



Alaska Climate Change Strategy

<http://www.akclimatechange.us>

Catalog of State Actions Natural Systems and Associated Economies Technical Work Group

(Note: This listing is underdevelopment and should be considered a draft document not for citation. The Natural Systems and Associated Economies Technical Work Group will be revising this list as the planning process continues. To follow the development of this document visit http://akclimatechange.us/Natural_Systems.cfm. Beyond the general trends outlined at the beginning of each section, forecasting ecosystem responses to global warming stressors is difficult. Many of the forecasts in this section are uncertain on this account. For example, it is not a foregone conclusion that just because the ice recedes in the Arctic there will be substantial new fisheries there as there might not be much for fish to eat. Nor is invasion by warmer water fish in substantial numbers from the south, as there are multiple habitat criteria that may not be met. The projections in this section are made to aid understanding about the direction and potential impacts of global-warming trends on Alaskan natural systems and the economies directly dependant upon them, not as hard-and-fast predictions.

General comments from TWG members.

- Need to add a theme of reserving water in streams and lakes. Note from the facilitators — suggestions from the reviewer have been incorporated.
- Need to address the challenge/difficulty of making predictions of global warming impact.
- One reviewer suggested: “Might it not be more informative to provide a brief description of how the major terrestrial, aquatic and marine ecosystems are thought to function at present, followed by a description of the likely systemic responses to increases in temperature and changes in circulation and precipitation?”
- Need to discuss uncertainty; both about projecting impacts and that managers will have increased uncertainty to manage as global warming upsets previously (relatively) predictable patterns in Alaskan natural systems.
- Stakeholders — Of a general comment, there might be someplace in the document that there be a mapping of stakeholders, both in-state and out of state regarding the various sectors that we are discussing. On land use related actions in Alaska, there are certain groups of stakeholders, both in-state and out of state, that are more than interested in happenings in Alaska. This work can help ensure that the Climate Change strategy has the vetting that will ensure its acceptance, as best as we can.

NS-1 AGRICULTURE

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

NS-1.1 Improve impact predictions

Convene agricultural representatives, scientists, government officials, and others to examine the impacts of current and projected climate change on agriculture in Alaska.

Recent Actions in AK: (Note — this item to be completed if and when it is appropriate later in the planning process)

NS-1.2 Define new opportunities

Examine what new opportunities exist for agriculture in Alaska and disseminate this information.

Recent Actions in AK: (Note — this item to be completed if and when it is appropriate later in the planning process)

NS-1.3 Plan pro-active pest management

Examine concerns about new or expanded insects, other pests, invasive species, and diseases on agriculture, and develop strategies addressing how best to address these issues.

Recent Actions in AK: (Note —this item to be completed if and when it is appropriate later in the planning process)

NS-1.4 Plan integrated pest management strategies

Examine, as appropriate, insect, and invasive species control measures, using least toxic options.

Recent Actions in AK: (Note —this item to be completed if and when it is appropriate later in the planning process)

NS-1.5 Increase monitoring of pests

Expand pest and invasive species monitoring.

Recent Actions in AK: (Note —this item to be completed if and when it is appropriate later in the planning process)

NS-1.6 Increase pest management research

Conduct research on new crops, pest and disease control, and other issues.

Recent Actions in AK: (Note —this item to be completed if and when it is appropriate later in the planning process)

NS-1.7 Pro-actively plan agricultural water management strategies

Consider the need for irrigation systems and containment measures to address potential water deficits and, where appropriate, construct these systems.

Recent Actions in AK: (Note —this item to be completed if and when it is appropriate later in the planning process)

NS-1.8 Improve agricultural outreach and support

Examine, and if appropriate, provide programs and incentives to promote the rapid transfer of new knowledge and technologies to assist farmers in adapting to climate change.

Recent Actions in AK: (Note —this item to be completed if and when it is appropriate later in the planning process)

NS-1.9 Promote new market opportunities

Assist in the creation and expansion of markets for new agricultural products.

Recent Actions in AK: (Note —this item to be completed if and when it is appropriate later in the planning process)

NS-2 BOREAL AND TEMPERATE FORESTS AND DEPENDENT SPECIES

Forest Insects and Diseases

Current impacts – greater incidence of existing diseases such as spruce bark beetle, resulting in massive forest death (over 4 million acres; *Question-is there a percentage figure to use here?*); other forest diseases include larch saw fly (killed 90% of larch near Fairbanks-*needs a citation*), birch leaf roller, birch leaf miner, aspen leaf miner, and wooly saw fly; introduction of new diseases in forests such as spruce bud worm and aphids, resulting in tree injury and death. (*Note —there is anecdotal evidence suggesting more impacts than initially reported. For example, in areas ranging from the Y-K up through the western interior to the Kobuk there are a number of expanses of compromised and/or dead spruce stands. Future projections – greater incidence of*

existing diseases, resulting in even greater forest death; more new diseases and greater expansion of recently introduced diseases resulting in further tree injury and death.

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NS-2.1 Improve impact predictions

Conduct a comprehensive assessment of the current impacts and future threats of forest insects and diseases on Alaska's forests (e.g., [impacts on yellow cedar in Southeast Alaska](#)).

Recent Actions in AK: (Note —this item to be completed if and when it is appropriate later in the planning process)

NS-2.2 Pro-active planning

Convene experts to determine what intervention strategies (such as early detection, selected removal, biological control or quarantine), if any, can be effectively taken.

Recent Actions in AK: (Note —this item to be completed if and when it is appropriate later in the planning process)

NS-2.3 Increase research

Research whether there are more insect and disease tolerant trees.

Recent Actions in AK: (Note —this item to be completed if and when it is appropriate later in the planning process)

NS-2.4 Improve problem detection

Establish more extensive monitoring, capture and reporting systems, including public reporting.

Recent Actions in AK: (Note —this item to be completed if and when it is appropriate later in the planning process)

NS-2.5 Define new opportunities

Examine what new market opportunities exist for spruce bark beetle-damaged timber in Alaska and disseminate this information.

Recent Actions in AK: (Note —this item to be completed if and when it is appropriate later in the planning process)

Forest Fires

Current impacts – more and earlier fires; record breaking acreage burned (over 11 million acres in 2004 and 2005); substantial impacts on forests and habitat for species (approximately 25% of all forests in 2004/2005 burned in NE Alaska); also expensive fire fighting (cost in 2004/2005

was \$108 million); less habitat available for some forest dependent species; potential increase in food availability for other species, such as moose. *Future projections – greater fire impacts, including possibility of fires in southeast Alaska.*

NS-2.6 Re-consider fire management objectives

Re-examine, as necessary, fire fighting goals and strategies in light of climate change.

Recent Actions in AK: (Note —this item to be completed if and when it is appropriate later in the planning process)

NS-2.7 Conduct priority assessments

Conduct a statewide assessment of areas of high ecosystem or other values and utilize fire fighting to protect these highly sensitive areas, as appropriate.

Recent Actions in AK: (Note —this item to be completed if and when it is appropriate later in the planning process)

NS-2.8 Improve predictions of fire management needs

Project future fire fighting needs using climate change assumptions and impacts on forest ecosystems.

Recent Actions in AK: (Note —this item to be completed if and when it is appropriate later in the planning process)

NS-2.9 Experiment with fire management innovations

Consider examining and testing pilot programs for alternative fire hazard treatments.

Recent Actions in AK: (Note —this item to be completed if and when it is appropriate later in the planning process)

NS-2.10 Implement priority habitats and species management

Assess whether some biologically significant natural areas need to be protected in other ways from fire for biodiversity or other reasons.

Recent Actions in AK: (Note —this item to be completed if and when it is appropriate later in the planning process)

NS-2.11 Improve use of fire as a management tool

Determine and implement increased prescribed burning, as appropriate.

Recent Actions in AK: (Note —this item to be completed if and when it is appropriate later in the planning process)

NS-2.12 Improve the funding base.

Obtain additional funding.

Recent Actions in AK: (Note —this item to be completed if and when it is appropriate later in the planning process)

NS-2.13 Investigate recent year experiences

Research impacts of 2004/2005 seasons on habitat.

Recent Actions in AK: (Note —this item to be completed if and when it is appropriate later in the planning process)

NS-2.14 Expand the fire risk management zone

Research possible fire risks in Southeast Alaska.

Recent Actions in AK: (Note —this item to be completed if and when it is appropriate later in the planning process)

NS-2.15 Increase public awareness

Increase public education about fire prevention.

Recent Actions in AK: (Note —this item to be completed if and when it is appropriate later in the planning process)

NS-2.16 Improved seasonal forecasting of forest fires

Produce decision aids on anticipated fire seasons.

Recent Actions in AK: (Note —this item to be completed if and when it is appropriate later in the planning process)

Warming Effects on Trees

Current impacts – tree growth decline, stress, and death due to warmer temperatures and less water availability (e.g., birch, white spruce, and yellow cedar); overall decrease in boreal forest productivity measured; loss of yellow cedar (over 1/2 million acres); some limited northern and western expansion of boreal forests and some expansion to higher altitudes and into drying wetlands, but a net loss overall. *Note —another source of expertise could be Glenn Juday who works on this topic. See: <http://www.uaf.edu/snras/faculty/juday.html>. Future projections – projected elimination of most of Alaska’s boreal forest if temperatures continue to increase and*

water availability continues to decline; loss of boreal forest habitat, turning into grasslands, impact on boreal forest species such as migratory songbirds; greater loss of yellow cedar and other tree species; potential northern and western forest expansion and expansion into drying wetlands.

