets/goals and Timing: The goal is to provide more effective management of Alaska's water resources under changing conditions, through adaptive management supported by adequate hydrologic data and modeling.

Potential targets and timing include:

- Take immediate steps to coordinate among agencies to evaluate hydrologic data needs and gaps, and to increase the surface and groundwater hydrologic data available for Alaska, through the strategic expansion of data collection methods and sites. (Targets and accomplishments depend upon funding.)
- Reestablish the Alaska Water Resources Board within one year.
- Complete adjudication for the approximately 150 fish-bearing streams in Southcentral and Interior Alaska that have adequate flow records to reserve water for fish and wildlife, within five years of receipt of funding.

- When data permit, conduct vulnerability and risk assessments to determine areas of the State most at risk for not having water needs met (for communities, industry, transportation/utilities and/or ecosystem health).
- On-going adjustment of water management laws, policies and practices, as required to adapt to changing conditions.

Evaluation: Metrics could be established around accomplishment of specific targets, dependent on funding. DNR, in close coordination with the Alaska Water Resources Board, would be the appropriate lead for evaluation of progress.

Participants/Parties involved: DNR, ADF&G, DEC, University of Alaska, USGS, Alaska Water Resources Board, non-government organizations, local and tribal governments, industry, public

Research and Data Needs:

- As described in more detail above, gather data on hydrologic parameters (surface and ground water) throughout the state to establish baselines and support modeling, to better understand the broad range of impacts of climate change on freshwater in Alaska.
- Develop new tools to assist water managers in addressing climate change such the USGS's *StreamStats* application for assessing stream flow and basin characteristics in gaged and ungaged watersheds (see <http://water.usgs.gov/osw/streamstats/>).

Implementation Mechanisms

The primary need for implementation of these recommendations is Cabinet-level emphasis, intention, and strategic funding. No new legislative authority is required. Reestablishment of the Alaska Water Resources Board, which operated for 15 years but was disbanded in approximately 2001 due to budget considerations, is recommended. More specific implementation steps are provided in the Option Design section, above.

Related Policies/Programs and Resources

Related Policies and Programs: These recommendations build upon existing government structures for water resources management in the State of Alaska, as provided in Alaska Administrative Order No. 130 (dated July 1992), and applicable State statutes and regulations. The DNR, Division of Mining, Land and Water has the statutory responsibility, authority and expertise to manage Alaska's water resources (appropriation), in coordination with many other parties, including ADF&G, DEC, University of Alaska, USGS, Alaska Division of Ocean and Coastal Management, other federal agencies, local and tribal governments, and non-government organizations (e.g., watershed groups, conservation organizations). Alaska's Department of Environmental Conservation has responsibility for management of water quality. Federal agencies, the University and the private sector also collect hydrologic data (quantity and quality), develop and apply hydrologic models, and have other involvement in water management issues. State and federal management agencies and the University coordinate at the staff level through the Interagency Hydrology Committee for Alaska (IHCA); however, this group does not have authority to allocate resources (funding, staffing) or provide the policy-level commitment needed to implement these recommendations.

Available Resources: Funding is the key limitation to fulfilling these recommendations. Expanded collection of hydrologic data is very costly and substantial federal funding would be required. The State and the participants/parties listed above have the expertise and authority to implement the recommendations, provided funding is available for required staffing, equipment, logistics, and other costs.

Feasibility

As detailed above, the primary constraint or limiting factor to effective water management under changing conditions is the lack of sufficient surface and groundwater hydrologic data, and lack of a consistent identified federal funding source for a sufficient data collection program. There will also be a substantial delay between actions taken (establishment of a data collection network) and benefits realized (more accurate water resource modeling and more effective management), because of the time needed to accumulate a meaningful hydrologic database.

Adaptation Benefits and Costs

Benefits: The primary benefits of these recommendations will be improving the State's capacity to provide fresh water of sufficient quantity and quality for the wide range of beneficial uses, into the future. By closing existing substantial data gaps and strengthening the management structure, the State will be better prepared to develop a strategic approach to water management, assess risk of water shortage and the need for replacement sources within and between regions, avoid over-appropriation, and protect beneficial uses.

In the short-term, the State can realize benefits through increased coordination of water management issues at the policy level, coordination of effort and resources to identify and tackle data shortages and address the highest priority data gaps, and completing reservation of water appropriations for key fish bearing water bodies.

However, gains in hydrologic data and data application will be long-term, due to the expense associated with establishing the monitoring network and obtaining a sufficient time series of data

Costs: Collecting additional hydrologic data and associated water quality data is very costly, due to the need to establish, maintain and monitor many surface water gages and groundwater monitoring sites in remote sites throughout Alaska.¹⁴ Substantial federal funding would be required and data collection would undoubtedly need to be prioritized. Federal funding sources might include ARRA funding or funds appropriated to the USGS for hydrologic work in Alaska. However, continuing to delay filling this essential data need will be costly to Alaska. Costs to establish the data collection network will increase, and Alaska will be faced with high costs in the future as conflicts over limited water increase, and resource value and economic growth is negatively impacted by lack of water, ongoing conflict over appropriations, or diminished water quality. Coordination of a round-table among the government agencies, University and other entities that collect and apply hydrologic and water quality data would be a feasible, affordable and important first step in developing a strategic plan to fill essential data gaps.

Less costly implementation steps would include reestablishing the Alaska Water Resources Board (estimated cost of \$50,000/year) and providing additional staffing in DNR and ADF&G to complete the reservation of water appropriations for fish bearing systems with adequate data for adjudication (estimated cost of \$500,000/year for the next five years.)

It is expected that the federal and State government would need to help bear the costs of implementation of these recommendations, with possible participation by the private sector.

Natural Systems TWG Approval and Deliberations

During the ranking and evaluation by TWG members, this option was the ranked third with no minority views. The option ranked highest in terms of its potential significance and benefits, and implementation timing (actions could be initiated relatively quickly). The TWG is in concurrence about the ranking of this option.

¹⁴ Each stream gage site is estimated to cost \$25,000-\$40,000 per year to set up and operate, with potential additional costs for measurement of water quality parameters. Installation of a groundwater well is estimated at \$9,000 per well, with additional annual staff costs to monitor the wells.

NS-4 Reduce Introduction and Spread of Invasive Species

Recommended Adaptation Option

The State of Alaska will expand efforts to become an active partner with all levels of government and other entities in addressing the problem of invasive species in the state, primarily through establishment of the Alaska Invasive Species Council and implementation of strategic actions to prevent and control invasive and eruptive species.

