Increasing Resiliency of Manitoba's Grassland Ecosystems to Climate Change Impacts: Final Technical Report

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PART A – REVIEW OF ADAPTATION OPTIONS

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A1 INTRODUCTION

The Prairies Regional Adaptation Collaborative (PRAC) is a three-year program on adaptation to climate change in the Prairie Provinces. One of the PRAC themes is Terrestrial Ecosystems, encompassing Forests and Grasslands. The vulnerability of Manitoba grasslands to climate change was examined in a previous report (Thorpe 2011). Major areas of vulnerability included:

- shifts in vegetation zones, with implications for woody cover, grassland structure, and photosynthetic types.
- decreases in average grassland productivity
- increased frequency of drought years with low productivity
- shifts in biodiversity including migration of new species and emergence of new communities.
- increased risk of exotic invasion
- loss of wetlands

The current report examines adaptation options for addressing these vulnerabilities.

A2 GENERAL ADAPTATION CONCEPTS

A body of general concepts has emerged around adaptation to climate change.

The response of ecosystems can be characterized in several different ways (Smit et al. 2000):

- sensitivity – degree to which a system is affected by, or responsive to, climate stimuli
- vulnerability – degree to which a system is susceptible to injury, damage, or harm (one part of sensitivity)
- stability – degree to which a system is not easily moved or modified
- resilience – degree to which a system rebounds, recoups or recovers from a stimulus
- resistence – degree to which a system opposes or prevents an effect of a stimulus
- adaptive capacity – potential or capability of a system to adapt to climatic stimuli

Perhaps the most widely used concept is resilience. In the context of rangelands, Walker et al. (2009) considered **resilience** to be the capacity of a system to experience shocks while retaining the same structure, functions, and feedbacks. Resilience has been related to state-and-transition models, in which an area of rangeland may have multiple stable states, with transitions between them caused by disturbance or management (Briske et al. 2005). Resilience is considered to be the amount of disturbance that the system can absorb before it passes over a threshold to a different state (Walker et al. 2009, Gunderson 2000). For example, some semi-arid areas can shift between grassland and shrubland depending on the types of disturbances affecting them. A more resilient grassland would be able to absorb more disturbance before shifting to shrubland. Adaptation to climate change is often characterized in terms of increasing the resilience of the system (Hansen and Biringer 2003, Gunderson 2000, Sarewitz 2011).

However, according to some authors, increasing resilience is only one approach to adaptation. Heller and Zavaleta (2009) contrasted **resilience** with **resistance**. For example, in the context of conservation, a resistance approach would focus on intensive management to secure existing populations, whereas a resilience approach would focus on increasing population adaptation capacity. Millar et al. (2007) extended this to three approaches (the “three Rs”), with examples from forest management:

- Create **resistance** to change – e.g. protect high-value plantations near harvest by control of fire and diseases.
- Promote **resilience** to change – help forests to return to their prior condition after disturbance (e.g. help tree regeneration to get through the establishment phase in order to reestablish a forest)
- Enable ecosystems to **respond** to change – intentionally accommodate change rather than resisting it (e.g. assist range shifts by increasing landscape connectivity or by intentionally moving species); Galatowisch et al. (2009) referred to this approach as "facilitation".

Smit et al. (1999) described several ways in which adaptations vary:

- purposefulness (autonomous vs. planned)
- timing (anticipatory vs. responsive)
- temporal scope (short term vs. long term)
- spatial scope (localized vs. widespread)
- function/effects (e.g. retreat/accomodate/protect)
- form (structural/legal/institutional/regulatory/financial/technological)
- performance (cost/effectiveness/efficiency/implementability/equity)

With respect to timing, Berrang-Ford et al. (2010) noted that responses by individual households (e.g. farming operations) are mainly responsive, whereas anticipatory responses are mainly by government. With respect to temporal scope, Fazey et al. (2010) noted that some adaptations address a short-term problem but exacerbate a long-term problem (e.g. building levees to cope with flooding, leading to more development in the floodplain and loss of flood-storage capacity).

The three approaches proposed by Millar et al. (2007) can be characterized in terms of several of the variables given by Smit et al. (1999):

Approach	**Temporal Scope**	**Spatial Scope**	**Timing**
resistance – resist the influence of climate change	short term	localized	responsive
resilience – return to prior state after disturbance	medium term	localized and widespread	anticipatory
response – adaptively respond to change rather than resisting it	long term	widespread	anticipatory

A variety of more general guidelines for adaptation have been proposed:

- Address climate change in the context of the multiple other drivers affecting the system (e.g. habitat degradation, pollution, etc.), rather than in isolation (Heller and Zavaleta 2009). According to Hansen and Biringer (2003), increasing the resilience of natural systems is a general goal for conservation. Natural systems are already affected by an array of stresses, and climate change will add one more.
- "Mainstream" climate adaptation policies into everyday decisions and actions (Henstra and McBean 2009). Policies on climate change adaptation should be seen as a subset of policies on sustainable development and natural resource management) (Howden et al. 2007). In part, this

reflects the political reality that society will not incur large short-term costs for uncertain long-term benefits, so the focus should be on near-term paths towards sustainability (Sarewitz 2011).

- Adapt existing conservation programs rather than building new ones for climate change adaptation (e.g. increase funding for easement programs because of the potential to improve habitat connectivity) (Heller and Zavaleta 2009).
- Maintain the diversity of future options (e.g. maintaining biological diversity increases the options for ecosystem response) (Heller and Zavaleta 2009, Fazey et al. 2010).
- Use the "adaptive management" approach, acknowledging that because of uncertainty and unpredictability, plans have to be continually adjusted using results from monitoring (Gunderson 2000, Hansen and Biringer 2003, Millar et al. 2007, Heller and Zavaleta 2009).
- Use a "toolbox" of treatments and practices that can be selected and combined to fit unique situations (Millar et al. 2007). Applying more than one strategy in moderate amounts allows emphasis to be shifted as conditions change (Fazey et al. 2010)
- Emphasize stakeholder engagement (Henstra and McBean 2009).
- Create positive economic outcomes for local people (Heller and Zavaleta 2009).
- Nurture the human capacity to take up response options (Fazey et al. 2010, Sarewitz 2011).
- Emphasize intergovernmental collaboration (Henstra and McBean 2009, Heller and Zavaleta 2009).
- Enhance institutional flexibility (Millar et al. 2007).

A3 AGRICULTURAL ADAPTATION

A wide variety of adaptation options have been discussed for the agricultural sector. Adaptations may be made by producers, who see them as part of ongoing management decisions (Smit et al. 1999), or by governments.

Technological adaptations:

- Develop technologies to harvest water and conserve soil moisture (Smit 1999, Howden et al. 2007).
- Develop new drought and heat-resistant crop varieties (Smit 1999, Bizikova and Boettcher 2010).
- Develop climate forecasting and early warning systems to reduce risk (Smit 1999, Howden et al. 2007).
- Monitor changes in soil, pests, diseases (Bizikova and Boettcher 2010).
- Translate information on climate change impacts to the applications that matter to producers (Bizikova and Boettcher 2010).

Management adaptations:

- Alter timing or location of cropping activities (Smit 1999, Howden et al. 2007).
- Increase irrigation, or alter amounts and timing of irrigation (Howden et al. 2007, Smit 1999, Bizikova and Boettcher 2010)
- Manage crops on uplands to reduce runoff (Bizikova and Boettcher 2010).
- Manage excessive water (Howden et al. 2007)
- Change from conventional to conservation tillage (Smit 1999, Bizikova and Boettcher 2010).
- Alter crop varieties/species to those with more climatic suitability (Smit 1999, Howden et al. 2007, Bizikova and Boettcher 2010).
- Change crop rotations (Bizikova and Boettcher 2010).

- Plant shelterbelts (Bizikova and Boettcher 2010)
- Improve effectiveness of pest, disease and weed management (Howden et al. 2007, Bizikova and Boettcher 2010).
- Change land use (Smit 1999)
- Substitute resources and inputs (Smit 1999); e.g. alter fertilizer rates (Howden et al. 2007) or inputs of organic matter (Bizikova and Boettcher 2010)
- Adaptations related to grazing management (discussed in Section 4).

Financial adaptations:

- Diversify income through integration with other activities (Howden et al. 2007, Bizikova and Boettcher 2010).
- Buy private insurance (Smit 1999).
- Government subsidy and support programs (Smit 1999).
- Government ad hoc assistance and compensation (Smit 1999).
- Government programs and policies related to land and water use (Smit 1999).
- Where climate impacts may lead to major land use change, provide support for industry relocation and migration of people (Howden et al. 2007).
- Financial incentives for resiliency (Bizikova and Boettcher 2010).
- Market linkages and integration (Bizikova and Boettcher 2010).

Integrated measures

- Practices that benefit both adaptation and mitigation (e.g. tree planting, wetland restoration, tillage practices that maintain soil carbon) (Bizikova and Boettcher 2010).
- Identify common interests and potential conflicts across sectors (e.g. watershed planning; development of markets; invasive species management; farmland protection for Ecological Goods and Services; land use planning in the urban/rural interface) (Bizikova and Boettcher 2010).

A4 ADAPTATION AND RANGE MANAGEMENT

Most of the literature on adaptation in grazing management relates to **short-term actions**, usually in response to drought. In the terminology of Millar et al. (2007), these adaptations represent a **resistance** strategy, in which producers try to resist the effects of an adverse event. While most of the actions are taken by producers, there are also roles for government, such as helping producers to find rental pastures or other alternative grazing.

Grazing management

- Assess your options at the first sign of drought (AARD no date).
- Use seasonal climate forecasts to make stocking decisions; in Australia only 30-50% of land-holders use them (Marshall et al. 2011).
- Evaluate your livestock inventory (AARD no date).
- In drought years, reduce stocking to balance demand with forage supply, preferably making reductions early in the season (BCMAFF 2005, AAFC 2010, AARD no date).
- The yearling component of the herd can be sold or put into the feedlot (AARD no date).
- The next step is to cull the cow herd, culling heavily the older cows, cows with physical defects, open cows, or cows that have difficult births, and keeping healthy, early to middle age cows (AARD no date).

- Wean calves early, and sell early-weaned calves (AARD no date, BCMAFF 2005).
- Graze reserve or buffer fields (AAFC 2010).
- Graze last year's crested wheatgrass litter (AAFC 2010).
- Rent additional pasture (BCMAFF 2005).
- Use forested rangelands if available (BCMAFF 2005).
- Improve distribution of livestock by water, salt, fencing, or herding (BCMAFF 2005, AAFC 2010).
- Distribute cattle across more fields in those areas where rangelands are more sensitive to erosion (AAFC 2010).
- Fertilize to increase grass production (BCMAFF 2005).
- Do not assume that the drought will end next year (BCMAFF 2005).