NS-2.17 Improve research base

Conduct a comprehensive assessment of the current impacts and future threats from temperature increases and less water availability on Alaska's forests.

Recent Actions in AK: (Note —this item to be completed if and when it is appropriate later in the planning process)

NS-2.18 Improve research base

Research and assess impacts of reduction or elimination of certain trees on other plant and animal species.

Recent Actions in AK: (Note —this item to be completed if and when it is appropriate later in the planning process)

NS-2.19 Evaluate a new forestry for Alaska

Test and then consider introducing new, more heat and drought tolerant trees, if they exist.

Recent Actions in AK: (Note —this item to be completed if and when it is appropriate later in the planning process)

Plant Invasive Species in Forests

Current impacts – increased number and distribution of invasive species in the forests, especially following major fires. *Future projections – likely increased invasive species in both the boreal and temperate rain forests; possibility of invasive species reducing biodiversity and food availability for species.*

NS-2.20 Improve impact predictions

Conduct a comprehensive assessment of the current impacts and future threats from plant invasive species on Alaska's forests.

Recent Actions in AK: (Note —this item to be completed if and when it is appropriate later in the planning process)

NS-2.21 Increase pro-active planning

Reserve water in stream and lakes to maintain essential fish and wildlife habitat

Recent Actions in AK: (Note —this item to be completed if and when it is appropriate later in the planning process)

NS-2.22 Increase pro-active planning

Project most likely future invasive species.

Recent Actions in AK: (Note —this item to be completed if and when it is appropriate later in the planning process)

NS-2.23 Improve intervention planning

Convene experts to determine what, if any actions, can be taken.

Recent Actions in AK: (Note —this item to be completed if and when it is appropriate later in the planning process)

NS-2.24 Improve pro-active planning

Prioritize threats and needs.

Recent Actions in AK: (Note —this item to be completed if and when it is appropriate later in the planning process)

NS-2.25 Improve pro-active planning

Develop an invasive species response plan.

Recent Actions in AK: (Note —this item to be completed if and when it is appropriate later in the planning process)

NS-2.26 Improve pro-active planning

Determine whether early detection and selected removal are effective options.

Recent Actions in AK: (Note —this item to be completed if and when it is appropriate later in the planning process)

NS-2.27 Improve pro-active planning

Determine whether complete removal from highly sensitive locations is appropriate.

Recent Actions in AK: (Note —this item to be completed if and when it is appropriate later in the planning process)

NS-2.28 Improve the research base

Research most effective removal methodologies.

Recent Actions in AK: (Note —this item to be completed if and when it is appropriate later in the planning process)

NS-2.29 Increase monitoring

Establish more extensive monitoring and reporting systems, including public reporting.

Recent Actions in AK: (Note —this item to be completed if and when it is appropriate later in the planning process)

Impacts on Forest-Dependent Species

Current impacts – few current ecosystem-wide impacts, some animals lost or displaced by loss of local habitat after massive fires. *Future projections – greater impacts on forest dependent species due to substantial loss of boreal forest habitat (e.g., forest dependent birds such as passerines).*

NS-2.30 Improve impact predictions

Convene forest, fish, wildlife, and other experts to assess current and projected impacts of climate change on forest dependent species.

Recent Actions in AK: (Note —this item to be completed if and when it is appropriate later in the planning process)

NS-2.31 Conduct priority assessments

Identify species and habitat at greatest risk.

Recent Actions in AK: (Note —this item to be completed if and when it is appropriate later in the planning process)

NS-2.32 Set priorities

Examine and, where appropriate, implement available strategies to protect species at greatest risk.

Recent Actions in AK: (Note —this item to be completed if and when it is appropriate later in the planning process)

NS-2.33 Improve pro-active planning

Review and, where appropriate, modify land management and fish and wildlife management plans to incorporate climate change projections.

Recent Actions in AK: (Note —this item to be completed if and when it is appropriate later in the planning process)

NS-2.34 Plan for specific, priority animal migratory needs

Investigate the possibility of providing needed protected forest corridors to facilitate the movement of species so that animals can migrate as forests change, using land acquisition, exchanges, cooperative management or other means.

Recent Actions in AK: (Note —this item to be completed if and when it is appropriate later in the planning process)

NS-2.35 Implement priority habitats and species management

Examine the need for new protected areas for forest dependent species using land management plans, land acquisition, cooperative management, exchanges or other means.

Recent Actions in AK: (Note —this item to be completed if and when it is appropriate later in the planning process)

NS-2.36 Increase monitoring

Increase monitoring of key species.

Recent Actions in AK: (Note —this item to be completed if and when it is appropriate later in the planning process)

NS-2.37 Modify harvest management regimes

Review and, where appropriate, modify fish and wildlife seasons, take, and other regulations to reflect changes in wildlife and fish abundance, locations and timing, including providing opportunities for harvesting new species.

Recent Actions in AK: (Note —this item to be completed if and when it is appropriate later in the planning process)

NS-3 FORESTRY

Current impacts – loss of some available trees due to fire, disease, and climate stress. *Future projections – likely substantial loss of yellow cedar trees (the most valuable tree economically) in the southeast; further loss of boreal forest trees due to fire, drought, and disease.*

NS-3.1 Improve impact predictions

Convene forest industry representatives, scientists, land managers (federal, state and Native corporation), conservationists, and others to examine the impacts of current and projected climate change on forestry in Alaska.

Recent Actions in AK: (Note —this item to be completed if and when it is appropriate later in the planning process)

NS-3.2 Improve impact predictions

Assess the impacts of global warming on the most valuable trees for forestry, especially yellow cedar.

Recent Actions in AK: (Note —this item to be completed if and when it is appropriate later in the planning process)

NS-3.3 Improve pro-active planning

Examine what measures exist to address projected changes, including whether forestry practices are appropriately modified.

Recent Actions in AK: (Note —this item to be completed if and when it is appropriate later in the planning process)

NS-3.4 Define new opportunities

Research, test and then consider introducing new, more heat and drought tolerant trees, if they are available.

Recent Actions in AK: (Note —this item to be completed if and when it is appropriate later in the planning process)

NS-3.5 Improve pro-active planning

Develop and implement fire protection plans.

Recent Actions in AK: (Note —this item to be completed if and when it is appropriate later in the planning process)

NS-3.6 Define new opportunities

Examine the development of markets for non-traditional products and services from commercial forests, including carbon storage.

Recent Actions in AK: (Note —this item to be completed if and when it is appropriate later in the planning process)

NS-4 TUNDRA AND ALPINE ECOSYSTEMS AND DEPENDENT SPECIES

Loss of Tundra and Alpine Habitat from shrub expansion and Tree-Line Expansion

Current impacts – because of warmer temperatures, increased bushification and tree-line expansion (e.g., in the Kenai Mountains, tree-line has advanced 3 feet/year in last 50 years). Future projections – greater loss of tundra and alpine habitat; potential elimination of alpine and tundra habitat in certain locations and extinction of dependent species (e.g., impacts on caribou due to reduction in lichens).

NS-4.1 Improve impact predictions

Assess tundra and alpine ecosystems at greatest risk.

Recent Actions in AK: (Note —this item to be completed if and when it is appropriate later in the planning process)

NS-4.2 Improve impact predictions

Conduct a species survey in areas at greatest risk. *Note that this impact assessment may flow naturally out of the work done in NS-4.1.*

Recent Actions in AK: (Note —this item to be completed if and when it is appropriate later in the planning process)

NS-4.3 Improve pro-active planning

Examine what, if any, strategies exist to protect areas at greatest risk, such as mechanical or other clearing. *Note that there are differences of opinion about the efficacy of mechanical removal. See: http://www.whrc.org/resources/published_literature/pdf/BunnetalEos.07.pdf.*

Recent Actions in AK: (Note —this item to be completed if and when it is appropriate later in the planning process)

NS-4.4 Implement priority habitats and species management

Evaluate and, as appropriate, protect key alpine and tundra habitats through regulation, legislation, cooperative agreements, or land acquisition.

Recent Actions in AK: (Note —this item to be completed if and when it is appropriate later in the planning process)

Tundra Fires

Current impacts – larger and more intense tundra fires (almost 250,000 acres in 2007); modification of tundra habitat from wildfires. *Future projections – more tundra fires and loss of*

habitat with impacts on dependent species. Research studies are underway now to illuminate impacts from the 2007 fire near Umiat.

NS-4.5 Improve impact predictions

Assess tundra ecosystems at greatest risk from fire.

Recent Actions in AK: (Note —this item to be completed if and when it is appropriate later in the planning process)

NS-4.6 Implement priority habitats and species management

Identify tundra areas of highest *priority for protection*.

