Anticipating Climate Change in Montana

A report on the workshop with Montana Department of Fish, Wildlife and Parks focused on the Sagebrush-Steppe and Yellowstone River systems

Workshop held in Bozeman Montana on December 9-10, 2008

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This report and other workshop materials and references available at:

https://online.nwf.org/site/SPageServer?pagename=NRNRC_CCFWP2008
or
http://www.worldwildlife.org/what/wherewework/ngp/publications.html
or
http://wcs.org/northamerica

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Executive Summary and Overview of Plenary Session

About 30 field and supervisory staff from the Montana Department of Fish, Wildlife and Parks (FWP) along with an equal number of representatives from non-governmental organizations and invited scientists convened during December 2008 for a 1.5 day-long workshop designed to identify impacts of climate change on the habitats, animals, and fish that inhabit the Yellowstone River and the sagebrush-steppe systems in Montana. Specific objectives of the workshop were:

- Increased awareness of the relevance of climate change as a challenge facing fish and wildlife managers in Montana;
- Identification of potential impacts and opportunities related to climate change on Yellowstone River fisheries and sage-steppe wildlife communities;
- Identification of areas where existing fish and wildlife management plans for these two systems are inadequate to address potential challenges posed by a climate change and development of a process for making needed changes;
- Identification of important ecosystem attributes that should be monitored to assess direction and pace of climate-induced changes in the selected ecosystems;
- Identification of available and useful management responses to changes anticipated under different scenarios or observed by monitoring efforts;
- Recommendations for further exploration of the impacts of climate change on fish and wildlife conservation in these and other ecosystems in Montana.

There were separate breakout sessions for each system under consideration, during which time participants were asked to identify impacts and management responses for three feasible climate scenarios. All scenarios included temperature increases, but varied in amount and seasonality of precipitation. Participants generally agreed that impacts might vary in magnitude among scenarios, but that the kinds of required management responses would vary relatively little. Among other functions, these discussions anticipated new perspectives on ongoing and needed future planning efforts including the State Wildlife Action Plans and on ways to effectively spend funds allocated to help wildlife and fisheries adapt to climate change.

In an introductory plenary presentation, Wyoming State Climatologist Dr. Steve Gray indicated that climate change is likely to result in warmer temperatures throughout western United States and Montana, and while precipitation changes are less certain, there may be general increases in precipitation in the winter and decreases in the summer. Dr. Gray anticipates the future will most likely bring earlier spring snowmelt (already 4-7 weeks earlier than historical records), less snow accumulation as more winter precipitation falls as rain, more frequent and extreme summer droughts, and more extreme variation in both temperature and precipitation. These changes will have obvious consequences for fish and wildlife management as assumptions about what constitutes "normal" conditions break down. Regardless, we know enough now to start anticipating likely consequences and adapting our management strategies to prepare for those changes.

In a presentation on terrestrial system responses to changing climate, University of Wyoming Botanist Dr. Bill Lauenroth discussed how large-scale distributions of vegetation types are controlled by temperature and water availability, and predicted that current sagebrush-steppe habitats in Montana may generally see gains in xeric shrub species, declines in perennial and tall grasses, and increases in

annual and short grasses. Other issues of concern for terrestrial systems in the region include how changing climate conditions may alter phenology (timing of life cycle events) for plants and animals, the likelihood of non-native invasions, the length and intensity of wildfire seasons, and the spread of pests, pathogens, and diseases.

Dr. Bob Gresswell of the U.S. Geological Survey highlighted some key risk factors facing aquatic systems as climate changes in western United States, including low baseflows, high water temperatures in late summer, larger and more frequent winter flood events, and more frequent wildfires. Cold water fish species are likely to experience significant habitat contractions, whereas warmer water species may see some expansions of habitat availability. However, if the rate of change is too rapid, or human activities prevent the movement of species or degrade habitat conditions, species may not be able to respond naturally to changing conditions caused by climate warming.