Option Description

More and more non-native species are turning up in Alaska, and lengthening growing seasons and less severe winters increase their likelihood of establishing and their rate of spread. The involvement of the State of Alaska is critical to controlling the introduction and spread of invasive species, yet to date the State's participation in efforts to prevent, control and respond to invasive species has been modest. Through establishment of the Alaska Invasive Species Council and implementation of a strategic invasive species program, the State will express its commitment to prevention and control of invasive and eruptive species and will join its efforts with work already underway by federal agencies and private entities.

The combination of changing climate and increasing globalization has dramatically increased the rate of introductions of non-native, invasive species to Alaska. Invasive species threaten every Alaskan ecosystem, from near-shore marine environments to arctic tundra. Invasions by non-native species have the potential to damage important economic sectors such as fisheries and forestry, as well as to alter fire cycles and subsistence opportunities. Longer growing seasons and less severe winters increase the opportunity for non-native species to become established and spread in Alaska (e.g. the recent dramatic spread of bird vetch (*Vicia cracca*) in the Fairbanks area). Insects are expanding their ranges in the state, and in some cases exacerbating vector-borne diseases. In addition, shifts in climate have contributed to heretofore atypical but dramatic eruptions of some native species (e.g. spruce beetles in Southcentral Alaska).

Alaska still has the opportunity to prevent the myriad problems that invasive species can provoke. If allowed to become widespread, invasive species can cause gradual and irreversible degradation of entire ecosystems, with substantial negative impact to local economies. Once invasive species become widespread, the possibility and economic feasibility of controlling them declines dramatically.

This option would take advantage of the opportunity that still exists to prevent the spread of invasive species to large areas of the state. Limited state funds would be far more effectively spent on prevention than on control.

Implementation of this option would include:

- **Creation of an Alaska Invasive Species Council**, through State support for House Bill 12 “Establishing the Alaska Council on Invasive Species,” introduced January 9, 2009). State representatives to the Council will include the Alaska Departments of Fish and Game (ADF&G), Natural Resources (DNR), Environmental Conservation (DEC), Transportation and Public Facilities (DOT&PF) and University of Alaska. The Council would include nine additional members appointed by the Commissioner of ADF&G. The primary purpose of the Council will be to coordinate the State's new and pro-active involvement in invasive species issues, and provide an effective forum for the State's coordination with local, federal and tribal governments and other entities. The Council will review the current funding mechanisms and levels for State agencies to manage noxious weeds and aquatic nuisance species on the lands and waters under their authority. The Council will establish criteria for the prioritization of invasive species response actions, and prepare an annual report to the governor and to the relevant policy committees of the Senate and House of Representatives.

Under the policy and strategic direction of the Alaska Invasive Species Council and the work of staff from represented agencies, additional actions would be implemented to address Alaska's most pressing invasive species challenges, including:

- **Develop modern and comprehensive noxious weed regulations.**
- **Encourage Alaskan agricultural producers, greenhouses and nurseries to enter the native-plants-as-revegetation-materials market.**
- **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.
- **Work with shellfish mariculture industry** on education and best management practices to prevent, identify and control non-native organisms that arrive with shellfish stock.
- **Evaluate ballast water treatment technologies now available.**
- **Evaluate the impact of hull fouling on the spread of invasive marine organisms to Alaskan waters.**

This option would contribute to and build on work underway by the statewide Alaska Committee on Noxious and Invasive Plant Management (CNIPM) and by the Alaska Invasive Species Working Group (AISWG).

Option Design

Structure/design: This option allows the State of Alaska to strengthen its commitment and organize its efforts through formation of the Alaska Invasive Species Council. Through the Council, the State can join forces with already-established federal efforts (US Forest Service, National Park Service, US Fish & Wildlife Service) and public sector programs (Cooperative Weed Management Areas, Watershed Partnerships, CNIPM, AISWG) to coordinate a cross-land-ownership program on invasive species in Alaska. This proposal includes tasks that can be implemented at both small and large scales. Examples of the types of actions that could be taken are provided in this section.

Currently, invasive plant propagules are being spread unintentionally in gravel and fill material used in construction projects statewide. Yet most of the state's material sales sites (gravel pits) remain, at this point, weed-free. A gravel pit certification program would be a simple means of documenting and maintaining weed-free status for state-owned pits. The next step would be to encourage that gravel used by Alaska DOT&PF and in other state construction projects come from certified pits only.

Routine road maintenance operations of the DOT&PF also spread invasive plant propagules, rapidly and unnecessarily increasing the distribution of those species. Simple changes in the timing, methods and equipment used in these activities would eliminate this acceleration of spread.

At present, the only plant/agricultural materials entering the state that are inspected in any way are potatoes and tomatoes. Nursery starts are being shipped into Alaska from outside the state with a wide variety of noxious weed contaminants. Western tent caterpillars are routinely found pupating on ornamental trees and shrubs brought to Alaska from the lower 48. In 2007, a 747-cargo plane of Christmas trees from Oregon was flown directly to Alaska after being rejected for off-loading in Honolulu by the Hawaii Division of Agriculture. The shipment was infested with a variety of species of insects and contaminated with soil, which was then distributed around Anchorage when the plane was off-loaded with no inspection whatsoever. As Alaska's climate warms, such introductions will increasingly lead to new established populations. For some species, the consequences for Alaskan ecosystems are potentially devastating. An inspection program is needed that would include all nursery materials and Christmas trees entering the state as well as wood shipping containers, pallets and wood products for exotic wood borers.

The University of Alaska Fairbanks (UAF) has begun to develop a management plan for the significant invasive plant infestations on the UAF campus. UAF facilities services and the UAF administration should be recognized for their commitment to this effort; it should be expanded to address similar issues at the Palmer Experiment Station. The next step would be to 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.

Plant species now recognized as invasive are still being used for revegetation projects around the state, in part because commercial sources of native plant seed or starts are extremely limited. Demand for native plant revegetation materials far outstrips supply. The state could initiate a small-grants program to encourage Alaskan agricultural producers, greenhouses and nurseries to enter the native-plants-as-revegetation-materials market. A next step would be to require that construction projects on state land revegetate with native species.

The State should work with and encourage the shipping industry to adopt any of the many treatment technologies now available to reduce the impact of ballast water in Alaska offshore environments. Ballast water coming into Alaska must be tested to gauge the range and types of organisms present. Ballast water may have the ability to transfer pathogens - such as a possible *Vibrio* outbreak, and may have implications to the health of the shellfish industry and human health. The state should consider regulation such as that for Washington and Oregon to protect Alaskan waters from ballast water release.

The State of Alaska should work to develop educational outreach materials and best management practices to prevent, identify and control non-native organisms that arrive with shellfish stock. Work with the shellfish mariculture industry to educate about and monitor for green crab occurrence in State.

The State should actively support the outcomes of a National Marine Fisheries Service (NMFS) -funded *Spartina* response plan.