Recent Actions in AK: (Note —this item to be completed if and when it is appropriate later in the planning process)

NS-4.7 Experiment with fire management innovations

Consider using fire prevention and suppression, as appropriate, to protect highly valued tundra areas *commensurate with avoiding creation of other problems such as landcover damage through disturbance during these interventions*.

Recent Actions in AK: (Note —this item to be completed if and when it is appropriate later in the planning process)

NS-4.8 Improve the research base

Research impacts of tundra fires *on forage for key species such as* caribou and musk oxen.

Recent Actions in AK: (Note —this item to be completed if and when it is appropriate later in the planning process)

NS-4.9 Improve monitoring

Research and monitor impacts of tundra fires on vegetation survival, growth and succession.

Recent Actions in AK: (Note —this item to be completed if and when it is appropriate later in the planning process)

Impacts on Tundra-Dependent Species

Current impacts – some current impacts on caribou, muskoxen, and other species because of decreased food availability due to freezing rain (e.g., porcupine caribou herd has decreased 3.5%/year between 1989 and 2001); decreased food because of tundra fire events; decreased habitat because of bushification and tree-line advance for dall sheep, mountain goats, and other alpine and tundra species; increased tundra plain flooding events (e.g., deaths of muskoxen on

North Slope);. *Future projections – further impacts on tundra and alpine species due to loss of habitat, less available food, more flooding, and changing distributions and abundance of pathogens and diseases, resulting in substantial population level impacts; altered patterns of distribution for pathogens and parasites with emergence of disease are predicted for caribou, wild sheep, moose, and muskoxen; diseases interact with habitat perturbation and other stressors to influence reproductive success, survival, and sustainability of wildlife populations.*

NS-4.10 Improve impact predictions

Convene tundra, alpine, fish and wildlife, and other experts to assess current and projected impacts of climate change on alpine and tundra dependent species.

Recent Actions in AK: (Note —this item to be completed if and when it is appropriate later in the planning process)

NS-4.11 Implement priority habitats and species management

Assess, examine, and where appropriate, implement strategies to protect species at greatest risk.

Recent Actions in AK: (Note —this item to be completed if and when it is appropriate later in the planning process)

NS-4.12 Implement pro-active planning

Review and, where appropriate, modify land management and fish and wildlife management plans to incorporate climate change projections and recognize the need for federal and state interagency coordination.

Recent Actions in AK: (Note —this item to be completed if and when it is appropriate later in the planning process)

NS-4.13 Plan for specific, priority animal migratory needs

Investigate the possibility of providing needed protected tundra or alpine corridors to facilitate the movement of species, through land acquisition, exchanges, or other means.

Recent Actions in AK: (Note —this item to be completed if and when it is appropriate later in the planning process)

NS-4.14 Implement priority habitats and species management

Examine the need for new protected areas for tundra or alpine dependent species through land management plans, land acquisition, land exchanges or other means.

Recent Actions in AK: (Note —this item to be completed if and when it is appropriate later in the planning process)

NS-4.15 Implement bio-resource savings programs

Where appropriate, consider relocating species at risk, especially to new alpine locations.

Recent Actions in AK: (Note —this item to be completed if and when it is appropriate later in the planning process)

NS-4.16 Improve monitoring

Increase monitoring of key species.

Recent Actions in AK: (Note —this item to be completed if and when it is appropriate later in the planning process)

NS-4.17 Modify harvest management regimes

Review and, where appropriate, modify fish and wildlife seasons, take and other regulations to reflect changes in wildlife and fish abundance, locations and timing.

Recent Actions in AK: (Note —this item to be completed if and when it is appropriate later in the planning process)

NS-5 FRESHWATER ECOSYSTEMS AND DEPENDENT SPECIES

Temperature Increases

Current impacts – river temperatures have increased throughout the state (e.g., Yukon River summer temperatures have increased more than 10 degrees Fahrenheit in last 25 years ([citation needed](#)), and monitored Kenai Peninsula river temperatures now repeatedly exceed 55 degrees Fahrenheit and occasionally exceed 68 degrees Fahrenheit (above which is deemed “unhealthy for spawning areas”); increased lake temperatures. *Future projections – continued increase in water temperature throughout the state with more 55 degree and 68 degree exceedences; greater impacts on fish spawning, disease, egg development, etc.*

NS-5.1 Increase monitoring and reporting

Increase stream, river, and lake temperature monitoring and reporting [including establishment of consistent, long term monitoring sites](#).

Recent Actions in AK: (Note —this item to be completed if and when it is appropriate later in the planning process)

NS-5.2 Reserve water

Reserve water in stream to buffer temperature impacts.

Recent Actions in AK: (Note —this item to be completed if and when it is appropriate later in the planning process)

NS-5.3 Review trends

Examine trends and provide best future projections.

Recent Actions in AK: (Note —this item to be completed if and when it is appropriate later in the planning process)

NS-5.4 Improve research

Increase research on impacts of increased temperatures on the life cycles and diseases of key fish species, including salmon, trout, and grayling; freshwater prey species upon which they depend; and on water quality.

Recent Actions in AK: (Note —this item to be completed if and when it is appropriate later in the planning process)

NS-5.5 Improve research

Increase research on stream/lake biogeochemistry impacts due to land cover conversion, permafrost degradation, and changing precipitation regimes within watersheds. Contact Bruce Peterson, Woods Hole Marine Biological Lab, <http://ecosystems.mbl.edu/Tide/contact/peterson.htm>.

Recent Actions in AK: (Note —this item to be completed if and when it is appropriate later in the planning process)

River Water Flows

Current impacts – increased flooding events; less water in many non-glaciated rivers during warmer summers, disrupting spawning and other functions; increased summer river flow for glaciated rivers; major landslides into rivers and retrogressive thaw slumps (e.g., Selawik River) resulting in sedimentation and other issues. *Future projections – even less water in many river systems especially those in Alaska’s interior and North Slope; increased summer flow in glaciated rivers until glaciers disappear; more major landslides and retrogressive thaw slumps*

NS-5.6 Improve monitoring and reporting

Increase stream and river flow monitoring and reporting, including establishment of long-term monitoring sites.

Recent Actions in AK: (Note —this item to be completed if and when it is appropriate later in the planning process)

NS-5.7 Improve landslide and retrogressive thaw slump monitoring

Increase monitoring of landslides and retrogressive thaw slumps that effect rivers.

Recent Actions in AK: (Note —this item to be completed if and when it is appropriate later in the planning process)

NS-5.8 Examine stream and river flows

Examine stream and river flow and obstruction trends and provide best future projections.

Recent Actions in AK: (Note —this item to be completed if and when it is appropriate later in the planning process)

NS-5.9 Reserve water

Reserve water in streams to sustain spawning and rearing habitats.

Recent Actions in AK: (Note —this item to be completed if and when it is appropriate later in the planning process)

NS-5.10 Improve research

Increase research on impacts of changed river and stream flows on the life cycles of key fish species, including salmon and trout; *their freshwater prey; and on water quality.*

Recent Actions in AK: (Note —this item to be completed if and when it is appropriate later in the planning process)

NS-5.11 Convene expert panel

Convene experts and others to discuss and evaluate potential impacts and responses to water flow changes.

Recent Actions in AK: (Note —this item to be completed if and when it is appropriate later in the planning process)

Loss and shrinkage of ponds and lakes

Current impacts – ponds and lakes are shrinking and disappearing throughout Alaska through evaporation, permafrost loss, coastline erosion, and coastal storm surges; shrinkage of ponds and lakes (e.g., in a statewide study, closed pond areas decreased by 4 to 31% in last 50 years); in northeast Alaska, of 23 lakes studied, 21 decreased in size; salinization of coastal ponds and lakes from storm surges (storm surge in 2005 covered extensive areas on Y-K Delta under 9 feet of saltwater), erosion (loss of lakes on North Slope), and sea ice scouring. *Future projections – greater loss of ponds and lakes, including substantial loss from sea level rise (projected approximate 18-inch sea level rise by end of century); major impacts on many species including*

waterfowl and migratory birds (Note: see subsector below); increased storm surges causing salinization of coastal lakes, ponds, and wetlands; some possible expansion of wetlands on the North Slope from thawing permafrost.

NS-5.12 Improve monitoring

Increase monitoring of changes in size of lakes and ponds through analysis of aerial photography and other means.

Recent Actions in AK: (Note —this item to be completed if and when it is appropriate later in the planning process)

NS-5.13 Assess future loss and shrinkage

Assess likely future loss and shrinkage of ponds and lakes.

Recent Actions in AK: (Note —this item to be completed if and when it is appropriate later in the planning process)

NS-5.14 Improve monitoring of sea level rise

Increase monitoring sites of sea level rise.

Recent Actions in AK: (Note —this item to be completed if and when it is appropriate later in the planning process)

NS-5.15 Conduct and Alaska Shoreline Impact Assessment

Conduct an ‘Alaska Shoreline Impact Assessment Project’, to establish a baseline of data on the existing coastal resources and the projected impacts of sea level rise, and include tides, weather, and short-term (El Nino-type) components as well as long term scenarios.