Dr. Molly Cross of the Wildlife Conservation Society emphasized that it is critical to clearly define management objectives, and that these should not be static but, rather, set into an iterative framework that is proactive and place-based. Managers should consider whether their goals include resisting the consequences of climate change, increasing the resilience of their system by reducing other stressors, facilitating the response of the system to changing conditions and extreme events, or encouraging realignment to a new state based on new realities. It also may be necessary to choose which species to save (triage) in order to use available resources efficiently. Given the uncertainties of predicting the consequences of climate change, scenario-based planning may be a valuable tool for thinking through possible management responses and overcoming the paralysis of uncertainty.

During the breakout sessions, participants were asked to fill out a matrix documenting their expert opinions for each climate scenario on:

1) impacts to habitats, species and/or guilds of species;
2) possible management responses to these impacts;
3) monitoring priorities;
4) research priorities; and
5) shortcomings in existing wildlife management planning efforts.

The climate scenarios were developed prior to the workshop, and were based on discussions with Dr. Gray and examinations of climate model output from the 2007 assessment report by the Intergovernmental Panel on Climate Change. All scenarios included increases in mean annual temperatures, but differed in the amount and seasonality of precipitation. Scenarios differed slightly between the Yellowstone River and sagebrush-steppe breakout discussions, but both included at least one scenario of increased precipitation and one scenario of decreased precipitation. Priority management responses, monitoring, and research activities for each system are summarized below.

Sagebrush-steppe System. Two key priority management responses to climate change included:

1) closer coordination with federal agencies that manage the majority of publicly-owned habitat in the sagebrush-steppe system; and
2) helping assure that private-land conservation incentives in the farm bill are maintained and strengthened.

Protection of large blocks of unfragmented and interconnected habitats was considered a more feasible management response than efforts to restore sagebrush-steppe habitat conditions lost as a consequence of climate change. Better mapping of the extent of sagebrush-dominated systems was identified as a

priority research need, as well as developing a state-wide monitoring initiative that will standardize monitoring efforts that are ongoing at a local scale. Finding new sources of funding for sagebrush habitat conservation and maintaining recreational hunting opportunities, and the corresponding funding base for FWP, was identified as important to FWP's ability to mitigate changes caused by climate change. During the 2010 revisions of the Montana Comprehensive Fish and Wildlife Conservation Strategy, it will be important to clearly incorporate anticipated impacts from climate change. A planning process within FWP on crucial areas and connectivity that includes climate change and other threats to the success of FWP's management efforts is currently ongoing.

Yellowstone River System. A critical management need will be to maintain water in tributaries, prairie streams and the mainstem of the river in the face of likely declines in flows, especially during late summer. Low flows combined with hotter air temperatures will increase water temperature and increase threats to native fish, especially cold water species and migratory species such as those that live in the mainstem but spawn in the tributaries. Removal of fish passage barriers will be necessary to allow fish species to move upstream in response to changing water temperatures. Conservation of threatened native cold water species such as Yellowstone cutthroat trout will require identification and protection of cold water habitat refugia, although some extinction of native species will likely occur. As the climate changes, the legal system regarding water allocation likely will need to be reexamined to accommodate additional demands from multiple sectors on decreasing water resources. Protection and restoration of floodplain and riparian areas will increase the natural "sponge" effect of upland areas and reduce negative consequences for stream flows. Additional monitoring of changes in climate and fish habitat is needed on a watershed basis to guide management responses. Additional research is needed on changes that will occur, or are occurring, in aquatic food webs.

Report on the Yellowstone River Breakout Session

Yellowstone River Scenarios

The scenarios for this breakout session all included an annual average temperature increase of 3°F and:

Scenario A: No change in annual precipitation, peak spring runoff 2-4 weeks earlier, roughly 10-14% decrease in base flow, warmer late summer water temperatures.

Scenario B: Increase of 5-10% in annual precipitation, peak spring runoff 2-4 weeks earlier, about 4-11% decrease in base flow, warmer late summer water temperatures.

Scenario C: Decrease of 5-10% in annual precipitation, peak spring runoff 2-4 weeks earlier, base flows as much as 30% lower than historical averages, much warmer late summer water temperatures.