The State should determine if action should be taken to address hull fouling as a vector to Alaska. This would involve evaluating the results of research funded by Prince William Sound Regional Citizen's Advisory Council (PWSRCAC) for possible follow up on additional research, education, or best management practices.

Targets/goals:

- Establish the Alaska Invasive Species Council. (State support for HB 12).
- Re-fill the integrated vegetation management position at the Alaska DOT&PF (position has been vacant since January 2008).
- Establish a dedicated plant/wood products quarantine inspector in the Division of Agriculture *with regulatory authority*.
- Implement actions identified as strategic priorities by the Council, such as the actions described in the Structure/Design section, above.

Timing: The groundwork for many of the targets/goals described above has already been laid. In some cases the only ingredient missing is committed State of Alaska involvement. Thus, many of these goals can be accomplished quickly, within two to five years.

Participants/Parties involved: There are a wide variety of entities that can participate in these efforts, including public and private organizations with broad expertise in the areas discussed. A partial list would include: DNR, DOT/PF, DEC, ADF&G, Alaska Committee for Noxious and Invasive Plant Management, Alaska Invasive Species Working Group, Alaska Cooperative Extension Service, Association of Alaska Conservation Districts, U.S. Forest Service, State and Private Forestry, National Oceanic and Atmospheric Administration, US Fish and Wildlife Service, USDI National Park Service, USDI Bureau of Land Management, USDA Agricultural Research Service, Juneau Watershed

Partnership, Anchorage Cooperative Weed Management Area, Alaska Center for Coastal Studies, and Prince William Sound Regional Citizen’s Advisory Council.

Evaluation: The body charged with monitoring these efforts would be the newly formed Alaska Invasive Species Council.

Research and Data Needs: Research is needed on a variety of topics associated with invasive species in Alaska, including:

- Commercial production of native plant materials for revegetation projects,
- Appropriateness of existing ballast water technologies for Alaska,
- Spread and distribution of *Spartina*, green crab and tunicates in Alaskan coastal waters, and
- Effectiveness of new road maintenance equipment, schedules and methods in reducing the spread of invasive plant propagules.

Implementation Mechanisms

- Support the creation of the Alaska Invasive Species Council. Legislative authority for the Council is proposed in HB 12, a bill “Establishing the Alaska Council on Invasive Species,” introduced January 9, 2009.
- Through the policy and strategic direction of the Council and the work of agencies represented on the Council, implement actions targeted to address Alaska’s most pressing invasive species challenges (see Option Description, above).
- Fill necessary State agency positions to support the strategic work of the Council.

Related Policies/Programs and Resources

Several federal agencies have developed strong invasive species programs in Alaska, beginning in about 2000. Two ad-hoc groups (Alaska Committee for Noxious and Invasive Plant Management and Alaska Invasive Species Working Group) have made important advances in the development of a coordinated invasive species response system. Websites, publications, sub-committees, annual meetings, listservs, all are up and functioning well. Those groups are primarily composed of representatives of federal agencies, the University of Alaska, the Soil and Water Conservation Districts, and the Cooperative Weed Management Areas.

Involvement by representatives of the State of Alaska has been modest, perhaps with the exception of ADF&G. Because invasive species don’t respect land ownership boundaries, the State’s DOT&PF, DEC, and DNR needs to become fully involved.

Seventeen states have established invasive species councils. It has been their experience that resources are effectively combined and leveraged when decision makers come together in these councils, so much more is accomplished at less cost. The existing Alaska Invasive Species Working Group has worked hard and accomplished a lot over the past three years, but sees the establishment of a Council as essential to provide a group that can make policy decisions and more effectively involve the State agencies. This is especially important given the growing concern with invasive species in light of the changing climate in Alaska.

Feasibility

All of the proposed actions are feasible. None are very expensive. Alaska is isolated from most of the worst invasive species problems in North America. Compared to the lower 48, the Yukon and northern British Columbia are very clean. We have few points of entry; few ports and very few roads coming into the state.

Adaptation Benefits and Costs

Benefits: Alaska's intact ecosystems are its most fundamental asset. The benefits to be gained by protecting those ecosystems from invasive species cannot be overstated. In Alaska, the subsistence lifestyle, our sport and commercial fisheries, hunting, trapping, wildlife viewing, the timber industry, and much of the tourism industry are directly connected to and fully reliant upon the functioning and intact ecosystems in our state.

The advancement of invasive species into intact ecosystems can be likened to the spread of an irreversible cancer. Sometimes it happens slowly, sometimes it happens very fast. The effects are difficult to predict, but invasive and eruptive species that threaten Alaskan ecosystems are directly aided and propelled by the changing climate.¹⁵

Success in this program would have several components, all of them feasible, none of them complex or especially costly. Establishment of the Alaska Invasive Species Council would provide immediate benefit, through coordinated policy and strategic direction, and coordination and leveraging of state resources. The DNR Division of Agriculture would develop an inspection program for untreated wood products and agricultural/horticultural products entering the state. This program would have regulatory authority. State employees in a wide variety of agencies would be trained to recognize and report non-native species. State agencies would participate in coordinated planning with federal partners on rapid-response plans to non-native insect and pathogen outbreaks. State agencies would review their own operations and modify or eliminate activities that contribute to introductions and spread.

The timeframe for realizing benefits is both short- and long-term. Alaskans would realize the ultimate benefits through the continued functioning of our ecosystems: producing fish, timber, and wildlife. Key uncertainties center on predicting the impacts of, and prioritizing responses to, a wide variety of potential invaders or eruptive species. However, a sophisticated system for ranking the invasiveness of plants in Alaska has been developed and is already being widely used: (<http://www.fs.fed.us/r10/spf/fhp/invasive/invasiveness%20ranking%20report.pdf>). Similar systems are being discussed for insects, pathogens, and marine organisms.

Costs: Implementation of this option would not be high cost. Costs would be contained by: (1) acting early to prevent and control invasive and eruptive species, (2) building on existing State of Alaska staffing and programs, and (3) coordinating and leveraging resources among state agencies, federal agencies and other partners. Depending upon the exact actions taken, costs could be associated with the following elements of this recommendation:

- The ADF&G has submitted a fiscal note for \$190K to the state legislature for costs associated with establishing the Alaska Invasive Species Council. It includes salary for an Executive Director and part-time administrative assistant.
- Limited staff increases, especially a plant/wood products quarantine inspector in DNR Division of Agriculture and re-fill of the vegetation management position in DOT&PF. It is estimated that a full-time inspector position and two seasonal positions would cost approximately \$150K per year.
- Support needed research efforts to support development of policies and best management practices.
- Development and implementation of regulations and best management practices.