Recent Actions in AK: (Note —this item to be completed if and when it is appropriate later in the planning process)

NS-5.16 Reserve water

Reserve water for lake level maintenance.

Recent Actions in AK: (Note —this item to be completed if and when it is appropriate later in the planning process)

NS-5.17 Improve research on impacts of lake and pond loss

Increase research on impacts of lake and pond loss, including impacts on waterfowl and species like muskrats.

Recent Actions in AK: (Note —this item to be completed if and when it is appropriate later in the planning process)

NS-5.18 Evaluate measures to protect species at risk

Where species are at risk, consider creating new lakes and ponds through river diversion or damming.

Recent Actions in AK: (Note —this item to be completed if and when it is appropriate later in the planning process)

Invasive species in freshwater systems

Current impacts – there are new invasive plant species that have the potential to adversely impact rivers and streams such as purple loosestrife. *Future projections – greater threat in numbers, types, and abundance of injurious invasive species, seriously impacting freshwater ecosystems.*

NS-5.19 Assess scope of impacts from invasive species

Conduct an assessment of the scope of the current and projected extent of invasive species in Alaska’s freshwater ecosystems.

Recent Actions in AK: (Note —this item to be completed if and when it is appropriate later in the planning process)

NS-5.20 Prioritize threats and needs

Prioritize threats and needs.

Recent Actions in AK: (Note —this item to be completed if and when it is appropriate later in the planning process)

NS-5.21 Create a response plan

Develop an invasive species response plan.

Recent Actions in AK: (Note —this item to be completed if and when it is appropriate later in the planning process)

NS-5.22 Predict future invasives

Predict most likely future invasive species.

Recent Actions in AK: (Note —this item to be completed if and when it is appropriate later in the planning process)

NS-5.23 Convene expert panel

Convene experts to determine what actions can be taken.

Recent Actions in AK: (Note —this item to be completed if and when it is appropriate later in the planning process)

NS-5.24 Assess effectiveness of early detection and selected removal

Determine whether early detection and selected removal are effective options.

Recent Actions in AK: (Note —this item to be completed if and when it is appropriate later in the planning process)

NS-5.25 Assess appropriateness of removal from sensitive locations

Determine whether complete removal from highly sensitive locations is appropriate.

Recent Actions in AK: (Note —this item to be completed if and when it is appropriate later in the planning process)

NS-5.26 Improve research on removal methodologies

Research most effective removal methodologies.

Recent Actions in AK: (Note —this item to be completed if and when it is appropriate later in the planning process)

NS-5.27 Expand monitoring and reporting systems

Establish more extensive monitoring and reporting systems, including public monitoring and reporting (such as Stream Watch).

Recent Actions in AK: (Note —this item to be completed if and when it is appropriate later in the planning process)

Impacts on freshwater dependent fish

Current impacts – increase in warmer water diseases such as *Ichthyophonus*; migration of salmon to more northern rivers and streams; decrease in salmon fry size in glacial-fed rivers and lakes (Skilak river fry 60% smaller when glacier melted extensively in 2005); greater spring flooding disturbing eggs; increase in warmer water predatory fish; impacts from expanding beaver populations on fish habitat; major landslide and slumping events (e.g., the Selawik slump affecting sheefish). *Future projections – more northerly migration of salmon and other species; threat to and potential elimination of grayling, steelhead, and some salmon from warmer streams and rivers; more predatory fish; more habitat disruption from major slumping events.*

NS-5.28 Convene expert panel

Convene fish, management, and other experts to assess current and projected impacts of climate change on freshwater dependent fish, and complete an assessment and incorporate socio-economic factors into impact assessments.

NS-5.29 Monitor distributional changes

Establish long-term monitoring efforts to document species distributional changes.

Recent Actions in AK: (Note —this item to be completed if and when it is appropriate later in the planning process)

NS-5.30 Identify at-risk species

Identify species at greatest risk.

Recent Actions in AK: (Note —this item to be completed if and when it is appropriate later in the planning process)

NS-5.31 Regulate water in streams for fish

Reserve water in streams for fish migration, spawning, and rearing.

Recent Actions in AK: (Note —this item to be completed if and when it is appropriate later in the planning process)

NS-5.32 Research impacts of climate change on cold-water fish

Increase research on impacts of climate change on cold water fish like grayling.

Recent Actions in AK: (Note —this item to be completed if and when it is appropriate later in the planning process)

NS-5.33 Evaluate strategies to protect at-risk species

Examine and, where appropriate, implement available strategies to protect species at greatest risk.

NS-5.34 Develop guidelines to assess risk

Develop guidelines for assessing risk to species and for providing protection to a given species.

Recent Actions in AK: (Note —this item to be completed if and when it is appropriate later in the planning process)

NS-5.35 Evaluate relocation options

Consider relocation of selected species to colder water systems.

Recent Actions in AK: (Note —this item to be completed if and when it is appropriate later in the planning process)

NS-5.36 Evaluate river, stream, and lake management plans

Review and, where appropriate, modify river, stream and lake management and fish management plans to incorporate climate change projections and to minimize other stream and river warming factors.

Recent Actions in AK: (Note —this item to be completed if and when it is appropriate later in the planning process)

NS-5.37 Determine the need for providing protected corridors

Investigate the possibility of providing needed protected river or stream corridors to facilitate the movement of species using designation, cooperative management, or acquisition.

Recent Actions in AK: (Note —this item to be completed if and when it is appropriate later in the planning process)

NS-5.38 Examine need for new protected streams, rivers, and lakes

Examine the need for new protected streams, rivers, and lakes using land management plans, land acquisition, exchanges, or other means.

Recent Actions in AK: (Note —this item to be completed if and when it is appropriate later in the planning process)

NS-5.39 Improve monitoring of key species

Increase monitoring of key species at all levels of the life cycle, including size, abundance and condition.

Recent Actions in AK: (Note —this item to be completed if and when it is appropriate later in the planning process)

NS-5.40 Monitor impacts on fish

Monitor impacts on fish of specific impacts such as slumping events and beaver pond expansion.

Recent Actions in AK: (Note —this item to be completed if and when it is appropriate later in the planning process)

NS-5.41 Evaluate appropriateness of fish regulations

Review and, where appropriate, modify fish seasons, take, and other regulations to reflect changes in fish abundance, locations, and timing, including providing opportunities for harvesting new species.

Recent Actions in AK: (Note —this item to be completed if and when it is appropriate later in the planning process)

Impacts on birds and other non-fish freshwater dependent species

Current impacts – loss of animals due to flooding events; impact on muskrats, waterfowl, migratory birds, and other species from smaller or eliminated ponds and lakes (e.g., scaup declines from over 7 million to 3.2 million). *Future projections – further reductions in waterfowl and other pond and lake dependent species.*

NS-5.42 Convene expert panel

Convene bird and other non-fish freshwater dependent species experts, together with management and other experts, to assess current and projected impacts of climate change on these species, and complete an assessment.

Recent Actions in AK: (Note —this item to be completed if and when it is appropriate later in the planning process)

NS-5.43 Identify at-risk species

Identify species at greatest risk.

Recent Actions in AK: (Note —this item to be completed if and when it is appropriate later in the planning process)

NS-5.44 Reserve water

Reserve water for key fish and wildlife areas.

Recent Actions in AK: (Note —this item to be completed if and when it is appropriate later in the planning process)

NS-5.45 Evaluate strategies to protect at-risk species

Examine and, where appropriate, implement available strategies to protect species at greatest risk.

Recent Actions in AK: (Note —this item to be completed if and when it is appropriate later in the planning process)

NS-5.46 Review and modify management plans

Review and, where appropriate, modify management plans to incorporate climate change projections.

Recent Actions in AK: (Note —this item to be completed if and when it is appropriate later in the planning process)

NS-5.47 Evaluate need for protected corridors

Investigate the possibility of providing needed protected corridors to facilitate the movement of species.

Recent Actions in AK: (Note —this item to be completed if and when it is appropriate later in the planning process)

NS-5.48 Evaluate need for new protected areas

Examine the need for new protected areas using land management plans, land acquisition, exchanges, or other means.

Recent Actions in AK: (Note —this item to be completed if and when it is appropriate later in the planning process)

NS-5.49 Improve monitoring of key species

Increase monitoring of key species, including size, abundance, and condition.

Recent Actions in AK: (Note —this item to be completed if and when it is appropriate later in the planning process)

NS-5.50 Improve research

Increase research on impacts of climate change on waterfowl.

Recent Actions in AK: (Note —this item to be completed if and when it is appropriate later in the planning process)

NS-5.51 Evaluate effectiveness of habitat modification

Examine the desirability of habitat modification to create or expand lakes and ponds, as necessary.

Recent Actions in AK: (Note —this item to be completed if and when it is appropriate later in the planning process)

NS-5.52 Review and modify management plans

Review and, where appropriate, modify seasons, take, and other regulations to reflect changes in abundance, locations, and timing, including providing opportunities for harvesting new species.