Generally, participants agreed that impacts to habitats and species, as well as management responses to challenges posed by climate change, would be similar across all three climate scenarios. Scenario C would clearly have the strongest consequences and provide more challenges to management than the other scenarios because of the more extreme changes in the hydrograph and increases in water temperature. Because all three scenarios result in warmer and drier conditions, and the workshop discussions were largely qualitative rather than quantitative, the resulting summaries of impacts and management responses apply to all three climate scenarios.

Impacts on Yellowstone River Aquatic and Riparian Habitats

The workshop considered the stretch of the Yellowstone River in Montana from the Yellowstone Park border to Miles City. In the upper reaches of the Yellowstone River, there likely will be a contraction of existing cold water habitats, an increase in the occurrence of fish kills due to increasing temperatures, and a loss of connectivity due to lower flows. In the lower Yellowstone River, concerns include the potential loss of turbidity and water quality, reduced icing, and loss of tributary connectivity because of reduced flows and the presence of diversion dams. Mainstem habitats will become warmer and experience lower flows, with a likely loss of habitat diversity and connectivity. Summer flows in prairie streams are already tenuous due to intermittent flows, earlier and reduced peak flows, and diversions for irrigation. Warmer and drier conditions are likely to exacerbate these problems and further reduce habitat availability and suitability for species that depend on prairie streams. Riparian vegetation communities may experience shifts in species composition, increased isolation from stream flow, increased stream bed erosion, increased water temperatures from reduced shading, and increased invasion by salt cedar.

Impacts on Yellowstone River Species and Guilds

Cold water fish species generally will be negatively impacted by warm late summer temperatures, habitat contractions, and overwinter conditions. Some cold water species that spawn in tributaries may have difficulty completing their life cycle. Even if flows are adequate in the spring for them to access the tributaries for spawning, there may not be adequate flows for incubation and hatching or for outmigration to the mainstem in August. *Yellowstone cutthroat trout* are likely to face significant challenges including tributary disconnects, increased predation, increased hybridization with non-native trout, increased temperature-related fry mortality, and possibly increased disease issues. *Burbot* and *mountain whitefish* are likely to be sensitive to changes in water temperature, diseases, and icing events, although more biological research on these species will be necessary to understand detailed consequences. *Brown and rainbow trout* are both likely to fair relatively better with warmer and drier conditions due to higher temperature tolerances and adaptability.

Warm and cool water fish species may have opportunities to shift distributions upstream, although other non-temperature habitat conditions may not be appropriate for those species. The degradation of habitat conditions in their current ranges may also prevent these species from surviving long enough to migrate upstream. Pallid sturgeon may find it more difficult to carry out spawning migrations. *Sauger* may suffer from low flows, decreased connectivity with tributaries for spawning, increased competition due to low turbidity, decreased late spring prairie melt, and increased hybridization and competition with non-natives. Species such as *small mouth bass, carp, walleye* and *brook trout* are expected to fair relatively better due to expanding habitat conditions as temperatures warm.

Guilds that generally will fare worse under the climate scenarios considered include *tributary spawners, bottom feeders, insect feeders, short-lived species, specialist species, and species with migratory life histories.*

Guilds that will benefit or fare relatively better include *mainstem spawners, piscivores, long-lived species, generalist species and those with non-migratory life histories.* As habitat conditions change, exotic species may out-compete some native species.

Uncertainties include specific knowledge of threshold points with respect to water temperature and flows at which specific species will be affected and habitats will contract or expand. Increased wildfire frequency and severity in the upper river reaches and possible altered disease dynamics also are likely to be important factors affecting aquatic species. Reductions in icing during winter may help overwinter survival for some species in some areas, but this may be compensated by increased icing in areas with reduced winter flows. There is concern that warmer and drier conditions will negatively affect spiny soft shelled turtles (a species of concern), and numerous amphibian species, although there were no participants who were experts on those species.

Management Responses

Discussions were organized around three management objectives identified prior to the workshop:

1) maintain water flows;
2) maintain native fisheries; and
3) maintain recreational opportunities.

Participants agreed that there is urgency to implementing management responses aimed at counteracting the impact of climate change on Yellowstone River flows if species like Yellowstone cutthroat trout are going to be able to persist. Management responses must focus on maintaining sufficient water in the river to achieve any and all of the objectives although recreational fishing likely would occur under many circumstances on species better adapted to warmer waters than currently exist in the Yellowstone River.