¹⁵ Alaska must learn from the consequences of inaction or insufficient action in other systems: kudzu and cogongrass in the American southeast, gypsy moths across the northeast, zebra mussels in the Great Lakes (and now spreading across the west), Chinese carp in the Mississippi watershed, tamarisk along water systems throughout in the southwest, leafy spurge and spotted knapweed in western rangelands, purple loosestrife in wetlands across the lower 48, the brown tree snake on Guam, the Emerald Ash Borer in the upper Midwest, rats and foxes in seabird colonies on islands in the Aleutian chain. Asian long-horned beetles, found for the first time in Worcester, Massachusetts in August, 2008, now threaten the maple trees of New England and eastern Canada.

- Possible small-grant program to encourage development of native-plants-as-revegetation-materials market.

The Council would determine the appropriate scale of the program, in keeping with the resources available.

The critical factor that will determine the likelihood of success and the cost of effective implementation is timing. Prevention is much more cost-effective and feasible than control. Alaska is in an enviable condition right now, with respect to invasive species. Compared with other states, there are relatively few non-native or erupted species in Alaska and they are not yet widespread. However, more and more non-native species are turning up each year, and it is expected the changing climate will exacerbate their spread. It would be fiscally prudent to implement these actions proactively rather than reactively.

TWG Approval and Deliberations

During the ranking and evaluation by TWG members, this option was ranked fourth, with no minority views. It ranked highest in terms of significance, timing and feasibility. The TWG is in concurrence about the ranking of this option.

NS-5 Provide for Adaptive Management of Fish and Wildlife**Recommended Adaptation Option**

The State of Alaska will improve its capability to adaptively manage fish and wildlife species harvested in Alaska to assure sustainable management of these important resources under conditions of rapid and substantial climatic change. Two specific actions are proposed to achieve this end:

- Sub-Option 1: Develop and adopt a more timely regulatory process for the harvest of game, in order to adapt and respond to short- and long-term changes in climate that can decrease harvest success under a static harvest season.
- Sub-Option 2: Develop a coordinated framework for monitoring the abundance and distribution of fish and wildlife in Alaska, to facilitate adaptation of resource development, harvesting systems, and conservation of biological diversity in response to changes caused directly or indirectly by climate change; including a system for coordinating the management, sharing and dissemination of monitoring data.

Sub-Option 1: Adopt a More Adaptive Regulatory Process for Game Harvest**Option Description**

This sub-option describes the need for a timely regulatory process for the harvest of game in Alaska, in response to short- and long-term changes in climate that can decrease harvest success under a static harvest season. Developing an option for in-season game harvest management is described below, along with challenges for its implementation. (Note that this recommendation focuses on management of game harvest, as fisheries management already provides for adaptive in-season management, as discussed further below.)

The rate of climate change in recent years is perceived to be disrupting historic patterns of movement and behavior by game animals (e.g., large forest fires, warm periods during rut) and transportation options for hunters during hunting seasons (e.g., low water depth in rivers, formation of ice that is inadequate for safe travel). There is concern by some hunters that the regulatory process for changing hunting seasons is too slow for timely adaptation to changing conditions, resulting in lower hunting success (proportion of people who harvest an animal compared to the number who attempt to harvest an animal).

The goal of this sub-option is to conduct a comprehensive review of laws, regulations, and policies on sustainable harvest of wildlife in Alaska and recommend changes that allow for more timely, coordinated, and effective adjustment of state and federal hunting regulations to allow hunters to adapt to effects of climate change. The current process of inseason management of commercial and subsistence salmon fisheries may provide a model for how this could be accomplished. A system of robust and timely stock assessments is essential to inform inseason management actions.

Hunting seasons restricted to inopportune periods may hinder harvest success of wild game as a food source, complicate care of meat in the field, force unsafe travel, or encourage illegal hunting during closed periods, especially where subsistence harvest is critical in remote communities. Requests to shift hunting seasons are occurring more frequently in certain regions (e.g., September moose hunts in western Interior), which increases workload and decreases efficiency for regulatory authorities and local advisory groups. Some rural residents perceive a lack of concern by management agencies and regulatory authorities, which hinders the cooperation necessary for effective harvest management and wildlife conservation in remote areas.

Option Design

Structure/design: Unlike some commercial and subsistence fisheries, presently it is not possible for local wildlife managers to extend hunts in-season or increase bag limits of game where appropriate. Emergency season closures do occur on some registration hunts when a general harvest quota is reached; but encourages strong competition to hunt early, when meat care may be difficult.

This sub-option recommends that a working group focused on a community or small region (as a test case) develop a proposal to the Board of Game for an in-season management option that would allow managers to avoid a hunting season in warm weather. The charge would be to design a hunting season and harvest quota system that is flexible and informed by knowledge of local conditions to allow a season extension if short-term weather hindered harvest during a general season (no restriction on access by non-local hunters) and the harvest quota for the community/region is not met. Communication and close cooperation between managers and hunters to ensure timely harvest reporting would be critical for low abundance animal populations to avoid overharvest with this approach.

Targets/goals: One goal would be a reduction in the number of proposals to the Board of Game and Federal Subsistence Board that request shifting hunting season dates later because of trends in warmer conditions during fall and early winter hunts. A second goal would be to allow hunting at times when travel is safe and meat can be preserved in good condition.

Timing: A working group could provide input through the local Fish and Game Advisory Committee (state) and Regional Advisory Council (federal) for development of a test proposal for a community or small region. Initial recommendations for changes in regulations could be completed within one year. The Alaska Board of Game and Federal Subsistence Board each convene annually but address regional issues (e.g., Southeast, Southcentral, Interior, Western/Arctic in state system) for wildlife on a two-year cycle. Thus, the entire process to put a new (flexible) regulation in place in a particular region may take up to three years.

Participants/Parties involved: Hunters, state and federal wildlife managers, Alaska Board of Game/Local Advisory Committees, Federal Subsistence Board/Regional Advisory Councils, and tribal organizations (e.g., Association of Village Council Presidents).

Evaluation: Effectiveness would be gauged as fewer proposals to shift seasons or create additional hunting seasons, community harvest needs being met (subsistence harvest monitoring), and a sustainable harvest that does not cause wildlife population declines (population monitoring, harvest reporting).

Research and Data Needs: The most common request for harvest regulation adaptation to date has been to shift moose hunting seasons later in autumn when weather is cooler (change to warmer weather in early September for parts of the Interior was documented by National Weather Service on request of Alaska Department of Fish and Game in 2008). Managers are concerned that shifting a hunt into the rut period (when bulls are preoccupied with breeding) can increase hunting success, which could be a problem in low-density populations or those with a low bull:cow ratio. Research on rutting behavior would require long-term observational studies, which would be challenging in boreal forest. A literature review about the effects of temperature on rut timing and the potential effect of allowing moose hunting during the rut on productivity of moose is warranted. It would also be instructive to understand the effect of temperature and rainfall patterns on river level for motorboat access in autumn and the effect of temperature patterns on ice formation for winter travel on both freshwater ice and sea ice. The travel relationships are complex, encompassing both natural sciences (climate, hydrology) and human behavior.