Recent Actions in AK: (Note —this item to be completed if and when it is appropriate later in the planning process)

NS-6 MARINE, SEA ICE, COASTAL ENVIRONMENT, AND DEPENDENT SPECIES**Sea ice loss**

Current impacts – decline of summer Arctic Ocean sea ice (39% smaller in 2007 than recent average, and even greater loss off the coast of Alaska); decline in winter extent of Bering Sea ice; substantial thinning of ice so average is now only approximately 3 feet thick. Loss of sea ice will cause major ecological reorganizations in the Bering Sea and Arctic Ocean, likely resulting in lower overall productivity at the base of these marine food webs. Almost half the primary productivity (i.e., plant growth) occurs on the underside of sea ice or in the surface meltwater as the ice recedes during spring in these regions. Most of the plants that are not immediately consumed as the ice recedes falls to the seafloor of the continental shelf, supporting a rich bottom-dwelling community of organisms that provide food for whales, walrus and seals. With the ice gone, much of this productivity will be lost, and most of what remains will be consumed by zooplankton before reaching the bottom, because zooplankton will grow faster in the warmer water. This complex of changes will affect the entire food web, by shrinking it overall and by altering the allocation of what is left. *Future projections – greater loss and projected elimination of summer sea ice in Arctic Ocean by as early as 2013; 40% loss of Bering Sea ice projected by 2050 –citation needed; continued thinning.*

NS-6.1 Improve monitoring of sea ice in the Bering Sea and Arctic Ocean

Insure comprehensive monitoring of sea ice type, thickness, and sea ice extent in the Bering Sea and Arctic Ocean especially in the nearshore areas, which aren't as well covered by satellites.

Recent Actions in AK: (Note —this item to be completed if and when it is appropriate later in the planning process)

NS-6.2 Improve sea ice forecasts

Improve sea ice forecasts to improve safety of ice-use (e.g., subsistence hunting, transportation) and improve freeze-up and break-up timing.

Recent Actions in AK: (Note —this item to be completed if and when it is appropriate later in the planning process)

NS-6.3 Improve research on impacts of sea ice loss, later ice-up times, and earlier ice-out times

Research impacts of sea ice loss, later ice-up times, and earlier ice-out times on key variables such as nutrient cycles and consequent impact on species (pelagic vs. benthic).

Recent Actions in AK: (Note —this item to be completed if and when it is appropriate later in the planning process)

NS-6.4 Assess costs and benefits from sea ice loss

Asses costs and benefits to Alaska from sea ice loss.

Recent Actions in AK: (Note —this item to be completed if and when it is appropriate later in the planning process)

NS-6.5 Improve research on impacts of changing sea ice dynamics

Research impacts of changing sea ice dynamics on nutrients cycles, primary and secondary productivity.

Recent Actions in AK: (Note —this item to be completed if and when it is appropriate later in the planning process)

NS-6.6 Support actions to reduce greenhouse gas emissions

Support local, state, and national actions and legislation that will reduce greenhouse gas emissions and associated sea ice loss.

Recent Actions in AK: (Note —this item to be completed if and when it is appropriate later in the planning process)

Impacts on marine mammal ice dependent species

Current impacts – walrus (abandoning calves, females hauling out on land, stampeding; displacement from normal feeding areas as the sea ice edge moves to deeper water); polar bears (drownings, cannibalism, reduced cub survival, smaller skull size —a proxy for body size, more on-land denning), ice seals (collapse of some ice dens, immature seals entering the water before they are ready, less habitat), grey whales (weight decline, population impacts), humpback whales (first documented appearance in Arctic Ocean); decline of benthic habitat in Bering Sea because of less ice thereby affecting walrus and grey whales. *Future projections – with the elimination of sea ice, many marine mammal species face dramatic reductions in numbers and possible extinction; some new marine mammal species from the south may move north and compete for available habitat; patterns of distribution for pathogens in marine mammals, including some zoonoses such as Trichinella, will influence exposure in humans (Note: see the Health and Culture sector for a full discussion of impacts on human health).*

NS-6.7 Convene expert panel

Convene ice dependent species experts, together with other experts to assess current and projected impacts of climate change on these ice dependent species.

Recent Actions in AK: (Note —this item to be completed if and when it is appropriate later in the planning process)

NS-6.8 Evaluate strategies to protect at-risk species

Examine and, where appropriate, implement available strategies to protect species at greatest risk.

Recent Actions in AK: (Note —this item to be completed if and when it is appropriate later in the planning process)

NS-6.9 Review and modify management plans

Review and, where appropriate, modify management plans to incorporate climate change projections.

Recent Actions in AK: (Note —this item to be completed if and when it is appropriate later in the planning process)

NS-6.10 Evaluate need for protected corridors

Investigate the possibility of providing needed protected corridors to facilitate the movement of species.

Recent Actions in AK: (Note —this item to be completed if and when it is appropriate later in the planning process)

NS-6.11 Evaluate need for creating new protected areas

Examine the need for creating new protected areas (for such needs as walrus haul outs) through land management plans, land acquisition, exchanges, or other means

Recent Actions in AK: (Note —this item to be completed if and when it is appropriate later in the planning process)

NS-6.12 Examine regulatory, management, and biological impacts of new species

Examine the regulatory, management, and biological implications of new species, such as humpback whales, in the Arctic Ocean.

Recent Actions in AK: (Note —this item to be completed if and when it is appropriate later in the planning process)

NS-6.13 Consider new regulations

Consider promulgating new regulations regarding human behavior that will provide greater protection to avoid stampeding and other problems in walrus haul outs and other sensitive areas.

Recent Actions in AK: (Note —this item to be completed if and when it is appropriate later in the planning process)

NS-6.14 Improve protection of polar bear denning sites

Consider providing greater protections for polar bear denning sites.

Recent Actions in AK: (Note —this item to be completed if and when it is appropriate later in the planning process)

NS-6.15 Improve monitoring of key species

Increase monitoring of key species, including size, abundance and condition.

Recent Actions in AK: (Note —this item to be completed if and when it is appropriate later in the planning process)

NS-6.16 Improve monitoring and forecasting of ocean and sea ice conditions

Increase monitoring for real time and forecasts of ocean conditions (winds, waves, currents, temperature, salinity, PH, etc.) and sea ice conditions (thickness, extent, movement, etc.) and at a scale appropriate for decision-making and then develop tailored products for various stakeholder groups using this information.

Recent Actions in AK: (Note —this item to be completed if and when it is appropriate later in the planning process)

NS-6.17 Evaluate “out of the box” strategies

Examine the possibility of “out of the box” strategies such as constructing walrus platforms.

Recent Actions in AK: (Note —this item to be completed if and when it is appropriate later in the planning process)

NS-6.18 Review and modify regulations

Review and, where appropriate, modify seasons, take and other regulations to reflect changes in abundance, locations and timing, including providing opportunities for harvesting new species, such as new seal species.

Recent Actions in AK: (Note —this item to be completed if and when it is appropriate later in the planning process)

Impacts on fish, birds, and other species from reduction in sea ice and marine terminus glaciers

Current impacts – loss of marine terminating glaciers with impacts on species such as Kittlitz’s murrelets (97% decline in Prince William Sound between 1989 and 2001; 89% decline in Glacier Bay between 1991 and 2000) and other species; in Arctic Ocean declines in species like black guillemot; in Bering Sea declines in fishery species that are benthic residing and/or feeding, such as snow crab (harvest down 85% in last 6 years), other crab, halibut, yellowfin sole, Greenland turbot, as well as certain species of birds (e.g., spectacled eiders); increase in some species (e.g., pollock, cod, arrowtooth flounder); some changes in species distribution; introduction of new species not ice dependent. *Future projections – greater declines in ice dependent species; more introduction and distribution of non-ice dependent species; greater loss of glaciers, potential extinction of Kittlitz’s murrelets.*

NS-6.19 Convene expert panel

Convene experts, fishermen, and others to assess current and projected impacts of climate change on these non-marine mammal ice dependent species.

Recent Actions in AK: (Note —this item to be completed if and when it is appropriate later in the planning process)

NS-6.20 Evaluate strategies to protect at-risk species

Examine and, where appropriate, implement available strategies to protect species at greatest risk.

Recent Actions in AK: (Note —this item to be completed if and when it is appropriate later in the planning process)

NS-6.21 Review and modify management plans

Review and, where appropriate, modify management plans to incorporate climate change projections.

Recent Actions in AK: (Note —this item to be completed if and when it is appropriate later in the planning process)

NS-6.22 Evaluate need for new protected areas

Examine the need for creating new protected areas through land management plans, land acquisition, exchanges, or other means.

Recent Actions in AK: (Note —this item to be completed if and when it is appropriate later in the planning process)

NS-6.23 Improve monitoring of key species

Increase monitoring of key species, including size, abundance, and condition.

Recent Actions in AK: (Note —this item to be completed if and when it is appropriate later in the planning process)

NS-6.24 Improve monitoring and forecasting of ocean and sea ice conditions

Increase monitoring for real time and forecasts of ocean conditions (winds, waves, currents, temperature, salinity, PH, etc.) and sea ice conditions (thickness, extent, movement) and at a scale appropriate for decision-making, and develop tailored products using this information for various stakeholder groups.