Cropland and hayland:

- Convert cultivated acres to temporary pasture by seeding annuals (usually oats, also fall rye, winter wheat, triticale); spring-seeded annuals can be grazed in July, giving perennial pasture a rest (AARD no date, BCMAFF 2005, AAFC 2010).
- Graze failed annual crops (AAFC 2010).
- Graze stubble fields after harvest (BCMAFF 2005, AAFC 2010).
- Swath grazing of cereals in winter (BCMAFF 2005).
- Graze hay land (AARD no date).
- Change irrigation practices on hay land (BCMAFF 2005)
    - well-timed to reduce water use
    - select species with some drought resistance
    - reduce expectations if you are forced to reduce water use
    - maintain residual plant material

Feeding:

- Extend the feeding period (AAFC 2010).
- Feed your one-year supply of hay (AARD no date).
- Buy additional feed (BCMAFF 2005).

Stockwater and salt:

- Use fields that will run out of water first (AAFC 2010).
- Spread cattle over more fields where water supplies are low (AAFC 2010).
- Ensure that cattle have adequate salt to prevent use of poisonous plants that are salt accumulators (AAFC 2010).
- Use portable stockwater supply (AAFC 2010).
- Fence off water sources that are low (AAFC 2010).

Many other adaptations can be thought of as **medium-term actions** aimed at increasing the **resilience** of grazing operations so they will be better prepared for future droughts or other extreme events. According to Brown and Thorpe (2008), "climate change does not alter the basic principles of range management; if anything, it increases their importance...the resilience-based approach will continue to be a rational strategy for managing rangelands in the face of the uncertainty of climate change."

- Use good range management practices, including appropriate stocking rates matched with pasture production (Howden et al. 2007). Moderate grazing produces deep-rooted plants which are less affected by drought (AARD no date). Maintaining pastures in good to excellent range condition provides the best protection against drought (AAFC 2010). Careful management of

native forage includes allowing grasses to set seed, maintaining 10 cm of stubble, and if possible grazing native range during the dormant season (BCMAFF 2005).

- Avoid over-grazing. According to AARD (no date) the worst drought scenario is when there is a history of over-grazing and a large number of cattle. Heavy livestock grazing impacts reduce resilience by compacting soils, reducing infiltration and drying out the soil surface, as well as favouring exotic invasion (Gelbard 2003). According to Holechek et al. (1999), several studies have shown that ruinous financial losses can occur under heavy stocking and drought, whereas conservative stocking is one of the surest ways to minimize financial loss. A rancher using conservative stocking will forego at worst 10-25% of the profits possible with moderate stocking. However when drought occurs, conservative stocking will give 30-60% higher net returns than moderate stocking.
- Maintain a good litter cover over the soil. This makes pastures more resilient to drought (AARD no date, AAFC 2010). Litter keeps the soil surface cooler and reduces direct evaporation (Willms et al. 1993). The effect of litter has been tested by comparing production between plots from which litter has been experimentally removed with control plots in which litter is still present. In Mixed Prairie, Willms et al. (1986, 1993) found that litter removal reduced production by more than 50%. However, in the moister Northern Fescue Prairie, Willms et al. (1986) found that litter removal had no effect on yield. These results suggest that litter has the greatest beneficial effect in drier climates. In the more productive grasslands of moister climates (e.g. tallgrass prairie), excessive litter accumulation can suppress production (Vogl 1974). In Saskatchewan fescue prairie, Pylypec and Romo (2003) found that production reached a peak at about 3500 kg/ha of litter, suggesting that accumulations beyond this level could suppress production. In the moister types of grassland, the strategy should be one of maintaining an appropriate level of litter cover, neither too low nor too high.
- After a drought, increase stocking rates gradually over a 1-3 year period (AARD no date)
- Rotational grazing systems are often recommended as good range management practice which will keep pastures healthy, build plant vigour, and reestablish litter reserves (AARD no date, Howden et al. 2007, AAFC 2010). However, there is controversy about the benefits of rotational grazing in the range management literature. Reviews of experimental grazing studies have found that rotational grazing has either no effect or only a small effect on forage production and animal production compared to continuous grazing (Van Poollen and Lacey 1979, Holechek et al. 1999, Derner and Hart 2007, Briske et al. 2008). Holechek et al. (1999) found more evidence of a beneficial effect of rotational grazing in humid areas than in semi-arid or desert areas. All of these studies showed that controlling stocking rate is more important than implementing grazing systems. Briske et al. (2009) addressed the conflict between these scientific results and the overwhelming support for rotational grazing among range professionals. One explanation is that the results are based on experiments in which human variables such as goal setting, experiential knowledge, and decision making are intentionally excluded. Investment in rotational grazing may contribute to greater managerial interest, increase the intensity of management, and lead to increased adaptation. These human variables, which are difficult to quantify in an experiment, may explain the observations of pasture improvement resulting from implementing grazing systems.
- For maximum flexibility, combine perennial tame forages (for spring grazing) with native range; seed more cropland to tame pasture to provide more relief for native grassland; crested wheatgrass is very tolerant of drought (BCMAFF 2005, AAFC 2010).
- Fertilize some tame pastures in good moisture years to take pressure off fields that need recovery (AAFC 2010).

- Shift to a more flexible herd structure: two-thirds to three-quarters as a cow-calf operation, the remainder as yearlings for replacements. Depending on the growing conditions expected for the coming year, one-quarter to one-third of the herd may be grazed, sold or put into the feedlot (AARD no date).
- Maintain emergency pastures that can be used in dry years (AARD no date).
- Maintain a year's supply of winter feed (AARD no date).
- Do not be hasty to reseed depleted range – recovery is rapid with good management (AAFC 2010).
- Ensure an adequate water supply, and monitor water supplies for reliability (AARD no date, Howden et al. 2007). Maintain windmills, use plastic pipe to improve water distribution, use snowfences to increase runoff into dugouts (AAFC 2010).

Compared to the short- and medium-term actions discussed above, there is much less discussion about **long-term actions** aimed at helping grazing systems to **respond** to climate change. However a number of general ideas have been discussed:

- Stocking rates and grazing systems will need to be modified where the seasonality, amount, and quality of forage production have been altered (Morgan et al. 2008).
- Ranchers and land-managers will need to be flexible and proactive in dealing with a more variable forage supply. They will need higher tolerance for fluctuations in herd size (Morgan et al. 2008). Managers will need to respond with unprecedented speed and flexibility (Brown and Thorpe 2008).
- Management flexibility should be the goal at all levels. This will require systems that identify effects of global change at an early stage and implement management responses (Brown et al. 2005). Rangelands must be managed at the landscape and ecosystem level as well as the individual management unit (Brown et al. 2005).
- There will be greater dependence on grass banks and hay supplies (Morgan et al. 2008).
- If there is a change in forage quality, there may be a requirement for more nutritional supplements (Morgan et al. 2008).
- If there is change in vegetation zonation, there may be a need to change animal species (e.g. sheep or goats for warmer/drier climate or more woody vegetation) (Morgan et al. 2008).
- If livestock production becomes economically marginal, land use may shift to ecotourism, hunting, open space, wind energy, or carbon sequestration. (Morgan et al. 2008).
- There may be a shift from equilibrium to non-equilibrium systems. Equilibrium theory is the basis of conventional range management. For example, if rangeland is overgrazed, the standard recommendation is to reduce stocking, which will allow overgrazed grassland to return to equilibrium. But rangelands in more variable environments are non-equilibirum systems dominated by abiotic forces such as drought. They are characterised by pulses of plant growth of unpredictable length and magnitude, rather than convergence around an average level of production (Ellis and Swift 1988). Most arid and semiarid rangelands are non-equilibrium systems, and degradation is permanent on human time scales, so the goal of management is avoiding catastrophic changes (Brown et al. 2005). Climate change in the Canadian prairies is expected to increase variability and unpredictability, so may prompt shifts towards non-equilibrium systems. Non-equilibrium systems have been studied in Kenya (Ellis and Swift 1988) and Inner Mongolia (Li and Huntsinger 2011). Traditional grazing practices in these countries responded to the conditions in a given year, by spreading livestock out over a larger area, or by migrating to a region with better moisture conditions. Modern land administration, in which defined land units are assigned to individual producers, discourages this type of adaptation. But

there are elements of it already in use, especially in the drier parts of the prairies. Practices such as keeping reserve pastures for dry years, grazing on annual crops, and moving cattle to rented land in moister regions, are in some ways comparable to the expanded grazing area practices used by traditional pastoralists.

- There is a need for improved prediction of changes in climate drivers and the effects on rangeland ecosystems at relevant spatial scales (e.g. need for early warning systems, especially for drought) (Brown and Thorpe 2008). Decision support systems that address drought response strategies will help in dealing with a more variable and drought-prone climate (Morgan et al. 2008).
- As the climates become more variable and extreme, monitoring will become increasingly important (Brown et al. 2005, Morgan et al. 2008). Monitoring combined with decision support systems based on weather forecasting and models of plant production will be essential for tactical (within-year) decisions (Morgan et al. 2008).
- Data collected from range reference areas (i.e. benchmark sites) will improve understanding of changes in species composition and productivity caused by climate change. More consistent monitoring of these areas is needed, but funding has been inconsistent. Information from range reference areas should be correlated with climate data so that managers can see where shifts are occurring, and use the information for adaptive management (BCMFR 2006)
- Present notions of management based on past ecological knowledge might be inadequate, for example if new plant communities arise (Morgan et al. 2008). Research is needed on how soils and vegetation respond to climate change (Brown et al. 2005). State-and-transition models will be used to represent these changes, and manage against undesirable states. However existing state-and-transition models will have to be modified to incorporate the latest information on impacts of climate change (Morgan et al. 2008)
- See additional material on long-term adaptation in Section 6 – Adaptation and Biodiversity.

A5 ADAPTATION AND WETLANDS

Adaptation ideas related specifically to wetlands include the following:

Planning:

- Broaden climate change programs beyond emission controls to include ecosystem adaptation, specifically wetland and watershed adaptation. (ASWM 2009).
- Beginning with existing watershed plans and other land use planning, determine the processes and actions needed to increase the resiliency of wetlands and watersheds in the face of climate change (ASWM 2009).
- Incorporate adaptation to climate change in water projects (e.g. safety factors for floods and erosion, low-flow protection for fish and wildlife) (ASWM 2009).
- Prioritize wetlands with regard to management and adaptation. (ASWM 2009).
- Carry out or fund demonstration projects illustrating various measures to protect and adapt wetlands to climate change (ASWM 2009).
- Implement watershed programs (e.g. nonpoint source pollution control with buffer strips) (ASWM 2009).

Conservation and restoration:

- More wetland protection and securement will allow society to retain options in the future under any climate change scenario (Sorenson et al. 1998).

- Strengthen controls on drainage of wetlands (ASWM 2009).
- Prevent fragmentation of wetlands (ASWM 2009).
- Create and protect multi-objective corridors for migration of species (ASWM 2009).
- Establish regulatory buffers for all wetlands and waters (ASWM 2009).
- Restore, create or enhance wetland types most threatened by climate change (ASWM 2009).
- Study and address invasive species in climate-stressed wetlands (ASWM 2009).