Implementation Mechanisms

Progress would occur by choosing a test case area of state where weather during hunting season has been a problem, asking for participants for a working group (one representative from each group noted in previous section), setting goals and a timeline for developing a regulatory proposal, and providing the group with the resources for meetings to occur. A local test case in the Bush where good cooperation already exists is advisable before attempting a more complex process on the road system or a process that

is regional or statewide in scope. These types of collaborative efforts to resolve hunting issues or conflicts have occurred in Alaska in the past. This test case would demonstrate the feasibility and effectiveness of providing for this type of timely and adaptive game harvest management more broadly in Alaska.

No new legislative authority would be needed to implement this option. The Alaska Board of Game sets hunting regulations for all lands statewide, and these regulations apply for all hunts on state and private lands (including Alaska Native allotments and Native corporation lands). The Federal Subsistence Board may separately set hunting regulations on some federal lands to ensure subsistence needs of federally-qualified rural residents are met, which may result in a priority for rural residents at times when sustainable harvest is less than demand by all hunters.

There would need to be a mechanism for resolution of state and federal harvest management in times of perceived game shortage in rural areas, when a subsistence priority could be given to rural residents on federal lands (see Feasibility section below).

Related Policies/Programs/Actions: There are good examples of consensus-based stakeholder groups to address hunting issues (Western Arctic Caribou Working Group) and fishing issues (Yukon River Drainage Fisheries Association) in Alaska.

Available Resources: Travel funding would be required for a working group to convene two to three times over several months to one year to draft a proposal (federal partners may be able to assist with funding). Depending on the schedule, additional travel funding may be needed for the rural Fish and Game Advisory Committee because some committees have funding only for one meeting per year. The working group would submit a proposal to the Board of Game at the next available cycle.

If the Board of Game adopted a quota system, it may require extra resources for ADF&G staff to travel to communities that do not have a license vendor so hunting licenses and harvest reporting information can be issued to hunters. Timely reporting would require hunters to provide ADF&G with harvest data by phone or email within a short period after harvest (e.g., three days) so a manager could estimate if a season extension is advisable.

Feasibility

The Alaska National Interest Lands Conservation Act of 1980 (ANILCA) required a subsistence hunting and fishing preference for rural residents of Alaska on federal lands, which compose 60% of the state. In the 1989 McDowell decision, the Alaska Supreme Court upheld the common use clause in the Alaska Constitution that provides for access to game by all Alaska residents. Since 1990, dual regulations for hunting and fishing have existed on most federal lands in Alaska (determined by Title VIII of ANILCA). While amending ANILCA or the State Constitution is problematic, it would be feasible to adopt a State regulation allowing manager discretion to extend season length for harvest up to a sustainable quota that meets subsistence harvest needs for a rural community or communities; this would eliminate the need for additional hunts on federal lands. Regulations that are simpler, apply to all land ownership, and are consistent over time are more likely to be understood and embraced.

Participating hunters will have to be convinced of the value of harvest reporting as a benefit to meeting their subsistence needs, because law enforcement alone is unlikely to be an effective means of change. Some people prefer cow moose (often more fat than bulls) or hunting in winter (additional season), when options exist for overland travel by snow machine and easier meat care. Some requests to adjust timing of harvest seasons may occur in areas where harvest is already managed to the sustainable limit (e.g., harvest in warm weather is more difficult but the quota is already being met). In that instance, shifting a State moose-hunting season open to all residents and possibly even non-residents from early September to late September or early October (during the active rut, when bull moose are more vulnerable) may increase harvest success to beyond sustainable yield. Allowing a winter hunt for bulls on federal lands (particularly after bulls have begun to drop their antlers) may increase the harvest of cows. This is a particular problem in low-density moose populations, which are common in predation-limited systems of

the boreal forest in rural Alaska. Coordination of state seasons and federal subsistence seasons is critical to prevent overharvest, particularly of cow moose during winter hunts.

Adaptation Benefits and Costs

Regulatory proposals to state and federal boards for fish and game management often create substantial workload for agency staff and boards, so success would be commonplace options for in-season management that would reduce the number of regulatory proposals. Better coordination of state and federal regulatory processes for fish and game management should also reduce duplication of efforts. An ancillary benefit may be to reduce the tendency for conflict between user groups and management agencies that having dual regulations for federal lands or waters can bring. The need for coordination is not unique to climate-driven issues, but concerns over climate change may serve as the catalyst for innovation, particularly in game management. The time frame for local case studies (if successful) to spread to larger regions or statewide is unknown because of the increasing complexity of dealing with resource allocation closer to the road system (high access potential for harvesters). Whether this approach could be applied successfully statewide is unknown.

Data collection to assess fish stocks or game populations in the short term is on going, regardless of climate change. The travel and staffing costs to implement a local case study over one year with a working group in a rural area (outlined above) would be small in comparison to the public process for a complex issue that includes a large number of stakeholders from a much larger geographic region. A large or complex process would also likely require additional planning and support staff in agencies.

Sub-Option 2: Develop a Coordinated Monitoring Framework for Fish and Wildlife to Facilitate Adaptive Management

Option Description

Changing climate is expected to continue influencing the distribution and possibly the quality of habitat for fish and wildlife in Alaska, which may cause declines in some native species and increases in other species. Important distributional changes in stocks may occur for some marine and freshwater fish species.

The goal of this sub-option is to coordinate efforts to monitor fish and wildlife species or stock abundance changes, evaluate the risk of species loss or decreased genetic diversity, and ensure that information and tools are in place for adaptive management to be implemented where feasible and warranted. Developing and using a coordinated system for managing, sharing and disseminating monitoring data is a key part of this recommendation. Through coordination, agencies could combine efforts and leverage funding to document changes sooner and make adaptive management possible. Adaptive management could include changing harvest patterns or taking steps to restore populations if adequate habitat remains. Note that under the Waxman-Markey bill pending in the U.S. Congress, it may be necessary for the state to revise its *Alaska Wildlife Comprehensive Conservation Strategy* to include adaptation measures for climate change.