Recent Actions in AK: (Note —this item to be completed if and when it is appropriate later in the planning process)

NS-6.25 Assess changes to existing commercial fisheries

Assess most likely changes to existing commercial fisheries, especially in the Bering Sea.

Recent Actions in AK: (Note —this item to be completed if and when it is appropriate later in the planning process)

NS-6.26 Assess opportunities for commercial fisheries

Assess potential commercial fishing opportunities in the Arctic Ocean.

Recent Actions in AK: (Note —this item to be completed if and when it is appropriate later in the planning process)

NS-6.27 Reduce stressors on declining species

Reduce other stressors on rapidly declining species like Kittlitz's Murrelets.

Recent Actions in AK: (Note —this item to be completed if and when it is appropriate later in the planning process)

NS-6.28 Review and modify regulations

Review and, where appropriate, modify seasons, take, and other regulations to reflect changes in abundance, locations, and timing, including providing opportunities for harvesting new species.

Recent Actions in AK: (Note —this item to be completed if and when it is appropriate later in the planning process)

Increase in marine water temperatures

Current impacts – in 2007, Arctic Ocean 5 degrees Celsius above normal **specify if mean temperature and citation needed**; in 2005, Gulf of Alaska 2-3 degrees Fahrenheit above normal; shifts in species distribution (e.g., pollock moving northward); introduction of new species such as tuna, anchovies, sardines, pomfret, and opah; new diseases such as *Vibrio*; increase in predatory fish such as barracudas and sharks; changes in food availability and size; decreased food availability for marine birds and other species because food is lower in the water column; changes in marine productivity; harmful algal blooms adversely affecting crabs, fish, marine mammals, seabirds, and mollusks. *Future projections – greater shifts of many species north, with impacts on other species, human communities, and fishery economics (Note: fishing economics has a separate subsector below); more predatory fish with potential impacts on indigenous fish population levels; further decreases in food availability and algal blooms may result in massive die-offs; decrease in size of plankton in Bering Sea with warmer temperatures leading to problems throughout the marine food chain; potentially significant declines or elimination of sockeye salmon; shifting patterns of distribution and abundance of pathogens and parasites in marine birds, mammals, and fishes are predicted; altered seasonal patterns of abundance for parasites circulating in mollusks and birds can lead to near collapse of intertidal ecosystems through mortality of molluscan hosts.*

NS-6.29 Improve ocean temperature monitoring and reporting

Increase ocean temperature monitoring and reporting.

Recent Actions in AK: (Note —this item to be completed if and when it is appropriate later in the planning process)

NS-6.30 Examine trends and future projections

Examine trends and provide best future projections.

Recent Actions in AK: (Note —this item to be completed if and when it is appropriate later in the planning process)

NS-6.31 Research impacts of warmer ocean temperatures

Conduct additional research on impacts of warmer ocean temperatures on physical oceanic factors.

Recent Actions in AK: (Note —this item to be completed if and when it is appropriate later in the planning process)

NS-6.32 Research impacts of increased temperatures

Increase research on impacts of increased temperatures on the life cycles of key species, including salmon, trout, and grayling; and **marine** plankton.

Recent Actions in AK: (Note —this item to be completed if and when it is appropriate later in the planning process)

NS-6.33 Improve monitoring of key species

Increase monitoring of key species, including size, abundance, and condition.

Recent Actions in AK: (Note —this item to be completed if and when it is appropriate later in the planning process)

NS-6.34 Assess changes to existing commercial fisheries

Assess most likely changes to existing commercial fisheries, especially in the Bering Sea and Gulf of Alaska, including the introduction of new commercial species.

Recent Actions in AK: (Note —this item to be completed if and when it is appropriate later in the planning process)

NS-6.35 Assess opportunities for commercial fisheries

Assess potential commercial fishing opportunities in the Arctic Ocean.

Recent Actions in AK: (Note —this item to be completed if and when it is appropriate later in the planning process)

NS-6.36 Review and modify regulations

Review and, where appropriate, modify seasons, take and other regulations to reflect changes in abundance, locations and timing, including providing opportunities for new species, such as new seal species.

Recent Actions in AK: (Note —this item to be completed if and when it is appropriate later in the planning process)

NS-6.37 Provide funding for fleet modifications

Provide state loans for fishery fleet modifications to accommodate new species and opportunities.

Recent Actions in AK: (Note —this item to be completed if and when it is appropriate later in the planning process)

Ocean acidification

Current impacts – ocean acidity has increased by 30% (*where?, over what time? – citation needed*). *Future projections – increased ocean acidity, potentially increasing to pH 7.9 by end of century; adverse impacts on calcium carbonate dependent species, from plankton such as pteropods to shellfish such as crabs, especially at larval stages; adverse impacts on deep sea coral and the coral dependent communities; adverse impacts on other species such as squid; adverse impacts on species that consume these species (such as salmon and pteropods).*

NS-6.38 Research impacts of ocean acidification

Research impacts of ocean acidification on key species.

Recent Actions in AK: (Note —this item to be completed if and when it is appropriate later in the planning process)

NS-6.39 Research impacts of increasing freshwater from glacier melt

Research impacts on habitats for increasing freshwaters from glacier melt.

Recent Actions in AK: (Note —this item to be completed if and when it is appropriate later in the planning process)

NS-6.40 Analyze risk to marine ecosystems and fishing industry from ocean acidification

Analyze risks to Alaska’s marine ecosystems and fishing industry from current and projected ocean acidification.

Recent Actions in AK: (Note —this item to be completed if and when it is appropriate later in the planning process)

NS-6.41 Convene expert panel

Convene experts to expand the analysis and understanding of the current and projected impacts from ocean acidification.

NS-6.42 Improve monitoring

Increase monitoring especially of pH, deep sea coral, shell fish larvae, and vulnerable plankton.

Recent Actions in AK: (Note —this item to be completed if and when it is appropriate later in the planning process)

NS-6.43 Reduce additive threats

Consider reducing additive threats to species most at risk, such as deep sea coral.

Recent Actions in AK: (Note —this item to be completed if and when it is appropriate later in the planning process)

NS-6.44 Support reducing carbon dioxide emissions

Support actions that will reduce carbon dioxide emissions at the federal, state, organizational, and individual level.

Recent Actions in AK: (Note —this item to be completed if and when it is appropriate later in the planning process)

NS-7 OTHER WARM TEMPERATURE IMPACTS ON ANIMALS

Non-fish animal impacts in addition to habitat-based changes

Current impacts – loss of animals due to new or increased viral, bacterial, and parasitic diseases, such as lungworm in muskoxen (a tipping point changing transmission from a 2 year to a 1 year cycle was reached in the 1990s); muscleworms in caribou where responses to extreme warm weather events can drive emergence of disease and mortality; increasing abundance of biting fly vectors linked to the emergence of parasitic diseases in reindeer; new distributions for viral pathogens in rodents (potentially transmissible to humans) through range expansion; earlier arrival and birthing of migratory species including birds, whales, etc. (e.g., hatch dates for geese in Yukon Delta 5-10 days earlier since 1982); new species both to the state as a whole and to specific areas; greater predation threats to eggs after storm surges reduce vole populations. *Future projections – more new or increased emergence of pathogens, diseases, and vectors (e.g., injury or death to moose from excessive ticks and deer-borne pathogens, including winter tick); potential new diseases affecting caribou; more damage to muskoxen and wild sheep from lungworm; other potential disease damage to caribou, muskoxen, and dall sheep; increase in biting flies both as direct nuisance and as vectors.*

NS-7.1 Improve monitoring of species

Increase monitoring of species numbers, diseases, distribution, and condition.

Recent Actions in AK: (Note —this item to be completed if and when it is appropriate later in the planning process)

NS-7.2 Establish or expand disease registries and reporting

Establish or expand disease registries and reporting.

Recent Actions in AK: (Note —this item to be completed if and when it is appropriate later in the planning process)

NS-7.3 Convene expert panel

Convene experts to examine the impact of climate change on current and new animal diseases, and to review possible controls.

Recent Actions in AK: (Note —this item to be completed if and when it is appropriate later in the planning process)

NS-7.4 Develop and implement strategies for at-risk species

Develop and implement specific strategies for species at greatest risk.

Recent Actions in AK: (Note —this item to be completed if and when it is appropriate later in the planning process)

NS-7.5 Research disease control strategies

Research, consider, and where appropriate, implement vaccination or other disease control strategies.

Recent Actions in AK: (Note —this item to be completed if and when it is appropriate later in the planning process)

NS-7.6 Research impacts of early migratory arrivals and hatching dates

Research impacts of early migratory arrivals and hatching dates on key species.

Recent Actions in AK: (Note —this item to be completed if and when it is appropriate later in the planning process)

NS-7.7 Research impacts of major storm surges

Research impacts of major storm surges on fish and wildlife populations and response strategies.

Recent Actions in AK: (Note —this item to be completed if and when it is appropriate later in the planning process)

NS-7.8 Review and modify regulations

Review and, where appropriate, modify seasons, take and other regulations to reflect changes in abundance, locations and timing, including providing opportunities for new species and earlier arrivals.