Management:

- Install water control structures at the outlets of freshwater wetlands (ASWM 2009).
- Divert sediments to nourish wetlands (ASWM 2009).

Information:

- Wetland inventory and mapping (ASWM 2009):
    - identify wetlands most threatened
    - document current changes in wetlands that may be related to climate change
- Establish wetland reference sites to document the impacts of climate change and to determine the effectiveness of management and adjustment strategies (ASWM 2009). Adaptive management would benefit from a larger network of long-term wetland monitoring sites to detect early signs of warming on water levels and hydroperiod (Johnson et al. 2010).
- Undertake priority research on climate change and wetlands (ASWM 2009):
    - document direct and indirect threats to wetlands
    - prepare and distribute a handbook on BMPs related to wetlands and climate change.
    - document successes and failures of strategies and techniques.
- Study and better understand species that are expected to migrate northward and upslope in order to determine which ones are most likely to support wetland functions and values given climate change (ASWM 2009).

A6 ADAPTATION AND BIODIVERSITY

The "three Rs" scheme of adaptation strategies (Millar et al. 2007), used above in the context of range management, applies equally to biodiversity management. For example, Galatowitsch et al. (2009) gave examples of **resistance** strategies (e.g. reducing drainage of wetlands), **resilience** strategies (e.g. adding buffers to protected areas), and facilitation (i.e. **response**) strategies (e.g. landscape corridors or assisted migration). However, the literature on agricultural adaptation focuses on the short and medium terms, whereas long-term response strategies are much more prominent in the biodiversity literature.

Many of the adaptation recommendations related to biodiversity have elements of **both resilience and response**. They will improve the ability of species and ecosystems to bounce back from disturbances, but they will also help species and ecosystems to adjust their ranges over the long run. These include the following:

- **Incorporate climate change into biodiversity planning**:
    - Integrate climate change into species and land management plans (protected areas, pest outbreaks, harvest schedules, grazing limits, incentive programs) (Heller and Zavaleta 2009, Mawdsley et al. 2009).

- Develop dynamic landscape conservation plans, including protected areas and the surrounding matrix, and incorporating predicted shifts in distribution of species (Mawdsley et al. 2009).
- Review and modify existing laws, regulations, and policies regarding wildlife and natural resource management to account for climate change (Mawdsley et al. 2009).
- Because of distributional shifts, there will be a need for greater integration of management across wider areas and longer time-scales (Heller and Zavaleta 2009). This will require more coordination between agency jurisdictions and across political boundaries (Hannah et al. 2002, Heller and Zavaleta 2009). Hannah (2009) used the example of a butterfly that is declining in Mexico but stable in California. Conservation of populations in Mexico without considering California would be inordinately expensive. In general, planning across a shared border will be more cost-effective than isolated national plans (Hannah 2009).
- Adapt existing conservation programs rather than starting new ones for climate change (e.g. increase funding for existing conservation easement programs because of their potential to improve habitat connectivity) (Heller and Zavaleta 2009).
- Develop goals for conservation that take climate change into account. For example, Henderson et al. (2002) presented three alternative models for conservation management, of which the first clearly ignores climate change:
  - the frozen landscape model, which aims to restore the presettlement landscape; this gives an understandable target, but there is no justification for picking a particular point in time as the goal, and becomes increasingly unsupportable with climate change.
  - the as-if-wilderness model, which allows natural processes to take place; this is traditional, inexpensive and painless, but could open the door to sweeping change (e.g. sudden elimination of tree cover).
  - the managed retreat model, in which managers are willing to intervene aggressively (e.g. introduction of new species).
- Changes in goals may require radical shifts in perspective (Heller and Zavaleta 2009).
  - may need to view a broader range of ecosystem states as desirable, including new communities that maintain function but not necessarily species identity.
  - may need to reevaluate what constitutes an invasive species (e.g. *Pinus radiata* naturalizing in its former range, but outside of its current native range).
  - may need to change restoration guidelines to use species adapted to the future climate, not the current one.

- **Enhance protected areas**:
  - Increase the extent of protected areas (Mawdsley et al. 2009). Modeling shows that creation of new protected areas (i.e. increasing area protected) can improve species conservation as climate changes, and suggests that the best strategy is to add area immediately (Hannah et al. 2007).
  - Increase the number of protected areas, providing redundancy (more than one protected area for each major community type) (Halpin 1997, Heller and Zavaleta 2009, Mawdsley et al. 2009). Because we do not know which types will be most sensitive to climate change, represent all grassland types across environmental gradients in protected areas (Gelbard 2003). However, representation of community types will become less relevant as climate change leads to new combinations of species (Mawdsley et al. 2009).

- Select protected areas that provide habitat diversity: as large as possible, as much altitudinal and latitudinal variation as possible; areas of high topographic heterogeneity; major transition zones (Halpin 1997, Gelbard 2003, Heller and Zavaleta 2009). Establish a network of protected areas along the elevation gradient, allowing species to shift upward as climate changes (Mawdsley et al. 2009).
- Expand the spatial scale of protected areas through buffer zones (Halpin 1997, Hansen and Biringer 2003, Gelbard 2003, Heller and Zavaleta 2009). This may require restoration of area outside the protected area (Galatowitsch et al. 2009).
- Take climate change into account in selecting new protected areas (Hansen and Biringer 2003). According to Halpin (1997), "A fundamental philosophical question in selecting protected areas... is whether the protected areas are intended to protect the current mix of species over time, or intended to represent arenas for changing species diversity". Many vegetation types and species are expected to lose representation in protected areas with climate change (Hannah et al. 2007, Heller and Zavaleta 2009). Because of constantly changing mixes of species, protected areas cannot be built around protecting particular communities (Hannah et al. 2002). The alternative is to manage and restore ecosystem function rather than focusing on specific components (i.e. stop using historic reference communities as a target) (Mawdsley et al. 2009).Some argue that future protected areas should be in areas predicted to be biodiversity hotspots, whereas others argue that, given the uncertainties, the priority should be on planning protected areas to minimize the distance among them (i.e. increase connectivity) (Heller and Zavaleta 2009).
- Include climate refugia (e.g. cool, moist microsites that allow species to survive heat or drought) in protected areas (Hansen and Biringer 2003, Gelbard 2003, Galatowitsch et al. 2009).
- Enhance genetic diversity by incorporating outliers, areas of high endemism, ecotones, and refugia, because diverse populations are more adaptable (Heller and Zavaleta 2009).

- **Mitigate other threats to biodiversity** besides climate change, such as invasive species, fragmentation, and pollution (Halpin 1997, Hansen and Biringer 2003, Czucz 2010). Non-climatic stresses are often more locally controllable than climate change (Hansen and Biringer 2003).
  - Prevent and control the spread of invasives (Galatowitsch et al. 2009). Manage disturbances so they do not trigger a shift to an invasive-dominated state (Galatowitsch et al. 2009).
  - Maintain natural fire regimes or other disturbance regimes (Halpin 1997, Gelbard 2003). Fire is often used in grasslands to keep out invasives (Galatowitsch et al. 2009). However, fire suppression may slow the transition from forest to grassland, so policy on fire depends on whether the goal is to maintain forest or to allow the transition to occur (Hannah et al. 2002). In some cases fires are suppressed in order to maintain fire-sensitive communities (Galatowitsch et al. 2009). Disturbance prescriptions (e.g. for prescribed burning) may have to be adjusted in accordance with new climates (Galatowitsch et al. 2009).
  - For high-priority species, practice intensive management to secure populations (Heller and Zavaleta 2009). Focus conservation resources on species that might become extinct (but traditional in situ conservation will become increasingly difficult) (Mawdsley et al. 2009).
- **Improve information on biodiversity and climate change**:
  - Study species responses to climate change (Heller and Zavaleta 2009)
  - Increase and maintain biodiversity monitoring programs (Heller and Zavaleta 2009). The need for adaptive management should drive a serious commitment to biological monitoring (Galatowitsch et al. 2009).

Strategies that more specifically address **response**, by helping species and ecosystems to shift their ranges, fall into two broad approaches.

- **Increase landscape connectivity:**
  - Predicted shifts in species ranges are much larger than can be accommodated by expanded protected areas (Krosby et al. 2010).Therefore one of the most frequent recommendations is to increase landscape connectivity by designing connective corridors, removing barriers to dispersal, locating protected areas close to each other, and protecting stepping stones and refugia (Heller and Zavaleta 2009, Mawdsley et al. 2009). Connectivity is one of the main indicators of the climatic adaptive capactiy of natural ecosystems (Czucz et al. 2011). Minor et al. (2009) found that invasive plant species are less limited by connectivity than native plants.
  - There has been extensive research on the biological functions of habitat corridors. A meta-analysis of well-designed experiments showed that corridors increase movement between habitat patches by 50% compared to patches not connected by corridors (Gilbert-Norton et al. 2010). Corridors are more important for invertebrates, non-avian vertebrates, and plants, and less important for birds (Gilbert-Norton et al. 2010). Natural corridors show more movement than manipulated corridors (Gilbert-Norton et al. 2010). The largest experimental study on plants used connected and unconnected clearings in a large, uniform pine plantation (Damschen et al. 2006, 2008, Brudvig et al. 2009). Connected clearings showed higher richness of native plants, including bird-dispersed, wind-dispersed, and unassisted-dispersal species. However this study was small in scale, with corridors 150 m long, compared to the range shifts associated with climate change.
  - Protecting riparian habitats increases connectivity, but can also be detrimental as a conduit for spread of invasives (Gelbard 2003). Existing linear features such as ditch banks and hedgerows are often suggested as corridors, but Dorp et al. (1997) found that they are usually ill-suited because they are too narrow and too disturbed. Modeling showed a strong positive effect of corridor width, with wide corridors having seed migration rates similar to continuous habitats. However, in all situations migration rates of plants were less than 5 m/year (Dorp et al. 1997).
  - More information is needed on optimal design of corridors, with mostly general, common-sense ideas at present (Heller and Zavaleta 2009). There are few examples of corridors designed for species shifts under climate change.
  - The practical effectiveness of landscape corridors has been questioned. Linkage needs differ among species, and protection of large-scale corridors will be very expensive (Mawdsley et al. 2009). According to Galatowitsch et al. (2009), “Landscape corridors, often touted as a way to foster range shifts, are unlikely to be an effective strategy for much of Minnesota given the amount of acquisition and restoration required to create corridors through agricultural landscapes and the low probability that many plant species will jump to these corridors and move at a rate that keeps pace with climate change.” Many grassland plants are slow dispersers, which limits the rate at which they can be expected to migrate even if there are corridors (Dorp et al. 1997, Bischoff 2002, Galatowitsch et al. 2009).
  - A more general approach is to manage the matrix of land uses surrounding protected areas in order to increase the “permeability” to migration of species. Biodiversity-friendly land uses in the matrix (e.g. conservation agreements with landholders) increase the chances for persistence when climate change affects populations within protected areas (Hannah et al. 2002, Hannah 2009). Minimize fragmentation by land use changes and roads, and protect roadless areas (Gelbard 2003). Restore grasslands (Gelbard 2003), taking into account future climatic conditions (Halpin 1997).