A decline or change in distribution of harvested species or stocks could have important economic impacts on local communities that rely heavily on commercial fishing. These changes may also have implications for food supplies, particularly for remote communities as the cost of transportation fuel increases. Climate change may also threaten populations of non-game species, leading to potential biodiversity loss or restrictions on uses of lands for some purposes. Indirectly, change in location of major vegetation types has implications for wildland fire regimes, which is the primary agent of habitat enhancement for game in boreal forest. Climatic changes may also accelerate loss or fragmentation of rare habitats (e.g., alpine in Yukon Tanana uplands) important to some endemic species (e.g., Alaska marmot). Changes in near-shore marine circulation patterns may alter food webs or migratory pathways for fish, and changes in freshwater flow and temperature regimes may impact salmon spawning habitat and juvenile survival.

Option Design

This sub-option recommends that the agencies and other entities that monitor fish and wildlife species abundance and distribution in Alaska develop a coordinated framework that documents existing monitoring efforts, identifies priorities for monitoring in the context of climate change, and identifies gaps and potential for collaboration. The option would also include development and use of a common structure for cataloging and disseminating monitoring information, perhaps through collaboration with the proposed *Alaska Climate Change Knowledge Network* (See additional detail in Implementation Mechanisms, below.)

Targets/goals: The initial target would be completing a coordinated framework for monitoring efforts for fish and wildlife. Quantitative targets or goals would need to be developed by participants once a review of the existing efforts is assembled in a single framework. Existing escapement goals for salmon species and stocks can be used to evaluate potential impacts of climate change on abundance, productivity, and distribution.

Timing: Various levels of collaboration on monitoring biological diversity for scientific and conservation purposes has occurred in the past. It should not be a lengthy process for a comprehensive participant group to meet to develop a monitoring framework and protocols for coordination and sharing of monitoring data.

Participants/Parties involved: State and federal management agencies, University of Alaska, tribal organizations, non-government organizations, citizen science efforts, and private business (e.g., oil companies).

Evaluation: Increased efficiency in obtaining fish and wildlife monitoring information at a single source, particularly as large development projects are undertaken (oil or gas pipelines, railroads, roads for resource extraction) that require comprehensive environmental studies.

Research and Data Needs: Once a review of the existing efforts has occurred, participants could identify gaps in knowledge, prioritize inventory and monitoring needs, and suggest protocols.

Implementation Mechanisms

Sub-option 2 would initially be implemented through meeting(s) of State and federal agencies, the University and other entities involved in fish and wildlife monitoring, to catalog monitoring efforts across fish and wildlife species, aquatic and terrestrial ecosystems, regions and jurisdictions to develop a monitoring framework that catalogs existing monitoring efforts, identifies priorities for monitoring in the context of climate change, and identifies gaps and potential for collaboration. Meeting participants would also discuss and develop protocols for improving coordination of monitoring data, so it can be more readily accessed and shared across organizations, possibly through collaboration with the proposed *Alaska Climate Change Knowledge Network*.

A data coordinator position would be required to link extant monitoring programs into an archival network for data exchange. The coordinator could be housed in a government agency that already has a substantial data archive. Alternatively, it could be located in a neutral organization such as the University of Alaska that has secure base funding (office space, internet data server, and technical specialists) and seeks operational/maintenance funding from conservation foundations and various agency members that contribute data on species status. A membership charter for the network to document responsibility of contributors (free access to data, providing metadata on sources of information, funding for upkeep of host website, etc.) would be needed. Several efforts to coordinate monitoring have already occurred in the last few years (see Related Policies/Programs/Actions below). No new authorities would be needed to implement this recommendation.

Related Policies/Programs and Resources

Related Policies/Programs/Actions: Efforts to inventory and monitor the status of species and their environments already exist in many forms and organizations. Harvested species are monitored by ADF&G. Non-game vertebrates, invertebrate animals, and plants are monitored through several groups or efforts, such as the High Latitude Ecological Observatory (part of national non-government organization), regional inventory and monitoring networks (National Park Service), the Comprehensive Wildlife Conservation Strategy (ADF&G), and the Alaska Natural Heritage Program (University of Alaska-Anchorage). Efforts are presently underway with respect to forecasting the effects of climate change on terrestrial, marine and freshwater species and ecosystems. (See Section I of the Natural Systems Technical Working Group Catalog or Adaptations and Policy Options, December 2008, which provides an overview of changes to Alaska’s habitats and dependent species due to climate change, and future trends.)

Available Resources: State and federal agencies have numerous monitoring programs in place already. Results of gap analysis can identify the need for new monitoring efforts. Indigenous knowledge may be highly useful to sampling design. Potential for citizen science involvement is high for some monitoring tasks and would leverage labor across our vast geography, although training and testing of observers will be necessary for some species or purposes.

Feasibility

ADF&G and the University of Alaska can play lead roles for the State in coordinating development of a fish and wildlife monitoring framework and for coordination of fish and wildlife monitoring data. The financial resources required to host and maintain a coordinated internet database could be estimated during the review of existing data sets and where gaps in data exist.

There would be a start-up period of perhaps one to two years before all the various entities and information sources are coordinated to fully identify data gaps and make existing data available in a consistent structure. Some data may be proprietary (e.g., private industry reports), and some will require filtering for posting on a public database (e.g., reduced geographic resolution for species listed as threatened or endangered). The funding required for sampling of data gaps would likely be substantial, and the time delay until a “useful” product exists depends on the desired resolution or intended uses of the data.

Adaptation Benefits and Costs

Development of a coordinated fish and wildlife monitoring framework would help ensure that the coverage and products of existing monitoring programs are well understood by all monitoring entities, that opportunities for collaboration and leveraging of effort are identified (and can be pursued), and that monitoring gaps are identified for species, ecosystems, or regions that should be addressed due to the potential for substantial change in fish and wildlife abundance and distribution due to climate change.

Benefits of a common structure for cataloging and disseminating monitoring information on species status and distribution would be better access to information for managers and harvesters of exploited stocks or populations. As the speed and success of adaptation by harvesters increases through information and technology, respectively, timely information on status of exploited populations would benefit in-season management decisions. This would be especially important as species ranges change and harvest systems may develop in new areas, thus lack the benefit of historic management experience in a particular area.

The cost of collaboration to develop a monitoring strategy and identify and consolidate sources of monitoring data is not expected to be large. However, there will be a long-term cost of staff (technical specialists and administrators) and computer hardware and software to update and maintain a database with strict protocols for data quality and to ensure its security on an internet server. Data collection costs would continue to be borne by the various contributors or end users.

TWG Approval and Deliberations

During the ranking and evaluation by TWG members, this option was the ranked fifth, with no minority views. It ranked highest for its potential significance and low cost. The TWG is in concurrence about the ranking of this option.

NS-6 Support Local Sustainable Agriculture in Alaska

Recommended Adaptation Option

The State of Alaska will develop a program to support sustainable agriculture in Alaska that will improve, secure and sustain the supply of quality, affordable food for all Alaskans, to respond to new challenges and opportunities presented by a changing climate and other future challenges (e.g., increasing food transportation costs to and within Alaska).