Recent Actions in AK: (Note —this item to be completed if and when it is appropriate later in the planning process)

NS-8 FISHING: COMMERCIAL AND SPORT

Commercial fishing

Current impacts – changes in fish distribution and catch composition; northern migration of species such as pollock (in some cases outside of U.S. waters); some fish farther away from on-shore processors, harbors, and communities, requiring further travel; introduction of new species such as tuna; declines in catch of benthic species in Bering Sea and elsewhere such as most species of crab, shrimp, and in some locations, halibut; increase in some pelagic species (e.g., cod). *Future projections – opening up of the northern Bering Sea and Arctic Ocean to the possibility of commercial fishing and potential conflicts with other fishing nations; greater introduction of new species; need for new gear and new infrastructure (harbors, ice plants,*

processing, airport shipment, etc); continued declines in benthic species; decline of sockeye salmon; potentially more dangerous fishing conditions due to greater storms, and more intensive waves (without sea ice protective barrier), less weather predictability, and the need to travel farther distances.

NS-8.1 Convene expert panel

Convene a statewide conference to examine current and projected impacts of climate change, including ocean acidification, on commercial fishing and prepare a report with specific recommended actions.

Recent Actions in AK: (Note —this item to be completed if and when it is appropriate later in the planning process)

NS-8.2 Assess statewide impacts of current and projected climate change on commercial fishing opportunities

Complete a comprehensive assessment of the statewide impacts of current and projected climate change on commercial fishing opportunities.

Recent Actions in AK: (Note —this item to be completed if and when it is appropriate later in the planning process)

NS-8.3 Improve monitoring and reporting efforts

Increase monitoring, observing, and reporting of species numbers, composition, and condition.

Recent Actions in AK: (Note —this item to be completed if and when it is appropriate later in the planning process)

NS-8.4 Improve monitoring and forecasting of ocean and sea ice conditions

Increase monitoring for real time and forecasts of ocean conditions (winds, waves, currents, temperature, salinity, PH, etc.) and sea ice conditions (thickness, extent, movement) and at a scale appropriate for decision-making, and develop tailored products using this information for various stakeholder groups.

Recent Actions in AK: (Note —this item to be completed if and when it is appropriate later in the planning process)

NS-8.5 Provide funding for fishermen

Provide state loans for boat, gear, and other adaptation.

Recent Actions in AK: (Note —this item to be completed if and when it is appropriate later in the planning process)

NS-8.6 Develop new markets

Help develop new markets as new species enter Alaskan waters.

Recent Actions in AK: (Note —this item to be completed if and when it is appropriate later in the planning process)

NS-8.7 Address strategies for increased foreign competition

Develop strategies for addressing increased foreign competition and resolve boundary disputes with Russia in the Northern Bering Sea and Arctic Ocean to reduce fishing conflict possibilities.

Recent Actions in AK: (Note —this item to be completed if and when it is appropriate later in the planning process)

NS-8.8 Increase Coast Guard presence

Increase Coast Guard presence in northern Bering Sea and Arctic Ocean.

Recent Actions in AK: (Note —this item to be completed if and when it is appropriate later in the planning process)

NS-8.9 Reduce stressors to key species

Reduce other stressors to key species.

Recent Actions in AK: (Note —this item to be completed if and when it is appropriate later in the planning process)

NS-8.10 Assess infrastructure requirements

Assess what infrastructure requirements exist for more northern fisheries, and provide that infrastructure, as needed.

Recent Actions in AK: (Note —this item to be completed if and when it is appropriate later in the planning process)

NS-8.11 Review and modify regulations

Review and, where appropriate, modify seasons, limits, areas, gear types, and other variables to reflect changes in abundance, locations, and timing, including providing opportunities for harvesting new species and earlier arrivals.

Recent Actions in AK: (Note —this item to be completed if and when it is appropriate later in the planning process)

NS-8.12 Improve monitoring and forecasting of ocean and sea ice conditions

Increase monitoring for real time and forecasts of ocean conditions (winds, waves, currents, temperature, salinity, PH, etc.) and sea ice conditions (thickness, extent, movement) and at a scale appropriate for decision-making, and develop tailored products using this information for various stakeholder groups.

Recent Actions in AK: (Note —this item to be completed if and when it is appropriate later in the planning process)

Sports fishing business

Future projections – likely decline in cold water sports fish such as grayling, steelhead, some salmon in warmer streams, and rainbow trout; longer open water season with potentially higher harvest rates on recreational fish; greater requests to stock non-native warmer water fish; changed access to water bodies for fishing; more dangerous fishing conditions due to greater intensity and/or frequency of storms, less weather predictability, and the need to travel farther distances (e.g., for halibut).

NS-8.13 Assess statewide impacts of current and projected climate change

Complete a comprehensive assessment of the statewide impacts of current and projected climate change on sports fishing opportunities and the sports fishing industry.

Recent Actions in AK: (Note —this item to be completed if and when it is appropriate later in the planning process)

NS-8.14 Consider criteria for stocking non-native species

Consider requests for stocking non-native species and the need to have criteria for that decision.

Recent Actions in AK: (Note —this item to be completed if and when it is appropriate later in the planning process)

NS-8.15 Improve observing and reporting

Increase monitoring, observing and reporting of species numbers, composition and condition.

Recent Actions in AK: (Note —this item to be completed if and when it is appropriate later in the planning process)

NS-8.16 Solicit feedback from the public

Provide the public an opportunity to report changes they are observing associated with sports fishing regarding fishery composition, abundance, location, and condition.

Recent Actions in AK: (Note —this item to be completed if and when it is appropriate later in the planning process)

NS-8.17 Educate the public about impacts of climate change

Provide public education regarding the impacts of climate change on sports fishing, including new fishing opportunities.

Recent Actions in AK: (Note —this item to be completed if and when it is appropriate later in the planning process)

NS-8.18 Review and modify regulations

Review and, where appropriate, modify seasons, limits, areas, gear types, and other variables to reflect changes in abundance, locations, and timing, including providing opportunities for harvesting new species and earlier arrivals.

Recent Actions in AK: (Note —this item to be completed if and when it is appropriate later in the planning process)

NS-9 SUBSISTENCE FISHING, HUNTING, TRAPPING AND GATHERING

Decline in traditional subsistence food availability

Current impacts – decline and disease in traditional subsistence foods; changed animal migratory routes, seasons, and patterns affecting hunting; hunting more dangerous if associated with ice; other adverse hunting and fishing access issues; decline in some animals traditionally trapped (e.g., muskrats); changes in berry distribution and availability; increased abundance of pathogens and parasites with emergence of diseases in muskoxen, caribou, moose, and wild sheep can influence availability and sustainability of these and other terrestrial, aquatic, and marine animals for exploitation in the subsistence food chain. *Future projections – additional decline and disease in traditional subsistence foods; decrease in hunting opportunities for dall sheep because of loss of alpine habitat, for caribou because of food availability issues and other impacts, for muskoxen because of disease and flooding events, for polar bears, walruses, and ice seals because of decrease in sea ice, and for waterfowl because of loss of ponds and lakes; ice-based and ocean-based hunting increasingly more dangerous because of thinning ice and unpredictable ice behavior; some new subsistence food possibilities (e.g., salmon in northern Alaska).*

NS-9.1 Assess statewide impacts of current and projected climate change

Complete a comprehensive assessment of the statewide impacts of current and projected climate change on subsistence hunting, fishing, and gathering opportunities.

Recent Actions in AK: (Note —this item to be completed if and when it is appropriate later in the planning process)

NS-9.2 Convene a statewide conference

Convene a statewide conference of regional subsistence representatives to examine current and projected impacts of climate change on subsistence hunting, fishing and gathering, including exploring new opportunities, and prepare a report with specific recommended actions.

Recent Actions in AK: (Note —this item to be completed if and when it is appropriate later in the planning process)

NS-9.3 Improve monitoring and reporting

Increase monitoring, observing and reporting of species numbers, composition, and condition.

Recent Actions in AK: (Note —this item to be completed if and when it is appropriate later in the planning process)

NS-9.4 Provide forum for fishers, hunters, and gatherers to report observed changes

Provide subsistence fishers, hunters and gatherers an opportunity to report changes they are observing associated with their hunting, fishing and gathering activities, including species composition, timing, abundance, location, and condition.

Recent Actions in AK: (Note —this item to be completed if and when it is appropriate later in the planning process)

NS-9.5 Educate public about impacts of climate change

Provide public education regarding the impacts of climate change on subsistence opportunities.

Recent Actions in AK: (Note —this item to be completed if and when it is appropriate later in the planning process)

NS-9.6 Increase disease testing

Provide increased disease testing to create greater consumption confidence.

Recent Actions in AK: (Note —this item to be completed if and when it is appropriate later in the planning process)

NS-10 SPORT HUNTING

Current impacts – changes in seasons and location of some species in some locations (e.g., caribou and moose). *Future projections – decrease in hunting opportunities for dall sheep because of loss of alpine habitat, for caribou because of food availability issues and other impacts, for muskoxen because of disease and flooding events, for waterfowl because of loss of*

ponds and lakes, etc.; new hunting opportunities as new species arrive or are introduced (e.g., possible expanded hunting for Sitka deer, bison).