- Protected areas should be close to other protected areas as well as similar unprotected habitat types (Halpin 1997).

- **Assisted migration:**
  - Natural movement may be insufficient for species to keep pace with climate change (McLachlan et al. 2007, Hoegh-Guldbert et al. 2008). Assisted migration is often recommended for species unable to migrate because of poor dispersal or restriction to specific habitats (Heller and Zavaleta 2009).
  - Assisted migration is often contrasted with the goal of maintaining natural species composition. Species brought into an area by assisted migration are by definition exotic to that area, and modern biodiversity policies are opposed to introduction of exotics. However, Johnson and Mayeux (1992) used the paleobotanical evidence of shifts in natural communities through time to argue against the need to conserve any particular plant community. Johnson and Mayeux (1992) took the extreme position that no special significance should be attached to the label "native", but this position appears to ignore the destructive effects of some exotic invasions. A middle-ground approach is to accept short-distance migration within a particular continent. Most invasive problems have been caused by continent-to-continent movement, whereas most assisted migration proposals deal with movement within the same broad biogeographic region (Hunter 2007, Hoegh-Guldbert et al. 2008).
  - Assisted migration is contentious because of difficulty, poor success, and unintended consequences (Heller and Zavaleta 2009). Ricciardi and Simberloff (2008) emphasized the risks, which they say are underestimated by proponents. Movement into regions with close relatives promotes introgression (i.e. gene transfer by interbreeding) that can erode native populations. Guiding the decision by cost/benefit analysis ignores our limited ability to forecast ecological costs. Using invasive behaviour elsewhere as an indicator of invasive potential can give wrong answers (e.g. Australian paperbark tree, which is a threatened species in its native Australia, became highly invasive after introduction to Florida). Introduced species may undergo rapid evolution in the new environment, becoming invasive there. Even movement within continents can cause problems. For example, the widespread planting of eastern redcedar (a small tree of eastern North America) in the Great Plains states has led to invasion of native woodlands and grasslands (Ganguli et al. 2008).
  - Mueller and Hellmann (2008) found that the risk of a species becoming invasive after intra-continental movement are much higher for some groups (e.g. fish) than for others (e.g. plants). They pointed out that there are risks on all sides of the decision: risk of inaction, risk of unsuccessful action, and risk of being too successful (i.e. creating invasion problems). Thorpe et al. (2006) and Ganguli et al. (2008) argued for a risk-assessment procedure for species proposed for introduction, considering such factors as potential for interbreeding with native species, transport of diseases, and invasive behaviour.
  - Assisted migration may be more suitable for some species and sites than others (Hunter 2007):
    - Species that are unlikely to disperse on their own are good candidates; species that have major ecological roles (dominants, keystones, strong interactors) are riskier to move than those whose role is redundant with others (e.g. an uncommon forest herb); however ecological roles can change over time and space.
    - Candidate sites also differ; a mine site under restoration is more acceptable than a pristine wilderness; an isolated site with unique biota is less acceptable; a site that is

currently surrounded by human-dominated landscapes is more acceptable; a site within the previous range of the species is more acceptable.
        - The feasibility of assisted migration depends on the costs and practical knowledge of techniques for safe movement.
    - McLachlan et al. (2007) summarized the contrasting positions on assisted migration in terms of three policy options (more extreme policy options, either maverick unsupervised assisted migration or the opposite "business-as-usual" policy which ignores the risks of climate change, are rejected)Aggressive assisted migration – based on high confidence in predictive models; apply assisted migration to a wide range of species, extensive translocation well beyond the native range.
        - Avoidance of assisted migration – based on high perception of perceived risk, and low belief in our ability to predict which species will become invasive.
        - Constrained assisted migration – based on the balance between benefits and risks, and the belief that assisted migration is necessary to preserve biodiversity despite the risks.
    - In Minnesota, Galatowitsch et al. (2009) argued that the risk is low for gradual shifts of common species. One straightforward way to do this is to make minor changes to restoration practice: broaden seed zones in the geographic direction of projected climate shifts; include many seed sources to maximize genetic diversity; and include some species from climates expected in the near future. Restorations for wildlife habitat, legally required mitigation, and expanding protected areas should provide significant opportunities for assisted migration without introducing species into remnant natural ecosystems. Following large-scale forest mortality, overseeding with mixes including species from adjacent warmer climates may be an effective adaptation strategy that reduces the likelihood of exotic invasion. Assisted migration will be less certain for uncommon species that may have specific habitat requirements, poor dispersal or small populations (e.g. species of calcareous fens or ombrotrophic bogs). But it should be attempted, because these species are most at risk of extinction (Galatowitsch et al. 2009). Planting trees a short distance north of their current range will create habitat for other associated species (Krosby et al. 2010).
    - While assisted migration is usually thought of at the species level, movement of warm-adapted populations within a species is another option (Hoegh-Guldbert et al. 2008). This is being actively pursued in forest regeneration (Ledig and Kitzmiller 1992, Spittlehouse and Stewart 2003, Rehfeldt et al. 1999).
    - At present, there are few legal restrictions on moving non-vertebrate species apart from a few recognized pests (McLachlan et al. 2007, Mueller and Hellmann 2008).

- **Several studies have directly compared the connectivity and assisted migration approaches:**
    - According to Krosby et al. (2010), there is a lower probability of unintended consequences from the connectivity approach compared to assisted migration. Introduction of warm-adapted genotypes can reduce the adaptation of local populations, whereas connectivity allows spread from local populations. Assisted migration may also introduce invasives.
    - According to Heller and Zavaleta (2009), there is a continuum of approaches depending on the tolerance for risk:
        - risk-averse - boost resilience, mitigate other threats, protect as much area as possible
        - intermediate – experimentation, build connectivity, diversify cultivars for a range of climatic tolerances

- risk-tolerant - pre-emptive interventions in response to model predictions, translocate organisms, limit land purchases to future hotspots

- Similarly, Lawler et al. (2010) characterized adaptations by the uncertainty of their outcomes. Lower-uncertainty strategies are likely to be useful regardless of the exact nature of climate change. They may not adequately address climate change impacts, but they are unlikely to have adverse effects. The success of the higher-uncertainty strategies will depend on the nature of future climate change.

high uncertainty	shifting management efforts to new sites, assisted migration
↕	habitat restoration
	restoring flow regimes
	removal of exotics
low uncertainty	increasing connectivity

- Hoegh-Guldbert et al. (2008) presented a decision tree for assisted migration. If the risk of extinction is low to moderate, or if the risk is high but the benefits of assisted migration are outweighed by biological and socioeconomic costs, then the practice should be rejected in favour of less drastic measures such as improving connectivity.

A7 SUMMARY OF ADAPTATION OPTIONS RELATED TO GRASSLAND MANAGEMENT

SHORT TERM – RESISTING CHANGE

Adaptation Options	**Producers**	**Government**
Use of drought forecasting tools – monitor precipitation to evaluate current year's growth potential	X	
Reduce stocking • increased sales of yearlings • increased culling of cow herd • reduce stocking rate early, at first sign of drought	X	
Earlier weaning, sell early-weaned calves	X	
Move livestock to alternative grazing • rent pasture in moister regions • use reserve pastures • seed annual forages on cultivated land • graze failed annual or hay crops	X	
Improve livestock distribution to make use of underused areas (may require hauling water)	X	

Increase feeding • Feed reserve supplies of hay • Buy additional feed	X	
Address shortages of stockwater: • Use fields that will run out of water first • Haul water	X	
Ensure cattle have adequate salt	X	
Spread cattle over more fields in areas sensitive to erosion, or where water supply is low	X	
Government programs to facilitate the above producer-level adaptations		X
Rental of crown land for emergency grazing		X
Forage insurance programs		X
Ad hoc assistance and compensation programs		X

MEDIUM TERM – PROMOTING RESILIENCE TO CHANGE

Adaptation Options	**Producers**	**Government**
Change herd structure (e.g. increased proportion of yearlings, which can be grazed, sold, or put in the feedlot depending on forage production in a given year)	X	
Plan for alternative grazing areas • plan grazing systems to include lightly used fields as an emergency grass reserve • make contacts for emergency pasture rental	X	
Sustainable grazing management, improving rangeland health • goals: – maintain good to excellent range condition – build plant vigour, deep roots – prevent soil compaction which reduces infiltration – restablish litter reserves (maintain 10 cm of stubble); maintain high litter cover except in moistest regions/sites where litter can be excessive – allow grasses to set seed [?] • most important factor is controlling stocking rates; follow recommended stocking rates for the region, site, and range condition; adjusting to more conservative stocking rates, especially in drier climates, will increase resilience; avoid over-grazing which increases vulnerability to climate change	X	

• rotational grazing systems are often recommended, but note controversies over scientific basis. • use tame pastures to defer grazing on native pasture in spring. • if possible, graze native grasslands during the dormant season • do not assume that drought will end next year • increase stocking rate gradually over 1-3 years after drought		
Convert cropland to annual or perennial forages (provide more relief for native range by complementary grazing)	X	
Plan for increased feed reserves (1 year or more)	X	
Protect stockpiled feed from wildlife	X	X
Improve water storage or water distribution systems • monitor water supplies for reliability • maintain windmills • deepen dugouts • use snowfencing to increase runoff into dugouts • install plastic pipe to extend water supply from a reliable source	X	X
Support programs for conversion to permanent cover		X
Community pasture programs to provide reserve grazing for drought years		X
Increase stakeholder awareness and engagement related to climate change		X
Develop tools for drought monitoring and prediction		X