Maintain water flows

- Legally secure senior water rights and agreements year-round, with a prioritization for late-summer flows.
- Collaborate with partners (e.g., USFS, Yellowstone River Conservation District, NGOs) to reform water laws and increase acquisition of instream rights for fish.
- Work towards a consensus with agricultural interests and other water users to increase the ability of fish and wildlife interests to leverage how water is used.
- Reduce pressures on (and restore) riparian vegetation through such means as reduction of grazing and removal of invasive species.
- Explore opportunities for temporary high-elevation water storage to increase summer flows in ways that won't impact natural recruitment and fish passage (e.g. beaver dams, groundwater storage, off-stream storage, selective withdrawals, and aquifer recharge basins).
- Increase understanding of impacts of different irrigation methods (e.g. flood and sprinkler systems) and work with irrigators to use the method that has the least impact on stream flows as climate changes.
- Increase the natural sponge effect of floodplain areas through actions such as reducing development in floodplains and removing streambed engineering.
- Be alert to threats posed by new hydropower proposals.

Maintain native fisheries

- Maintain water flows as outlined above.
- Concentrate native fish restoration activities in those areas most likely to remain suitable habitat for cold water fish species.

- Remove impediments to fish passage in the mainstem, starting from downstream regions and working upstream. Tributary impediments to passage also should be addressed.
- Place greater emphasis on non-native species removal to reduce competition between natives and non-natives, and maximize habitat availability for natives as climate changes.
- Re-examine culverts, road-crossings, and other barriers for necessary upgrades that climate change will make more necessary and urgent.

Maintain recreational opportunities

- Maintain water flows as outlined above.
- Increase information and education efforts based on updated economic assessments of the value of native fish and habitats, and the relative value of maintaining water instream instead of for other uses.
- Explore ways to carefully market native fishing opportunities (e.g., as a "unique" and, therefore, more costly fishing experience), as well as fishing opportunities for new species entering the system (although this might create a constituency for the new species at the cost of protecting native species).
- Be prepared for angler shifts to alternative species that are not currently preferred.

Monitoring Priorities

Participants agreed that better monitoring would enhance flexibility in management responses based on documented changes that occur and that monitoring is an activity that is cost-effective for the benefits derived. Some priorities included:

- Expand network of flow gauges, temperature gauges, and weather stations. Develop better information on a watershed basis rather than a point basis where most data currently originate.
- Standardize water quality monitoring to better evaluate changes in primary productivity and nutrient loading (especially in lower basin—associated with turbidity).
- Increase monitoring of climate change impacts on food webs, including issues related to emergence of invertebrates.
- Create a better balance between expenditures on restoration and monitoring; monitoring is needed to know if restoration efforts are working.

Research Priorities

- Identify areas where cold water habitats have the best chance of persisting.
- Increase our understanding of water temperature tolerances for different fish species, and how changing air temperatures and river flows will affect water temperatures.
- Update the economic assessment of aquatic recreation opportunities and how they stand to be impacted by climate change.

Summary of Yellowstone River Session

While the climate scenarios discussed during the Yellowstone River breakout session represent futures of both increased and decreased precipitation, all three scenarios result in decreased baseflows, earlier peak flows in the spring, and increased late summer water temperatures. Since the discussion of

impacts largely was qualitative, there were little differences across the scenarios other than saying that Scenarios A and B would be bad, and Scenario C even worse. A more quantitative analysis of impacts might identify threshold points where river conditions change so significantly that there are fundamentally different impacts on the system, but this workshop did not attempt to identify such threshold points. Future discussions on impacts and management options in this system may want to address issues related to those threshold points.

While many of the management responses participants identified are similar to current management activities, participants did identify areas where there is a need for increased emphasis and/or urgency to implementing those actions. For example, while FWP already is working to secure water rights on the Yellowstone River, these activities have been relatively small so far and there is a sense that those efforts need to be increased as quickly as possible to balance out the loss of flows due to climate change. There also were a few management responses proposed that currently are not part of FWP's fisheries management program, such as exploring beaver restoration opportunities. Participants also recognized the need to think outside of the banks of the river in terms of restoring and protecting floodplains and riparian areas. This work clearly will require collaboration with state and federal land management agencies, as well as local governments and private landowners.