Option Description

The goal of Option NS-6 is to develop a program to improve, secure, and sustain the supply of quality, affordable food for Alaskans by expanding and enhancing food production in rural and urban Alaska and improving marketing of Alaska-grown products.

Option NS-6 will be incorporated into the Alaska Division of Agriculture's (ADOA) strategic planning process with the purpose of complementing ADOA efforts to expand community-based agriculture across Alaska. (See Objective 3.2 of ADOA's strategic plan, *Challenges and Opportunities for the Future - While Meeting the Needs of Today*, 2009, which calls for addressing climate change effects on the agriculture sector.)

To achieve this goal, one has to look not only at what agricultural products Alaska can grow, but also infrastructure/processing capabilities, marketing, and other considerations. One of the largest hurdles to truly sustainable agriculture in Alaska is the seasonality of our production combined with the lack of infrastructure/processing capabilities and limited marketing. For instance, Alaska is probably capable of producing more vegetables, but only so many of them can be consumed while still 'fresh'. The market for unprocessed vegetables (such as potatoes, which can be stored year round) is also limited. The amount of cold storage available in the state may also be another limiting factor.

Anecdotal observations indicate that well over 98% of Alaska's total food supply is imported. With the current uncertainty in the national and global economies, the security of that food supply is at risk. The impacts of climate change on the food producing capabilities of the state are unknown but can be expected to provide both opportunity and the need for adaptive change. The state has a history of food production including agriculture, commercial seafood harvesting, and fishing and wildlife hunting for personal and community use. There is both an opportunity and a need to build on our history to create a new system of food production that can maximize the potential of the state to feed itself.

Option Design

Structure/design: Four initiatives or tasks are needed to improve, secure and sustain the Alaskan food supply for the future:

- 1) Encourage community-based agriculture.
- 2) Research the magnitude and composition of food consumption in the state.
- 3) Research the sources of food supply and the risk associated with high reliance on imported foods.
- 4) Develop in cooperation with the University a strategic Alaska food policy to increase reliance on locally produced food sources through agriculture, seafood harvesting, and subsistence activities, including enhanced marketing of Alaska-grown products.

Targets/goals:

- ADOA will provide the leadership to create an Alaska Food Coalition of producers, providers, and consumers.
- ADOA will work to support the expansion of locally produced food through farmers markets and community-based agriculture initiatives.
- ADOA will partner with the University of Alaska to design and conduct the research identified above.
- ADOA will facilitate the development of a draft Alaska Food Policy by the Alaska Food Coalition.

Timing:

- Year One: begin and complete task 1 above and begin work on task 2.
- Year Two: Continue support for task 2 above and work on tasks 1 & 3 by facilitating the development of research initiatives in collaboration with the Alaska Food Coalition and the University of Alaska.
- Year Three: Continue work on task 2 and support for research initiatives including funding and information.
- Year Four: Begin facilitating the development of an Alaska Food Policy with the Alaska Food Coalition based on new research findings.

Participants/Parties involved: The Alaska Division of Agriculture will serve as lead for implementation of NS-6. The UAF Cooperative Extension Service, the UAF School of Natural Resources and Agricultural Sciences, and others will assist ADOA.

The first task of NS-6 will be to organize the Alaska Food Coalition to include representatives of producers, consumers, processors and providers.

Evaluation: Create a data collection system to record production and consumption progress related to the goal of creating a secure and sustainable food system in Alaska.

Continue work with the Alaska Food Coalition to evaluate how programs and policies are meeting the needs identified by the coalition.

Research and Data Needs: The research need associated with NS-6 is to conduct an analysis of the demand and supply for food in Alaska, including an analysis of how this demand is currently met. The findings of this research would inform development of a strategic Alaska Food Policy and serve as a baseline to measure future progress of this option. Following the accomplishment of this task, the ADOA strategic plan will be reviewed to see how much of Alaska's supply of food could be provided by local growers in the various communities (i.e., examine potential for import substitution opportunities).

This research is a HIGH priority for implementation of NS-6. The Alaska Food Coalition would have an important role in coordination to accomplish this research.

Implementation Mechanisms

First: Need to prepare an **analysis of Alaska's DEMAND for food** -- this is for ALL types of food (not just agriculture sector – Note: Need to analyze by sub regions, since there are great differences in different geographic regions and differences rural / urban, etc.):

- What is Alaska's food need?
- To what extent are our current needs met?
- What needs are not met (i.e., current hunger)?

- What are the sources of our food supply?
- What is the risk to our food supply, under different potential change scenarios?

Second: Research findings regarding Alaska’s food supply and demand would be incorporated into the ADOA Strategic Planning Process and used to develop a strategic Alaska Food Policy addressing the following questions:

- What is the capacity of Alaska to be self-sufficient in food production?
- How can agriculture contribute to the food needs of Alaskans?
- How can the seafood industry contribute to the food needs of Alaskans?
- How can subsistence and personal use activities contribute to the food needs of Alaskans?
- How can a marketing and distribution system be created to deliver Alaska produced food to Alaskans?

The Alaska Food Policy “Findings” will also identify the need for any legislative action.

The ADOA is well placed to provide leadership for this effort. Implementation of NS-6 will require the creation of a new stakeholder group (the Alaska Food Coalition) to coordinate the activities of agencies and industry involved in food production, processing, and marketing. ADOA will need an increase of professional staffing (2.0 FTE at a minimum) to support this effort.

Related Policies/Programs and Resources

Related Policies/Programs/Actions: There are many state and federal programs with (potential) food related responsibilities that will need to be consulted and/or included in the Food Coalition as stakeholders. (See the ADOA Economic Development Resource Guide at <http://www.commerce.state.ak.us/dcra/edrg/EDRG.htm>)

Available Resources: The ADOA is well placed to provide leadership to implement NS-6, but will need an increase of professional staffing (2.0 FTE at a minimum) to support this effort.

Feasibility

It is very feasible and realistic for the State to implement this option through the leadership of ADOA. However, ADOA has limited resources to take on this additional and important task, and would require a minimum of 2.0 FTE additional professional staff. Additional resources would also be needed to support the Alaska Food Coalition process and research. (See Costs section, below).

Adaptation Benefits and Costs

Benefits: The long-term benefit is to reduce the food supply risks for Alaskans, in light of changing climatic conditions in Alaska and other future challenges (e.g., increased costs for food transportation to and within Alaska.) The short-term benefits will be the development of information, a coordinating body, and a strategic plan to accomplish the long-term benefits to include:

- A comprehensive analysis and assessment of Alaska's food needs and vulnerabilities -- important to determining how critical it might be for Alaska to have a policy and subsequent actions promoting local sustainable food sources.
- Vital information for identifying market opportunities for locally produced agriculture and other locally produced foods (e.g., seafood).
- Increased economic opportunity for Alaska businesses.
- Improved nutrition, particularly in rural communities (= health benefits). Reduced hunger (by meeting more of Alaska's food need).