LONG TERM – HELPING SYSTEMS TO RESPOND TO CHANGE

Adaptation Options	**Producers**	**Government**
Increase stakeholder education, awareness and engagement related to climate change	X	X
Promote flexibility on the part of producers, land-managers, and government agencies in dealing with a more variable forage supply (e.g. consider changing grazing systems or even type of grazing animals).	X	X
Sustainable grazing management, improving rangeland health • goals: – maintain good to excellent range condition – build plant vigour, deep roots – prevent soil compaction which reduces infiltration – maintain desirable levels of litter cover • most important factor is controlling stocking rates; follow recommended stocking rates for the region, site, and range condition; adjusting to more conservative stocking rates,	X	X

especially in drier climates, will increase resilience; avoid over-grazing which increases vulnerability to climate change		
Adjust range management standards if monitoring shows directional trends • adjust recommended stocking rates to reflect changes in productivity • adjust range condition standards and/or state-and-transition models to reflect changes in vegetation composition • emphasize ecosystem function rather than similarity to historic reference communities		X
Promote retention of native grasslands • agricultural incentive programs • land use planning • increase protected areas – make PAs as large as possible – provide buffer zones around protected areas – protect past climatic refugia so they can again act as refugia under future climate change – select areas of high topographic heterogeneity, large elevational gradients		X
Restore grasslands in strategic areas		X
Reduce fragmentation and improve connectivity of grassland areas to facilitate migration of species from the south • develop dynamic landscape conservation plans – control proliferation of residential properties, roads • promote biodiversity-friendly land uses in non-protected areas (e.g. by agricultural incentive programs) • protect riparian areas • select new protected areas in locations that will act as corridors and enhance connectivity • research on optimal design of corridors		X
Wetland inventory and mapping – identify wetlands most threatened by climate change		X
Retain wetlands by restrictions on artificial drainage		X
Restore or enhance wetland types most threatened by climate change		X
Assisted migration for selected plant species • emphasize modest shifts within the same broad biogeographic region, not inter-continental translocation • modify restoration guidelines to facilitate shifts in common species • target programs for species that are dispersal-limited or restricted to uncommon habitat types • following large-scale forest mortality, overseed with mixes including species from adjacent warmer climates • require risk assessment for any translocation		X
Reduce other threats to grasslands: breaking, exotic invasion,		X

pollution, overgrazing, off-road vehicle impacts		
Increase surveillance and control of invasive species		X
Coordination among agencies and institutional flexibility • future range shifts require integration of management across wider areas and longer time-scales • promote institutional flexibility (e.g. managers of crown forest may need to shift from a focus on forestry to focus on livestock grazing, wildlife habitat, etc.)		X
Review of government policies to incorporate climate change • review and modify existing laws, regulations and policies • identify existing government programs that contribute to adaptation, and expand the role of climate change in those programs. • incorporate climate change into planning (e.g. land use plans, watershed plans, conservation plans) • incorporate climate change into BMPs		X
Shift in conservation thinking: • shift from thinking of protected areas as protecting the current mix of species, to being arenas for changing species diversity • reduce emphasis on "representativeness" of protected areas • reduce use of historic plant communities as the goal • accept a broader range of ecosystem states as desirable, including new communities that maintain ecosystem function but not necessarily species identity • reevaluate what constitutes an invasive species • modify fire suppression policy depending on objectives (e.g. retain forest vs allow transition to grassland)		X
Implement monitoring systems to provide information on trends and provide feedback for adaptive management • remote sensing of land cover changes • grassland benchmark sites • wetland monitoring • wildlife surveys, species-at-risk monitoring • analysis of relationships among monitoring results • monitoring of agricultural trends • ranch-level monitoring		X
Ongoing research on how soils, vegetation, biota, land use, and society respond to climate change; develop models for predicting responses.		X

A8 PUBLIC POLICY RELATED TO CLIMATE CHANGE AND GRASSLANDS

Public programs and policies related to climate change adaptation in management of grasslands were reviewed for a number of North American jurisdictions.

A review by the Association of State Wetland Managers reported that **Wyoming, North Dakota, South Dakota, Nebraska,** and **Kansas** have not developed climate action plans or taken other actions directly related to climate change (http://aswm.org/wetland-science/81-climate-change-adaptation-summaries/, accessed Oct 26, 2011). A few programs mentioned in this review that are indirectly related to climate change adaptation include regulation of water extraction during drought years (Nebraska), invasive species control (Nebraska), development of a predictive model for invasive species (North Dakota), and development of methodology for wetland inventory (Kansas).

Montana's Climate Change Action Plan (CCAC 2007) deals exclusively with mitigation, not adaptation. A review by the Association of State Wetland Managers reported that Montana is not developing an adaptation plan at this time (http://aswm.org/wetland-science/81-climate-change-adaptation-summaries/1170-climate-change-adaptation-montana, accessed Oct 26, 2011). One current program mentioned in this review carries out beaver relocation, and is intended to promote resiliency of stream/riparian ecosystems during climate change (particularly droughts), including habitat for the rare Arctic Grayling in the Big Hole River watershed.

Colorado's Climate Action Plan mainly addresses mitigation, but has a short section on adaptation. (http://rechargecolorado.org/images/uploads/pdfs/5f7e2afe6caecefd248d140d0514895a.pdf, accessed Oct 26, 2011)

- Water:
    - will pursue a water adaptation plan
    - development of regional hydrological models
    - analysis of water rights and compacts
    - comprehensive drought planning
        - revision of the State Drought Mitigation and Response Plan
        - ongoing drought and water supply assessments
        - development of drought planning and decision support tools
        - participation in the National Integrated Drought Information System
    - ongoing education education and outreach on the importance of drought preparedness
    - information exchange and education
        - with technical, research and education experts
        - maintain a clearinghouse of climate projection data
- Forests:
    - reduce risk of fire by restoring health of forests (thinning, timber cutting, prescribed fire, replanting)
    - use of forest biomass for energy

Minnesota

A review by the Association of State Wetland Managers reported that Minnesota has undertaken a number of actions related to adaptation (http://aswm.org/wetland-science/81-climate-change-adaptation-summaries/1170-climate-change-adaptation-minnesota, accessed Oct 26, 2011).

- Climate change is recognized by the Department of Natural Resouces (DNR) as a key trend on their Conservation Agenda
    - planned adaptations include efforts to create wildlife corridors, improve habitat connectivity, and expand habitat buffers to facilitate plant and animal migration as

climate changes (www.dnr.state.mn.us/conservationagenda/direction/climate_change.html, accessed Oct. 27, 2011)
    - will be coordinating monitoring systems and participating in research to detect climate change impacts on natural resources, and track the effectiveness of mitigation and adaptation efforts (www.dnr.state.mn.us/conservationagenda/direction/climate_change.html, accessed Oct. 27, 2011)

- DNR has formed several work groups around specific aspects of adaptation and mitigation. Galatowitsch et al. (2008) (discussed in Section A6 above) is the key foundation document being used.
- Programs:
    - wetlands trends and status monitoring – provides data on achievement of state goal of no net loss in the quantity, quality, and biodiversity of wetlands
    - peatland restoration project
    - study of carbon cycling in peatlands
    - study of carbon burial in shallow lakes
    - study of methane flux in peatlands

In **Canada**, Jacques et al. (2010) reviewed work in climate change adaptation in the agriculture sector (only western provinces shown here):

- British Columbia
    - mostly aimed at securing water supply;
    - planning to ensure that BMPs are geared more to adaptation; support for research;
    - system of protecting agricultural land is considered one of the best policies for climate change adaptation.
- Alberta
    - Alberta Environment's Climate Change Strategy called for adaptation strategies in various sectors;
    - Alberta Agriculture, Food and Rural Development is developing its own strategy
    - Alberta Land Stewardship Act requires watershed committees to produce a land use plan that accounts for climate change;
    - Irrigation Management Climate Information Network provides up-to-date info on irrigated crop water use;
    - Agriculture Financial Services Corporation (i.e. crop insurance) funds weather stations;
    - Environmentally Sustainable Agriculture Initiatives Program supports projects with indirect benefits for adaptation in agriculture
    - Alberta is a member of the Prairie Adaptation Research Collaborative (PARC), which does research on impacts of climate change.
- Saskatchewan
    - Bill 95 calls for the creation of various climate change research and funding organizations
    - Technology Fund could open the door for projects on adaptation in agriculture
    - Saskatchewan Agriculture is working on a climate change adaptation strategy
    - Saskatchewan Agriculture and Saskatchewan Watershed Authority are active in monitoring drought and building the capacities of businesses and communities to deal with drought [not too specific]

    - agreement with University of Victoria for research on climate change impacts
    - Saskatchewan is relying mainly on PARC to assess climate change impacts
- Manitoba
    - Climate Change and Emissions Reduction Act requires Manitoba to report regularly on climate change impacts and adaptation
    - Manitoba Agriculture, Food, and Rural Initiatives plans to work more on adaptation (mostly mitigation up to now)
    - There are plans for extension, communication, policy, agricultural insurance, crop research
    - Participation in PARC
    - Manitoba Sustainable Agricultural Practices Program focuses on mitigation
    - Agricultural Sustainability Initiative encourages sustainable agro-environmental practices (including water quality, environmental goods and services, improvements in crop system efficiency) which contribute indirectly to adaptation
    - Wetland Restoration Incentive Program, Integrated Watershed Management Planning, and Manitoba Ecological Goods and Services Initiative Working Group could also help adaptation
- Summary of main government initiatives
    - research
    - raising producer awareness
    - agricultural insurance
        - premiums are adjusted based on previous losses, so indirectly shift with climate change
        - no more direct effort to integrate climate change into crop insurance
    - indirect support for adaptation through existing programs

Alberta Sustainable Resource Development is developing an adaptation framework for its departmental operations. Adaptation options that have been identified for rangeland management include:

Climate Change Impacts	**Risk**	**Potential adaptation options**
Hydrology and Water Resources		
Water quality	M	**People** - Educate public and livestock industry on importance of riparian health
		Process - Cooperatively work with other Alberta Government ministries to create a climate change adaptation strategy for water resource and riparian vegetation
		Technology - Develop long-term monitoring protocol in order to investigate riparian health
		Governance - Market-based policy instruments for rewarding ecological goods and services for achieving healthy riparian areas

Water-use conflicts (quantity)	H	**People** - Multi-stakeholder consultation to ensure open lines of communication and the prevention of disinformation
		Process - Cooperatively work with other Alberta Government ministries to create a climate change adaptation strategy for Alberta's water resources
		Technology - Development of off site watering and water development (wells etc.) or implement grazing management to control livestock distribution and access
		Governance -Need for policy on water development

Biodiversity

Habitat loss and fragmentation of rangeland communities	H	**People** - Multi-stakeholder consultation to ensure open lines by creating a Biodiversity Implementation Plan
		Process - Cooperatively work with other Alberta Government ministries to create a cumulative effects management plan or Land use planning framework
		Technology - Develop inventories and detailed ecological maps and long-term monitoring protocol
		Governance - Market-based policy instruments for rewarding ecological goods and services
Invasive species	H	**People** - communication and awareness on invasive species
		Process - Cooperatively work with other Alberta Government ministries to create a invasive plant species policy
		Technology - Databases to monitor compliance and inventory weed infestations and weed migrations.
		Governance - Develop provincial invasive species policy and branch

Agriculture

Shifting vegetation and grazing zones	H	**People** -Active involvement of the ranching community to address changes to carrying capacity
		Process - Shift allowable grazing zones in highly sensitive areas to highly adaptive areas (i.e. sandy areas), may include reducing grazing capacity for all areas