Impediments to implementing identified management responses that will need to be addressed include costs, water laws, conflict with other water users (which is likely to increase with climate change), and the difficulty of valuing less tangible benefits of naturally functioning rivers. Collaboration with other partners, including state and federal agencies, local governments, private landowners and other private stakeholder groups, will be necessary to protect water flows, native fisheries and recreation opportunities. Further discussions about management responses to climate change should include those various partners.

Report on the Sagebrush-steppe Breakout Session

Sagebrush-steppe Scenarios

The scenarios for the sagebrush-steppe breakout session all included warmer annual average temperatures and:

Scenario A: An increase in winter precipitation.
Scenario B: An increase in summer precipitation.
Scenario C: A decrease in precipitation in both winter and summer.

Impacts on Sagebrush

There may be differences between sagebrush taxa in response to the climate-change scenarios. A key factor in determining what taxa will exist in any one place will be the amount of *effective* summer precipitation (that amount of precipitation that does not evaporate off, but accumulates in the soil), soil suitability, competition with other native or exotic flora, the invasion of exotic grasses, and increases in fire frequency due to direct climate effects and/or the invasion of flammable species like cheatgrass. These factors may inhibit sagebrush from persisting or establishing in areas that otherwise may be climatically suitable for sagebrush. Participants generally agreed that under the different scenarios the

impacts of climate change to sage habitat could be positive or negative, depending on the amount and timing of precipitation. For example, if growing season precipitation becomes either too effective or too dry you could loose the sagebrush component.

Impacts on Sagebrush-Steppe Species

Generally, participants agreed that impacts, both adverse and beneficial, would be similar across all the climate scenarios considered during this workshop. For most species, impacts will be more rapid and extreme with Scenario C. Some species with southern limits of their distributions in the Montana Sagebrush Steppe may disappear from Montana while others with northern limits of their distribution near Montana may increase in abundance and distribution. Some specific species-level impacts considered included the following.

Pronghorn antelope and mule deer overwinter survival might improve with milder winters. Fawn survival may increase with increased spring moisture, although this potential benefit could decline if summer droughts increase. Overall, recruitment to yearling cohorts will likely decline. In the short term, reduced recruitment will skew age classes toward older animals.

Sage grouse will be negatively affected by declining extent and density of sagebrush for food and shelter. This, in combination with reduced herbaceous plants, could lower brood survival. Reduced insect availability may be possible with drier summers although some insect species may benefit. Winter ice events could also reduce survival.

Elk might benefit if native annual grasses increase but suffer especially in late season if non-native species like cheatgrass increase. Changes that result in reduced productivity of grasses will exacerbate competition between some wildlife species (like elk) and cattle.

Sagebrush obligate passerine birds like *lark sparrows, Brewer's sparrow, sage thrashers,* and s*age sparrows* would be adversely impacted as northward range shifts are unlikely to replace amount of existing habitat. Species like *long-billed curlews* might benefit.

Habitat generalist mammal species (e.g. *deer mice, coyotes*) might benefit (or at least not be disadvantaged) from climate change in the short term, but as changes become extreme, many of these species would be ultimately adversely affected. Generalist species with a wide niche will likely adapt better to changes in habitat conditions and shifts in food sources than specialist species.

Habitat specialist mammal species dependent on sagebrush or steppe habitats will suffer (e.g., *voles*). *Red foxes* would not benefit, but some species like *swift fox* might benefit. Species with low reproductive rates would be disadvantaged more than those with higher rates.

Migratory birds might prove to be relatively adaptable to climate change because of their enhanced ability to locate remaining islands of acceptable habitats as these shift geographically on the landscape, as long as islands of acceptable habitat persist.