Costs: Cost of these implementation steps will include:

- Funding for new positions and related support for the ADOA (a minimum of 2 FTE is anticipated).
- Funding for research identified in tasks above (estimated \$100,000) – estimate based on consultation with Dr. Bret Luick, University of Alaska Fairbanks, Cooperative Extension Service regarding implementation of the on-going Alaska Food Cost Survey (See <http://www.uaf.edu/ces/fcs/2008q1data.pdf>)
- Funding to support meetings and work of the Alaska Food Coalition (e.g., travel, staff support, meeting expenses).

Data sources used for the estimates provided in this section and additional references related to Alaska's agricultural sector are footnoted.¹⁶

TWG Approval and Deliberations

During the ranking and evaluation by TWG members, this option was the ranked last of the six recommended natural system adaptation options, with no minority views, due to its lower rankings for significance, benefits and timing. The TWG is in concurrence about the ranking of this option.

¹⁶ Alaska Cooperative Extension, University of Alaska Fairbanks. Organizing For Business As a Cooperative. Fairbanks, Alaska: August 1995.
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NS-7 Promote Climate-Change Literacy through K-12 Education

Recommended Adaptation Option

Despite the critical and growing importance of climate change to Alaska's residents, there is a generally a poor level of public understanding of the causes and consequences of climate change. In order for Alaska to adapt effectively to climate change in the future, there is an urgent need to raise the level of literacy about climate change. To address this essential need, the State of Alaska will increase emphasis, curriculum and training for delivery of climate-change content in grades K-12 and increase coordination among existing programs and entities that address climate-change education in Alaska's schools.

Option Description

The State of Alaska will implement steps to rapidly improve public understanding of the causes and consequences of climate change in Alaska through K-12 education programs, under the framework of the existing Alaska Science Standards. The State will identify provide training and curricula to teachers on climate change, provide an education specialist to focus on science and climate change education, and increase coordination among existing programs and entities that address climate-change education in Alaska's schools.

By emphasizing climate-change education, Alaska will provide adequate educational resources to its residents to enable them to make wise choices about how to minimize the costs and maximize the opportunities that result from climate change. In the absence of such education and outreach initiatives, K-12 teachers in schools will not be able to teach about climate change because of the time and subject-matter constraints in their existing curricula. Alaskans are unlikely to take climate change seriously and will not be prepared to adapt to the environmental and ecological changes that are occurring.

Option Design

Structure/design: Sub-option 1 has three major components:

- The State will provide funding to the University of Alaska or other appropriate entities to develop courses for K-12 teachers so these professionals have the training necessary to teach about climate change in Alaska. These courses will involve professionals in education and extension/outreach. It would be important to determine cost effective, yet successful methods for delivery of this training to Alaska's teachers, through distance delivery, training at district in-service sessions, etc.
- The State will establish and fund a new environmental/climate change science education specialist at the Department of Education and Early Development (DEED) to provide coordination among existing programs and entities that address climate-change education in Alaska's schools, and to coordinate development and dissemination of new curriculum, materials and teacher training. (At present, DEED does not have an environmental science education specialist.)
- The State will increase coordination with and utilization of existing programs that address climate change education for Alaska's school-age children. (See Related Programs, below)

Targets/goals: The goal of this sub-option is to include climate change as an integral component of public education in Alaska, so Alaska's youth are prepared to make wise choices about adapting to climate change. Targets will include completion of the tasks listed above.

Timing: Implementation for this policy can begin immediately and could be completed within three to four years.

Participants/Parties involved: DEED, U.S. Department of Education, University of Alaska, stakeholders, school districts, teachers, and entities listed in the Related Programs section, below.

Evaluation: Implementation of the adopted policy in classrooms can be monitored and evaluated through formative and summative assessments administered by classroom teachers and/or by DEED.

Research and Data Needs:

- Research public education curricula and teacher training materials developed and implemented in other states (e.g., California).

Implementation Mechanisms

The primary need for implementation of these recommendations is Cabinet-level emphasis, intention, and limited strategic funding. Specific implementation steps are provided in the Option Design section, above.

Related Policies/Programs and Resources

Several organizations that have initiated efforts to integrate climate-change understanding into the educational program include the Center for Ocean Sciences Education, International Arctic Research Center, and the Alaska SeaLife Center. For example, the Alaska SeaLife Center in Seward is expanding its education program to include curriculum about the marine environment and climate change. This eight-unit Marine Ecosystems Curriculum will initially target students in grades 6-9 through Distance Learning. The curriculum will also form the basis for a summer camp program and can be modified for in-classroom use with grades 4-6.

The document on *Climate Literacy: Essential Principles of Climate Science* has been developed by federal science agencies including NOAA and NSF in collaboration with many individuals and the following science and education partners: American Association for the Advancement of Science Project 2061, American Meteorological Society, Association of Science-Technology Centers, College of Exploration, Cooperative Institute for Research in Environmental Sciences, Federation of Earth Science Information Partners, Lawrence Hall of Science, University of California, Berkeley, National Environmental Education Foundation, National Geographic Education Programs, North American Association For Environmental Education, TERC, Inc., GLOBE Program, National Center for Atmospheric Research and University Corporation for Atmospheric Research. This Climate Science Literacy Guide includes science concepts aligned with the National Science Education Standards and the AAAS Benchmarks for Science, and provides a framework for understanding and communicating about climate change and climate science for individuals and communities.

Feasibility

These recommendations could be feasibly implemented within three to four years, if targeted funding is appropriated.

Adaptation Benefits and Costs

Benefits: The primary and essential benefits to this option will be improving the literacy of Alaska's youth (our future adults) in basic information about climate change, mitigation and adaptation, to inform their future decisions regarding their own actions and to ensure that Alaska's population understand the importance in future State decisions and actions.

Costs: This recommendation would involve the following general costs:

- A new statewide staff position (Education Specialist II: approximate cost \$83,000 per year, salary and benefits) to coordinate climate change education efforts for the DEED and to coordinate with other organizations involved in climate-change education.

- Development of climate change curriculum, teacher training materials and accomplishment of teacher training by the University would require contractual funding.

TWG Approval and Deliberations

The TWG did not rank this option (NS-7) relative to the other six natural systems adaptation options because it has a broader application (e.g., K-12 education curriculum could also address potential impacts of climate change on health and culture, mitigation approaches, etc.). However, the TWG reached complete consensus on this recommendation and requests that the AAG include it in its final recommendations to the Governor's Climate Change Sub-Cabinet.