		Technology - Use modeling software to identify areas where grazing is more suited
		Governance - Alter rangeland management practices to target species at the edge of their range where early impacts will be evident (inventory and PVI)
Reduced overall bioproductivity due to poor soil moisture	H	**People** -Active involvement of the ranching community to address issues on drought and riparian grazing
		Process - Identify sensitive grazing areas (develop a policy and identify areas which may have temporary grazing opportunities)
		Technology - Use modeling software (GIS) to identify areas where grazing is more suited, requires detailed ecological information and long-term monitoring
		Governance - Alter rangeland management practices to ensure rangeland health is maintained on all public grazing land

Saskatchewan programs were evaluated by Steinley and Mowchenko (2011) with respect to adaptation to drought and flooding:

- Canada-Saskatchewan Farm Stewardship Program – intended to reduce environmental risk and provide benefits to soil, water, air, and biodiversity; funding support for adoption of BMPs (e.g. improved storage of chemicals and wastes, remote watering systems and riparian area management, conversion to permanent cover, low-disturbance openers, precision farming technology); conversion to permanent cover increases preparedness for both flood and drought.
- Farm and Ranch Water Stewardship Program – intended to assist producers in developing secure water sources for livestock; provides funding support for wells, pipelines, and dugouts; these increase drought preparedness and facilitate improved range management.
- Agri-Environmental Group Planning Program – mostly address water quality within a particular watershed
- Environmental Farm Program – provides funding for all BMPs; e.g. high rate of adoption of precision farming and low disturbance openers.
- These programs have benefits for drought and flood preparedness, but these are co-benefits (programs had other objectives)
    - benefits of conversion to permanent cover increases preparedness – reduces impact of high moisture events and protects soil during droughts.
    - drought preparedness is already a big part of range management practice
- Evaluation of BMPs
    - Pasture management (fencing and remote watering systems) - co-benefit of improved range management (e.g. increased litter reduces soil evaporation)
    - Water quality protection (relocation of livestock confinement facilities, farmyard runoff control, modifying and revegetating waterways) – does not help with drought, but does help in reducing pollution and erosion during flood events.
    - Forage establishment (convert cultivated land to perennial forages) – co-benefit of forage crop yields being more predictable and stable compared to annual crops; also

reduce erosion during droughts and floods; also more likely to yield a hay crop during flood years, compared to annual crops.

- Protection of stockpiled feed from wildlife – co-benefit of increasing storage for drought years

Manitoba has developed a list of initiatives, programs and policies that may promote adaptation to climate change in the agriculture sector:

Initiative/Program/Policy	Objective	Activities	Instrument Type
Provincial Flood Mitigation Strategy	To develop a province-wide flood mitigation strategy for flood proofing flood prone communities and individual residences	Flood forecasting initiatives, construction of dikes, feasibility assessment of flood infrastructure and other flood mitigation activities	Information; infrastructure
Environmental Farm Action Program (EFAP)	Improved environmental performance and sustainability	Producer incentives for BMP adoption	BMP Incentive; Extension
Manitoba Sustainable Agriculture Practices Program (MSAPP)	Climate change mitigation and adaptation	Producer incentives for BMPs, R&D and extension activities	BMP Incentives; Extension
Agro-Woodlot Program Climate Friendly Woodlot Practices	Promote environmentally sensitive logging and forest regeneration	Rejuvenate woodlots & train micro-forestry entrepreneurs	Incentive; Extension
Wetland Restoration Incentive Program (WRIP)	Carbon sequestration, improvements to water quality and quantity	Producer incentive program to restoration previously drained wetlands on private land	Incentives; Technical Support
Integrated Watershed Management Planning (IWMP)	Create common goals for the watershed and a prioritized and targeted action plan	Public consultations, technical and advisory support	Planning; Incentives; Education
Manitoba Organic Transition Program	Increase organic agriculture production and processing in MB	Financial support to help establish an organic operation	Certification; Incentives
Sustainable Development Innovation Fund (SDIF) - Manitoba Water Stewardship Fund (MWSF)	Promote sustainability of Manitoba's environment, human health, social well-being and economy	Financial assistance for research and activities related to Water Protection Act, Watershed management plans.	Incentives
Riparian Tax Credit	Encourage green practices on riverbanks and lakesides	Applicable to agricultural land only	Tax Credit

Odour Control Tax Credit	Reduce odour emissions by reducing cost of equipment required	Available to corporations or individual farmers	Tax Credit
Manitoba Agricultural Services Corporation (MASC)	Support the Manitoba's producers and rural communities, through innovative and targeted risk management and financial programs	Provide a variety of lending and insurance programs for agricultural producers in Manitoba	Loans; Insurance
Environmental Enhancement Loan	Assist financing of more costly BMPs	Finance producer's share of project costs and provide advance on fed/prov contributions	Loan (up to $150,000)
Alternate Energy Loan	Assist with smaller ethanol, bio-diesel, wind and biomass operations	Increase processing of Manitoba agricultural products while encouraging sustainable alternate energy sources	Loan of 0.75 million for individuals and 1.5 million for businesses
Agri-Recovery	Help affected producers resume business operations and/or take actions to mitigate the impacts of a natural disaster as quickly as possible.	Payments to producers who have suffered from a natural disaster.	Financial assistance
Agri-Stability	Provides support when a large margin decline is experienced.	Payments to producers who suffer a large margin decline.	Financial assistance
Trees for Tomorrow Manitoba	Assist in reduction of GHG emissions	Plant 6 million trees by 2012. Free seedlings, site preparation	Free seedlings; Technical Support
Biomass Energy Development	Develop opportunities for the use of biomass energy in Manitoba	Research and demonstration of biomass energy projects	Research; Extension; Information
MAFRI's Diversification Centres (CMCDC, PESAI, PCDF, WADO)	To support innovation, diversification and value-added opportunities in Manitoba	Focuses on applied research and extension on innovation, diversification, value-added, advanced technology, market development and sustainability initiatives that directly benefit producers	Research; Extension; Information

Sustainable Development Innovation Fund (SDIF) - Manitob Climate Change Action Fund (MCCAF)	Promote sustainability of Manitoba's environment, human health, social well-being and economy	Increased public awareness on climate change and measurement of long term GHG reductions;	Information; Extension
Agricultural Sustainability Initiative (ASI)	Improve agricultural ecosystems in Manitoba by encouraging adoption of sustainable practices	Financial incentives for demonstrations of technology transfer projects or sustainable agriculture practices	Extension; Information
Crop Residue Burning Reduction Program	To control smoke dispersion caused by burning crop residues	Provide assistance and extension to producers in terms of proper crop residue burning	Extension; Information
Environmental Farm Plan (EFP)	Identify and reduce on-farm environmental risks	Information workshops, workbook completion and EFP verification	Extension; Information
MAFRI Growing Opportunities (GO) Teams	Provide front line service for MAFRI to the agricultural community in Manitoba	Provide agricultural extension, support and assistance to agricultural producers and industry	Extension; Information
Wetlands - Health of Manitoba's Coastal Marshes: Delta and Netley-Libau	To look at the status and health of Delta and Netely-Libau Marshes with regards to excess nutrients, dredging and invasion of non-native species	Developing management strategies and restoration work at Delta and Netely-Libau Marshes. Studies on historic roles of marshes in reducing the nutrient load from the Red River Basin	Information; Research
Beyond Kyoto – Provincial Climate Change Actions	To reduce GHG emissions to 6% below 1990 levels by 2012.	Implementation of new regulations and policies to protect water resources, improve emergency preparedness for extreme weather events, assess MSAPP for its ability to build resiliency to climate change on the farm	Information; Research and Development
Ecological Goods & Services (EG&S) Pilot Projects	Test and select EG&S policy instrument(s) suitable for Manitoba’s landscape	Conduct EG&S research studies and pilot projects	Research; Information

Adapting Agriculture to Climate Variability on the North Central Great Plains of North America	Gather information and provide guidance concerning the implications of rapid climate change in the north central Great Plains region	Consultations, technical and advisory support	Information
Agro-Meteorology Information System	Provide supportive Ag-Met information for agro-Manitoba	Monitor meteorology patterns, develop decision support systems	Information
EG&S Working Group	Develop an innovative EG&S approach for agro-Manitoba by integrating existing and new policies to provide environmental and socio-economic benefits	Examined policy tools, recommend pilot studies for Manitoba to optimize environmental, social and economic benefits	Information
Prairie Regional Adaptation Collaborative	Build adaptive capacity for decision makers and policy makers to climate change	Three major themes: Water Resources, Drought and Excessive Moisture, and Terrestrial Ecosystems (Forests and Grasslands)	Information
Soil Survey Program	Provide an inventory of soil properties to direct agricultural management practices	Soil sampling and analysis, information presentation	Information
Bioenergy X Bioproducts Team	Coordinate provincial, federal and industry efforts and resources to grow the bioenergy and bioproducts sectors that contribute to environmental sustainability, economic growth and social revitalization.	Develop projects in the context of Manitoba bio-products strategy	Information
Drought Management Planning for Manitoba	To develop indicators and strategies for managing short, medium and long term drought including assuring resiliency for long term events associated with climate change	Collecting background information, analysis and identification of potential indicators for different types of drought, public consultation and development of draft drought management plan.	Information

Western Water Stewardship Council	ADM-level council that addresses issues of common interest among the western provinces and territories such as water efficiency, drought preparedness, watershed governance, and flood management	Collecting background information, analysis and identification of potential indicators for different types of drought, public consultation and development of a draft drought management plan.	Information
Water quality flood sampling for spring 2011	To collect water samples to understand the impacts of flooding on water quality	Flood and water sampling analysis	Information
Re-Evaluation of Flood Mitigation Infrastructure	Re-evaluate effectiveness of existing flood mitigation infrastructure in the light of changing hydrologic realities	Re-calculation of flood frequencies and assessment of the capability of existing flood mitigation	Information
Memorandum of Understanding with South Australia	Develop collaborative projects to deal with reducing flood hazards, long term droughts, and preserving ecological goods and services affected by climate change	Sharing of best practices and learning on issues relating to drought and drought preparedness and flooding and flood mitigation.	Information
Strategic Directions for Water	Three year action plan to develop policy and recommendations for Canada wide water strategy to protect aquatic ecosystems, promote wise use of water, water quality and water quantity management, adaptive strategies to reduce impact of climate change.	Promote positive changes to conserve water and water quality, transition science into policy, develop water valuation and guidance document for water managers. Develop tools to facilitate sharing of water data Canada-wide. Identify and share BMPs	Information
Hydrometric Monitoring System	Bilateral agreement with the federal government to monitor water levels and stream flow	Monitor and measure water level and stream flow using sophisticated monitoring equipment and methods to collect and process the hydrometric data	Information

Agricultural Crown Land Leasing Program	Manage 1.5 million ac of crown land within a multiple resource use framework	Provide crown land to agricultural producers via leases and permits, providing pasture and hay to 20-25% of the province's beef herd.	
The Manitoba Benchmark Project Crown Lands	Verification of crown lands classification and provide basis for crop and livestock extension.	Monitor forage yield and quality on historically grazed native pasture in Manitoba taking into account different soil types and 4 different eco-regions in Manitoba.	Information
Agri-Extension Environment Program	Changes in practice to encourage the adoption of environmentally sustainable agriculture practices	Extension	Extension
Provincial Land Use Planning	To express the provincial interest in the use of land and resources to provide guidance to local planning authorities in the preparation of local land use plans	Advice and education to local planning authorities regarding the preparation of land use plans that integrate social, environmental, economic, and cultural considerations and support community sustainability	Extension
Agri-Food Research and Development Initiative (ARDI)	Provides funding for research and development in agri-food production and processing in Manitoba	Provide an avenue for research and development for projects that result in new farm income streams, growth in the value-added sector, reduced costs for primary production and also those that expand knowledge, translate knowledge into new products and practices, or verify new technology and practices under Manitoba conditions.	Research & Development

A9 CONCLUSIONS

The summary of adaptation options (Section A7) represents the main ideas that have been found in the scientific and extension literature. It is recommended that government agencies use this list of options for internal review:

1. Review the list to identify any additional adaptation options that should be included.
2. Review existing programs and policies to identify those which address (directly or indirectly) particular adaptation options.
3. Identify existing programs and policies that could be modified or expanded to increase their focus on climate change concerns.
4. Identify adaptation options that are not addressed by any current programs or policies.
5. Develop new programs and policies to address these gaps.