All *wetland species of birds* that depend on ponds, mesic, or riparian systems (e.g. waterfowl) will likely decline. "Big Sagebrush: A sea fragmented into lakes, ponds, and puddles," by Bruce Welch (2005) is a useful reference in deciding which species will be impacted. Under Scenario B (wetter

summers), these species might benefit or be less adversely impacted than under scenarios A and C. This is also true for *amphibian and reptile* species such as *frogs* that depend on standing water to lay eggs or on mesic habitats. With more spring moisture, *toads* will already have completed the tadpole cycle and will be less affected by subsequent summer droughts. *Horned lizards* dependent on ants will trend in the same direction as the abundance of ants. Generally, wetland species that have long life cycles are likely to be more adversely impacted by climate change than wetland species with short life cycles and highest vulnerability in the spring.

Management Responses

The participants, with exceptions noted where they were identified, decided that management responses, and monitoring and research needs generally did not vary between climate scenarios. The three management objectives identified were:

1) maintain native sagebrush species assemblages;
2) maintain native sagebrush habitat; and
3) maintain hunting opportunities.

Some key points identified and discussed follow.

There will be spatial variation in how climate change affects different areas within the sagebrush-steppe and it was noted that research based on downscaled future climate data that is currently available at coarse resolutions may not be particularly useful from a regional-level planning perspective. However, there was general agreement that focusing on monitoring and protecting sagebrush habitat will enable the agency to better anticipate and track climate change-associated shifts in sagebrush communities and the associated wildlife, and adjust management activities accordingly. To this end, it is very important that agencies work collaboratively to develop a map of current sagebrush distribution within Montana that may be used to develop such monitoring protocols, to standardize those that are ongoing, and to facilitate development of better models of sagebrush distribution.

The FWP has limited ability to manage habitats and will have to work more closely with habitat management agencies such as the BLM and NRCS in sagebrush-steppe habitat. National farm bills are an important mechanism for conservation of native habitats at a regional scale. There will be increasing pressures on landowners to break sod to produce biofuel crops. State agencies can influence the conservation provisions in federal farm legislation by collaborating with NGOs that have lobbying capabilities. It can also be effectively done through lobbying efforts of multi-state and professional groups (e.g. Western Governors' Association, the Association of Fish and Wildlife Agencies, and The Wildlife Society). These national efforts will be more convincing if the state is also undertaking initiatives to respond to climate change and the needs of wildlife affected by climate change. The FWP should work with partners to ensure that farmers and ranchers retain incentives for conservation. There is also a need for better coordination with federal agencies on fire management, especially early responses in key mature sagebrush habitats.

Many management responses identified by participants are already being done to varying degrees (e.g., the identification of key areas and corridors for protection), but for these management actions to build resilience in response to climate change, they need to be implemented on a larger scale. Reserves that are presently designated to protect particular species or their habitats may not be suitable for protecting

those species or habitats following climate change. It will be important to protect large blocks of intact open space, even if the species or habitats that occur there change. One priority action is to coordinate and catalog current habitat protection efforts.

It may be necessary to do triage, and not waste time trying to prop up habitats and species that have a high probability of failing regardless of amount of effort expended.

Alternative energy developments (notably wind and ethanol crops) can pose threats to wildlife. There will be strong pressures to plow up native habitats (sod bust) for such developments. It will be important to compare existing maps of wind potential in relation to biodiversity hot spots and develop guidelines for where wind energy sites can be placed with minimal impacts on wildlife. These maps are already in development for Montana (by The Nature Conservancy) and have been developed for Wyoming by the Biodiversity Conservation Alliance.

For big game management, FWP has not historically considered the availability of free water to be a limiting factor for wildlife species seeking drinking water. Under warmer and drier scenarios, competition for free water may become significant between wildlife and other users such as agriculture. Under these circumstances, competition with wildlife will increase for available water with other users such as agriculture. This may be mitigated, to some degree, if water shortages lead to a decline in the extent of area under irrigation.

Climate change will likely have consequences for hunting regulations, perhaps leading to reduced hunting opportunities for some important species, increases in permit (instead of open) hunts, shifts in hunting seasons (e.g. waterfowl with delayed migrations), and separate deer and elk seasons. Generally, the current system for setting hunting regulations will probably be adequate to respond to the needs for changes. Participants agreed that there needed to be continuing resistance to pressures to shift to the Texas model of hunting (with an emphasis on exotic ungulates from Africa and fee hunting on private lands). If hunting opportunities decline, revenues from hunters will decline along with an ability to address some of the problems that develop.