NS-10.1 Assess statewide impacts of current and projected climate change

Complete a comprehensive assessment of the statewide impacts of current and projected climate change on sports hunting.

Recent Actions in AK: (Note —this item to be completed if and when it is appropriate later in the planning process)

NS-10.2 Convene statewide conference

Convene a statewide conference of sports hunting representatives to examine current and projected impacts of climate change, including exploring new opportunities, and prepare a report with specific recommended actions.

Recent Actions in AK: (Note —this item to be completed if and when it is appropriate later in the planning process)

NS-10.3 Improve monitoring and reporting

Increase monitoring, observing and reporting of species numbers, composition and condition.

Recent Actions in AK: (Note —this item to be completed if and when it is appropriate later in the planning process)

NS-10.4 Solicit feedback from sports hunters

Provide sports hunters an opportunity to report changes they are observing associated with their hunting activities, including species composition, abundance, timing, location, and condition.

Recent Actions in AK: (Note —this item to be completed if and when it is appropriate later in the planning process)

NS-10.5 Educate public about impacts of climate change

Provide public education regarding the impacts of climate change on sports hunting opportunities.

Recent Actions in AK: (Note —this item to be completed if and when it is appropriate later in the planning process)

NS-11 TOURISM AND WATCHABLE WILDLIFE

Summer and shoulder seasons

Current impacts – longer summer and shoulder tourism season; expansion of cruise season; expansion of other summer and shoulder tourism opportunities throughout the state; some adverse impacts on summer tourism, including melting of glaciers, reducing tourism attractions (e.g., Portage), damaged roads, and diseased and dying forests; summer smoke from large wildland fires causes disruption in tourism (e.g., visibility diminished of Denali and other sites, highway closures); health issue for tourists (e.g., smoke and Vibrio); hotter temperatures without air-conditioning. *Future projections – even greater expansion of summer season; increased melting, decline, and/or elimination of glaciers; more dead and dying trees; greater disruption from smoke over a longer season; hotter, especially in interior Alaska.*

NS-11.1 Maintain roads, airports, and bridges

Provide proper road, airport, and bridge maintenance that is responsive to climate change to support the needs of the tourism economy.

Recent Actions in AK: (Note —this item to be completed if and when it is appropriate later in the planning process)

NS-11.2 Market Alaska's longer summer season

Help market Alaska's longer summer season.

Recent Actions in AK: (Note —this item to be completed if and when it is appropriate later in the planning process)

NS-11.3 Help extend services in response to longer seasons

Work with communities to extend services in response to longer seasons.

Recent Actions in AK: (Note —this item to be completed if and when it is appropriate later in the planning process)

NS-11.4 Evaluate cooling needs

Examine and respond to cooling needs associated with warmer summers.

Recent Actions in AK: (Note —this item to be completed if and when it is appropriate later in the planning process)

NS-11.5 Address changed itineraries

Adjust permits and other requirements to address changed itineraries due to impacts from climate change.

Recent Actions in AK: (Note —this item to be completed if and when it is appropriate later in the planning process)

NS-11.6 Provide adequate health system responses

Insure adequate health system responses for tourists in case of smoke, fire, flooding, or disease emergencies.

Recent Actions in AK: (Note —this item to be completed if and when it is appropriate later in the planning process)

NS-11.7 Locate visitor centers aware of future climate changes

Locate visitor centers with an awareness of future climate changes.

Recent Actions in AK: (Note —this item to be completed if and when it is appropriate later in the planning process)

NS-11.8 Examine tourism expansion

Study expansion of tourism into the Arctic Ocean and assess infrastructure and other needs.

Recent Actions in AK: (Note —this item to be completed if and when it is appropriate later in the planning process)

NS-11.9 Modify interpretive signage

Modify interpretive signage to reflect changed species composition or other impacts from climate change.

Recent Actions in AK: (Note —this item to be completed if and when it is appropriate later in the planning process)

Winter tourism season

Current impacts – shorter season; some adverse impacts include canceling of dog sled racing events (cancellation of Fur Rendezvous races 3 times in the last 9 years), changing start of Iditarod, shorter downhill skiing season, less cross-country skiing; positive impacts include warmer temperatures in previously very cold locations such as Chena Hot Springs and Bettles. *Future projections – increased reduction in winter season, dog sled races, downhill skiing, and lower elevation cross-country skiing; continued more comfortable temperatures for previously very cold locations.*

NS-11.10 Report the likely impacts of climate change

Study and prepare a report that examines the likely impacts of climate change on winter tourism, given an appropriate range of winter temperature increase assumptions.

Recent Actions in AK: (Note —this item to be completed if and when it is appropriate later in the planning process)

NS-11.11 Assess benefits of warmer winter temperatures

Explore benefits of warmer, but still below freezing, winter temperatures for winter tourism in locations like Bettles.

Recent Actions in AK: (Note —this item to be completed if and when it is appropriate later in the planning process)

NS-11.12 Examine possibility of expanding higher altitude lands for recreation

Examine the possibility of making additional higher altitude lands available for activities like downhill skiing.

Recent Actions in AK: (Note —this item to be completed if and when it is appropriate later in the planning process)

NS-11.13 Examine alternative winter activities

Examine alternative winter activities for tourism.

Recent Actions in AK: (Note —this item to be completed if and when it is appropriate later in the planning process)

NS-11.14 Consider establishing earlier dates for major winter events

Explore establishing earlier dates for major winter events.

Recent Actions in AK: (Note —this item to be completed if and when it is appropriate later in the planning process)

Watchable wildlife

Current impacts – less watchable wildlife for such species as Kittlitz’s murrelets that have already declined significantly; changes in watchable wildlife distribution and timing (e.g., arrival dates of migratory birds). *Future projections – fewer watchable wildlife opportunities if populations of dall sheep, mountain goats, muskoxen, caribous, certain birds, etc., decline; potentially more watchable wildlife opportunities in the near term for polar bears and walruses on land; new watchable wildlife opportunities as new species arrive.*

NS-11.15 Report the likely impacts of climate change

Study and prepare a report that examines the likely impacts of climate change on watchable wildlife.

Recent Actions in AK: (Note —this item to be completed if and when it is appropriate later in the planning process)

NS-11.16 Modify or create interpretive signage

Modify or create interpretive signage to reflect changed species composition or other impacts from climate change.

Recent Actions in AK: (Note —this item to be completed if and when it is appropriate later in the planning process)

NS-11.17 Consider new wildlife regulations

Consider the need to promulgate new watchable wildlife regulations, especially with respect to polar bears and walrus as they become more prevalent on land to avoid disturbances and hazardous situations.

Recent Actions in AK: (Note —this item to be completed if and when it is appropriate later in the planning process)

NS-11.18 Allow wildlife observers to report observed changes

Provide wildlife observers an opportunity to report changes they are seeing associated with watchable wildlife activities, including species composition, abundance, timing, location, and condition.

Recent Actions in AK: (Note —this item to be completed if and when it is appropriate later in the planning process)

NS-11.19 Educate the public about the impacts of climate change

Provide other public education about the impacts of climate change on watchable wildlife, including new watchable wildlife opportunities.

Recent Actions in AK: (Note —this item to be completed if and when it is appropriate later in the planning process)

NS-12 OTHER ADAPTATION ISSUES

NS-12.1 Evaluate the claim that Alaska should receive compensation as a carbon sink

Research, document, and potentially pursue the claim that Alaska should receive compensation as a carbon sink for temperate rainforests, oceans, and other natural areas.

Recent Actions in AK: (Note —this item to be completed if and when it is appropriate later in the planning process)

NS-12.2 Develop research and practitioner training program

Develop a comprehensive research and practitioner training program in climate change adaptive management.

Recent Actions in AK: (Note —this item to be completed if and when it is appropriate later in the planning process)

NS-12.3 Develop climate change indicators

Develop a set of useful climate change indicators (including species), identify the most effective ways to monitor them over the short/mid/long term, and develop report card for public use.

Recent Actions in AK: (Note —this item to be completed if and when it is appropriate later in the planning process)

NS-12.4 Conduct a vulnerability assessment

Complete a vulnerability assessment to identify specific species, habitats, landscapes, ecosystem functions, and cultural resources that may be most sensitive to climate change in order to prioritize.

Recent Actions in AK: (Note —this item to be completed if and when it is appropriate later in the planning process)

NS-12.5 Review the CZMA and other laws

Review Coastal Zone Management Act and other laws to determine need for new tools and responses for climate change impacts.

Recent Actions in AK: (Note —this item to be completed if and when it is appropriate later in the planning process)

NS-12.6 Ensure that revenues from auctioning emission allowances are dedicated to conserving wildlife and other natural resources threatened by climate change

Ensure that a substantial portion of the revenues from the auction of emission allowances under state climate change legislation or from OCS oil and gas development are dedicated to conserving wildlife and other natural resources threatened by climate change.

Recent Actions in AK: (Note —this item to be completed if and when it is appropriate later in the planning process)