This review has emphasized that there are different adaptation approaches depending on the time-scale:

- In the short term, create **resistance** to change
- In the medium term, promote **resilience** to change
- In the long term, enable ecosystems to **respond** to change

Many existing public policies help to address short and medium term adaptations in management of grasslands. This is because droughts and other extreme events have always been recognized as threats to livestock producers. Existing policies help producers to cope with current droughts, and to increase their resilience to future droughts. Adaptation to climate change will be achieved by "mainstreaming": building on existing policies and programs, and identifying those that need to be modified or expanded if the frequency of extreme events increases with climate change.

However, there is much less public policy that addresses long-term adaptation to climate change. This is largely because of the lack of political support for incurring large present costs to address risks that are somewhat uncertain and that will mostly affect us decades in the future. However certain aspects of long-term adaptation can be mainstreamed into current programs.

- Keeping grassland systems healthy will enhance their ability to respond to future changes. Ongoing programs, including support for sustainable grazing management practices and control of invasive species, contribute to keeping grasslands healthy.
- Programs aimed at conserving our remaining grasslands and wetlands will help to keep our options open for the future. However, these programs need to be greatly expanded, with adaptation to climate change providing one more reason to do this.
- Ongoing research on climate change impacts will better prepare us for future adaptation.

Other aspects of long-term adaptation present greater challenges:

- The review of adaptation options underscored the need for long-term grassland monitoring. This is needed to detect the rate at which grasslands are changing in response to climate change, to trigger changes in management such as revision of recommended stocking rates, and to measure the success of adaptation programs. The Manitoba Forage Benchmarking Project is an excellent start, but such monitoring projects are vulnerable to loss of funding. Maintaining support for long-term monitoring through short-term budget cycles will be challenging.

- Helping grasslands (and other ecosystems) to respond to climate change will eventually require measures to help southern species to migrate northward. Whether this is done by designing landscape corridors, by assisted migration of key species, or by some combination of approaches, this work is not addressed by any current programs.

Mainstreaming climate change considerations into current programs is important, and will probably be the main way in which progress on adaptation is made. However, long-term adaptation will also require raising awareness among governments on the need for new programs.

Native grassland is a vital asset in our future ability to adapt to climate change. The grasslands of the Great Plains evolved in a highly variable climate, and as a result they are more tolerant of climatic extremes than croplands or woodlands. They are made up of a mix of species: taller and shorter species; warm-season and cool-season species; drought-tolerant and moisture-requiring species. Grassland communities vary continuously over a huge area, from Canada to Mexico. Research on previous droughts showed that grasslands adjust by shifts in the proportions of species, while maintaining a grassland ecosystem (Thorpe 2011). Healthy native grassland can do this without expensive management inputs – it is an autonomous system. And this system will continue to support livestock production.

Because of conversion to cropland, native grassland has already been reduced to about 20% of its former extent in the Prairie Provinces (and probably much less than that in Manitoba). While it is easy to shift land use between cropland and tame pasture, it is difficult to recreate native prairie after it is lost. For this reason, destroying our remaining native prairie reduces our future options. In the future climate, we may well find that land now considered suitable for cropland would have been better left in native grassland. Conserving our remaining native grassland, keeping it healthy by reducing threats such as overgrazing and exotic invasion, and helping it to respond to climate change by facilitating northward movement of species, will help the prairies to cope with the coming change.

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PART B – MANITOBA'S AGRICULTURAL CLIMATE CHANGE ADAPTIVE PLANNING WORKSHOP

Winnipeg, Nov. 30 – Dec 1, 2011

B1 EXECUTIVE SUMMARY

On November 30th and December 1st, 2011 Manitoba Agriculture, Food and Rural Initiatives (MAFRI) hosted a two-day Agricultural Climate Change Adaptation Workshop. The workshop was facilitated by Deloitte as part of the Terrestrial (forests and grasslands) component of the Prairies Regional Adaptation Collaborative (PRAC) initiative. This workshop was held in Winnipeg, Manitoba, and was attended by 35 participants, mainly consisting of Government of Manitoba employees from four provincial government departments. The workshop was focused on climate change adaptation for the cattle and forage sectors in Manitoba.

This workshop was designed to: 1) create awareness regarding climate change and the potential impacts on agriculture, and more specifically the forage and grassland sectors; 2) to demonstrate and apply a risk-based climate change adaptation planning framework; and 3) to allow participants to assess the use of the framework for application within MAFRI.

The workshop began with greetings from Fred Meier (Deputy Ministers of Conservation) and Barry Todd (Deputy Minister of MAFRI). Following these opening remarks two presentations given by Dr. Danny Blair (University of Winnipeg) and Dr. Jeff Thorpe (Saskatchewan Research Council) on '*Current and Projected Temperature and Precipitation Trends in* Manitoba' and '*Future Impacts to Forage and Grasslands Sectors'*, respectively. The intention of initiating the workshop with these presentations was to level-set the participants with foundational climate change science to prepare for the planned risk assessment activities.

The participants were oriented to the Adaptation Framework by a presentation from Geneva Claesson (a Sustainability & Climate Change specialist with Deloitte. The presentation focused on outlining the key concepts of the framework and the steps involved to assess an organization's adaptive capacity to respond to climate change by analyzing vulnerability and risk. A final presentation was given during the lunch hour by Dr. Paul Bullock featuring '*Future Impacts to Manitoba's Crop Sector*'.

Following the morning session, participants were divided into breakout groups for the remainder of the two-day workshop. During this time they were given the opportunity to go through the vulnerability and risk assessment process in order to determine MAFRIs organizational vulnerability to climate change using the forage and beef sectors as a test theme. All of Agro-Manitoba was assessed for a 10-year planning process, and climate impacts were based on 2050 climate predictions. Participants were provided with a summary of climate projections for Manitoba in addition to a short list of programs currently being administered by the provincial and federal governments that are somewhat involved in adaptation to climate change. An initial planning step in the framework is the compilation of current adaptation-related programs and policies; MAFRI completed this step prior to the workshop.

After completing the vulnerability and risk assessment process, to focus participants for the adaptation identification step, Dr. Thorpe gave a second presentation on potential adaptation options for Manitoba grasslands developed with reference previous research on grassland vulnerability completed for the PRAC. The session concluded with a final breakout session where participants were asked to identify adaptation options that MAFRI could implement to assist producers in adapting the forage and beef sectors to climate change.

Outputs obtained from the workshop included: a list of current policies and programs being implemented by provincial and federal governments, a preliminary vulnerability and risk assessment for the forage and beef sectors in Manitoba, a list of suggestions provided by participants on how to modify the SRD framework for use by MAFRI, and suggestions on next steps for MAFRI and other provincial governments in adapting to climate change.

Overall, participants felt that adaptation to climate change is important for MAFRI and other provincial departments to be involved in however it should be done as a collaborative effort and an inter-departmental adaptation team should be developed to carry out this process.

The following report gives a detailed summary of the two-day adaptive planning workshop.

B2 BACKGROUND

Manitoba is a key partner in the Prairies Regional Adaptation Collaborative (PRAC), which is a joint partnership with Alberta, Saskatchewan and Natural Resources Canada. The PRAC has three main themes: water resource management, drought and excess moisture management, and terrestrial ecosystems adaptation. The PRAC was initiated to build capacity among decision-makers in order to incorporate adaptation in to current policies and programs, to encourage knowledge transfer, and to develop adaptation options that mitigate risks and enhance opportunities resulting from climate change in the three Prairie Provinces.

In November 2010, MAFRI and Manitoba Conservation held a successful Inter-departmental Workshop on Climate Change Adaptation in Winnipeg as part of the Terrestrial component of the PRAC. This purpose of this workshop was to demonstrate the use of an adaptation framework to four provincial departments (MAFRI, Conservation, Water Stewardship, and Local Government), and to identify potential adaptation options using a framework developed by the Government of Alberta's Sustainable Resource Development Department for the grassland and forest ecosystems in Manitoba's Parkland Region. This workshop provided a preliminary assessment, and in September 2011 MAFRI began planning for a second workshop to build upon the November 2010 workshop. This second workshop was held in Winnipeg, Manitoba where 35 participants (Appendix A) convened from the same four provincial governments; however, for this workshop the focus was on the forage and beef sectors in Manitoba. The workshop objectives were as follows:

1. Evaluate, at a high-level, organizational vulnerability and risks for MAFRI to climate change impacts on grasslands, and to identify potential adaptation options for priority risks;
2. Communicate and demonstrate the use of an adaptation planning framework to incorporate adaptation into decision-making;
3. Obtain feedback from workshop participants on potential modifications to the Alberta Sustainable Resource Development (SRD) Climate Change Adaptation Framework, and identify possible gaps, barriers to and opportunities for integrating climate change adaptation into existing decision-making processes; and
4. Generate interest and commitment to adaptation readiness and resilience within MAFRI, Conservation and other departments.

Materials provided to participants prior to, during and following the workshop included:

1. The workshop agenda (Appendix B);
2. The Climate Change Adaptation Framework Manual, which includes the step by step process that Alberta SRD followed[1];
3. Terms of Reference[2] for the assessments were provided at the workshop (Appendix C)

[1] Note: the workshop was facilitated with slight modifications for MAFRI's forage and beef sectors.

[2] Note: the Adaptation Framework includes a process to develop a 'Terms of Reference' for the assessment. A sample was provided to participants as a case study to test the assessment method.

4. A list of provincial and federal policies and programs currently in place that could assist with adaptation (Appendix D)
5. A summary of projected climate impacts for Southern Manitoba (Appendix E)
6. A copy of the presentations given by Dr. Blair, Dr. Thorpe, and Dr. Bullock.