At least in the short term, there may be significant increases in abundance of wildlife species leading to management problems. Warmer winters, less early snowpack, huge swings between warm/cold cycles will likely benefit some wildlife species, especially those with generalist niches like elk and white-tailed deer even while it disadvantages species like mule deer with more specialized niches.

Generally it was recognized that sagebrush-steppe habitat will be very difficult or impossible to re-create once it is lost since sagebrush can be regrown, but the system often cannot be reestablished to its former state.

Monitoring Priorities

- Need more aggressive and robust monitoring to document trends caused by climate change.
- Select specific species for monitoring focus (such as those affected by diseases like West Nile Virus). Non-game species such as amphibians and some bird species may prove to be the most sensitive early indicators of impacts and useful surrogates for other species.
- For those species that shift in distribution in response to climate change (e.g. northward), it might be useful to establish north-south transects crossing the limits of a species current

distribution and monitor presence or absence along this transect over time. In addition to directional shifts in distribution, such transects would also document contractions of species distribution toward the center of their current distributions.

Research Priorities

- There is a priority need for a good map of current sagebrush distribution for the various sagebrush species so that a baseline can be established from which to measure trends. In some cases, these maps will also be useful to identify causes of shifts such as conversion of native habitats to croplands.
- Continue research related to disease concerns (e.g. West Nile virus) is also important. Historically, disease research has had positive spin-offs for non-disease issues for wildlife. Disease tracking may also be helpful in monitoring progress of climate changes.
- It will be important for FWP to work directly with researchers using projections from Global Climate Models to better understand likely impacts on wildlife and habitats. Improving predictability on a larger, more regional, scale is important. This will likely be a feedback process as models get refined based on empirical data of the changes that are occurring. Getting a clearer picture of what will happen with precipitation is clearly needed information and model refinement on this is a priority. For most adaptation needs, workshop participants did not identify geographically fine scale resolution for GCM model predictions as a priority need although these refinements may be important for some species already of conservation concern because of limited habitat.
- Impacts of increased CO_2 (and other factors in addition to temperature and precipitation) on vegetation are important (although not a FWP priority).

State Wildlife Action Plans (Comprehensive Plans)

The next revision of the Montana Comprehensive Fish and Wildlife Conservation Strategy needs to incorporate risks from climate change, including a reframing of management objectives and significant consequences to wildlife from climate change. Other management plans like the elk plan and the North American Waterfowl Management Plan also need to be revised to incorporate climate change. The state's ongoing planning effort on critical areas and corridors, which includes impacts of climate change as well as other factors such as developments and roads, already are starting to incorporate some needed new thinking.

Summary of Sagebrush-Steppe Session

There are more uncertainties associated with anticipating impacts of climate change on the sagebrush-steppe ecosystem than for the Yellowstone River. There are also more uncertainties associated with what specific new actions will be most effective at helping wildlife species adapt to adverse or even beneficial (at least in the short term) impacts of climate change. Species that are likely to be least adversely affected or even benefit will likely be those with broad niches, habitat and food source generalists, and high reproductive rates; generally these characteristics are consistent with invasive species. Species most likely to be adversely affected will be habitat and food-source specialists.

Protection of large blocks of unfragmented and interconnected habitats was considered a more feasible management response than efforts to restore habitat conditions lost as a consequence of climate

change. Efforts to accomplish this represent a continuation and expansion of activities that are currently a priority for FWP. Two key priority management responses to climate change included closer coordination with federal agencies that manage the majority of publicly owned habitat in the sagebrush-steppe system, and helping assure that private-land conservation incentives in the farm bill are maintained and strengthened. Better mapping of current extent of and trends in sagebrush-dominated systems was identified as a priority research need. Finding new sources of funding and maintaining recreational hunting opportunities, and the corresponding funding base for FWP, was identified as important to FWP's ability to mitigate changes caused by climate change. During the 2010 revisions of the Montana Comprehensive Fish and Wildlife Conservation Strategy, it will be important to clearly incorporate anticipated impacts from climate change. An ongoing planning process within FWP on critical areas and corridors that includes climate change and other threats to the success of FWP's management efforts is currently ongoing.