B3 SUMMARY OF WORKSHOP PROCEEDINGS

MORNING SESSION: November 30th, 2011

Geneva Claesson initiated the workshop by providing the objectives for the two days and the agenda. She then introduced the DMs of Conservation and MAFRI to give welcoming remarks.

Dr. Fred Meier
Deputy Minister of Conservation

The DM of Conservation provided opening remarks which mentioned the Climate Change Report from the National Round Table on the Environment and Economy (NRTEE) that highlights the importance of spending today to adapt to climate change in order to offset the future costs. He indicated that Conservation will lead climate change adaptation for the overall provincial government in the coming years.

Dr. Barry Todd
Deputy Minister of MAFRI

The DM of MAFRI followed the DM of Conservation with opening remarks. He indicated that climate change will have significant impacts on agriculture and that the Manitoba agriculture industry represents $5 billion dollars in sales annually and this industry feeds into the food processing sector, which is responsible for 25% of Manitoba's economic output. He went on to state that 20 million acres in Manitoba is devoted to crops and livestock production and it is the government's responsibility to guide communities in dealing with the impacts of climate change. He highlighted the importance of these interdepartmental workshops that bring specialists together to identify long term solutions because in government we are very good at responding to immediate threats but not so good at seeing and dealing with the long-term.

Presentations on Temperature and Precipitation Trends, and Climate Change Impacts on Grasslands and Crops

Four presentations were given during the morning session to provide workshop participants with the background information required to complete the vulnerability and risk assessment process for the remainder of the workshop. Scientific presentations were given by: Dr. Danny Blair, Dr. Jeff Thorpe, and Dr. Paul Bullock, and an introduction on the adaptation framework that would later be applied was given by Geneva Claesson.

Dr. Danny Blair

Acting Associate Dean of Science, Principle of the Richardson College for the Environment
University of Winnipeg
Presentation: *Current and Projected Temperature and Precipitation Trends in Manitoba*

Dr. Blair began his presentation by highlighting that the climate does vary based on climatic patterns such as El Niño and La Niña however overall it is still warming. He indicated three key trends: atmospheric CO_2 has now reached 390 ppm; there is not quick solution to minimize the warming; and Canada will experience greater warming than the rest of the world. He went on to provide information on current and projected temperature and precipitation trends in Manitoba. The presentation highlighted the expected increase in overall variability of weather patterns, increased annual temperatures, increased risk of excess moisture, flooding and drought. It concluded with indications of how these changes in climate may impact the agriculture industry.

Dr. Blair's presentation generated many questions from participants regarding how ozone impacts climate change, how Manitoba will look in the future, and how agriculture can take part in mitigation efforts.

Dr. Jeff Thorpe
Principle Research Scientist
Saskatchewan Research Council (SRC)
Presentation: *Grasslands and Climate Change: Vulnerability and Adaptation Options*

Dr. Thorpe presented on the vulnerability of native grasslands to future climate change based on different temperature and precipitation scenarios of the 2080s. He explained that even in the coolest scenarios we see that vegetation from the US is pushing into Canada, and that even in the warm dry scenarios the decrease in grassland productivity is not as great as we would expect. He highlighted the impact of extreme events, indicating that past droughts have caused a shift in species of prairie grasslands and contributed significantly to tree mortality.

Additionally, Dr. Thorpe noted that there is much more research currently focused on drought compared to excessive moisture, and that these periods of excess moisture may lead to increased production; however the quality of forages may be compromised. A problem that was highlighted was invasive species and their improved ability to adapt to climate change. He ended by mentioning the three Rs to adaptation, which include: Resist (short-term), resilience (medium), and respond (long term). Short term examples included: reducing the number of livestock, moving livestock to alternative grazing, & purchasing feed. Medium term examples included: converting crop land to perennial forages, changing herd structure, planning for increased feed reserves, improvement of water distribution systems & detection and control of invasive species. Long-term examples included: have monitoring systems in place so you can identify directional change when it happens.

Ms. Geneva Claesson
Manager, Sustainability and Climate Change
Deloitte & Touche, Inc.

Just prior to lunch, Geneva provided an overview of the Adaptation Framework that we would later be testing for the remainder of the workshop and was originally developed for Alberta's Sustainable Resource Development (SRD) Department. She explained how Alberta initiated climate change adaption efforts and the context for developing the Adaptation Framework, and also provide examples where other Canadian governments are currently working on adaptation. She went on to explain the four step approach of the Adaptation Framework: scope, vulnerability assessment, risk assessment, and identification of adaptation options. She indicated that when it comes to identifying adaptation options we should look at how MAFRI has coped to recent events and how the department delivers existing policies and programs in order to determine these could be modified in the future. The goal is to identify options for the department to be resilient and adaptive in light of the uncertainty posed by climate change, and as a side-benefit, MAFRI can continue to deliver actions that can contribute to resiliency in the agriculture sector as well.

Dr. Paul Bullock
Professor, Department of Soil Science
University of Manitoba
Presentation: *Climate Change and Manitoba's Agriculture: Potential Impacts*

The keynote speaker over the lunch period was Dr. Paul Bullock. Dr. Bullock began by giving background information on climate projections and highlighted how our greatest challenge is adapting to the increased climate variability and extreme weather (droughts, floods). He demonstrated the positive and negative impacts of increased atmospheric CO_2 concluding that the negative impacts will outweigh the positives. He also mentioned that with this increased CO_2 we will be subjected to more weeds and decreased effectiveness of certain herbicides.

AFTERNOON SESSION: November 30th, 2011

Test Lab 1: Scope and Preparation
The afternoon session began with Geneva providing the workshop participants with the scope of the vulnerability and risk assessments. This gave participants the geographic, organizational, and time horizon boundaries. Workshop participants were then divided into 5 breakout groups.

Test Lab 2: Applying Alberta's SRD Adaptation Framework to Assess the Vulnerability of Manitoba's Forage and Beef Sectors
Ms. Geneva Claesson assisted by Joyanne Lizotte

During the afternoon session participants took part in the first test lab where they evaluated the use of the vulnerability assessment applied for Alberta's SRD for MAFRI's purposes. The forage and beef sectors were used as test themes. Participants were

asked to identify climate impacts on sectors, along with current and potential stressors. Prior to the assessment they were provided with a list of current programs and policies being administered by the provincial and federal departments and this list was used to determine the adaptive capacity of the department to future impacts. Results are provided in Table 1 & 2 below.

Table 1: MAFRI's Organizational Vulnerability Assessment for the Support of the Beef Cattle Sector

ES	Climate Change Impacts	Existing Stress	Degree of Sensitivity	Potential Climate-related Stress	Degree of Sensitivity	Total Degree of Sensitivity	Existing Adaptation Responses	Degree of Organizational Adaptive Capacity	Organizational Vulnerability
Cattle Production	Access to forage during freezing rain; quality water available; increased survival of parasites; heat stress on pastures or in crops; extreme weather - survivability, increased mortality; access to water for use and/or storage; Manitoba may be a low cost producer; longer grazing season; reduction in feed requirements during milder winters.	Country of origin; lack of local slaughter capacity; post-BSE effects; feed availability; regional diseases (TB); decreasing cowherd; public perception of environmental effects; changing diets; current market; food traceability; regulation; flood related problems;	Sensitivity was rated as **medium to high** based on market influence	Availability of feed; Availability of water; Decreased forage quality; Water quality; Pests; Disease; Heat Stress; More susceptible to environmental stressors than confined livestock;	Sensitivity to potential stress was also rated as **medium to high**	Total degree of sensitivity was rated as **high**.	Extension & AgriRecovery program; BMP incentive programs (EFAP), AgriStability; Research (ARDI); Conservation districts; weather stations; Drought/Excess moisture planning; Community Pasture Program; Ag Crown lands policy; DFA;	Organizational Adaptive Capacity was rated as **medium** due to the fact that programs and policy emphasis has been related to income losses and not adaptation. Business risk management programs dominate the political budgets and account for an estimated 70% of spending. Also, programs are mostly short term with limited proactive programming. Within Manitoba we work in silos more often that in collaboration with one another.	On average the organizational vulnerability was rated as **high**. The reasoning behind this was the lack of co-ordination between departments in the province, the lack of funding for staff for a long term approach; political whim (short-term thinking); everyone is caught in crisis mode (public, producers and politicians); Region specific differences may mean that there isn't once solution for all of Manitoba

Table 2: MAFRI's Organizational Vulnerability Assessment for the Support of the Forage Sector

ES	Climate Change Impacts	Existing Stress	Degree of Sensitivity	Potential Climate-related Stress	Degree of Sensitivity	Total Degree of Sensitivity	Existing Adaptation Responses	Degree of Organizational Adaptive Capacity	Organizational Vulnerability
Forage Production	Decrease in yields; decrease in quality and palatability; variability in yields; impacts on storage capabilities; increased invasive species; increased risk of disease; increase in grassland acreage in Manitoba; increased growing season	Current extreme weather; flood vs. drought; invasive species; market pricing; poor quality and production in certain areas; market pressure from higher crops; changing land use (more urbanization); forage production being moved to more marginal land; policy related to rangeland; decreasing native grassland;	Average sensitivity rating was **medium** based on the ability of forage to bounce back after poor production years, the relatively low frequency of extreme events	Decrease yield; increased variability; decreased quality; disease; more emphasis on food production vs. forage production; increasing crop prices may cause increased use of marginal lands for crop production	Sensitivity to potential stress was also rated as **medium to high**	Total degree of sensitivity was rated as **medium to high**.	Community Pasture; Drought and excess moisture planning; invasive species council; BMP funding; Ag Crown Lands; Diversification centers; Conservation districts forage seeding; benchmarking project; research (ARDI); recognize the value of marginal lands in land use planning regulations; Agristability; weather stations; Habitat connectivity retention (CON, MHHC, NGOs)	Organizational Adaptive Capacity was rated as **medium** for similar reasons as cattle production. However one group suggested that it was a more stable commodity than cattle.	On average the organizational vulnerability was rated as **high**. The reasoning behind this was similar to those listed for cattle production as well as the lack of funding for research.

Feedback on Vulnerability Assessment Process and Suggestions for Improvement:

Each breakout group provided feedback specific to the process of assessing vulnerability. Their comments are summarized below:

- It might be more beneficial to look at gaps in programming to determine what priorities are urgent instead of looking at existing adaptation responses.
- There should be benchmarks for high/medium/low scores indicating what each score means.
- The process is too high level, intangible and technically complicated. The process is not effective and isn't real.
- Listing the adaptive programs under adaptive capacity seems to give a false sense of capacity. Programs are generally short term and heavily influenced by politics
- This analysis would require a policy re-evaluation every year to incorporate new ideas into the cycle.
- More data is needed to provide the basis for the assessment. This may require additional research.
- There was no real evaluation of the success of the existing programs or policies
- The assessment was issue based vs. department focused
- More consultation with scientific experts would be needed along with expert staff.
- How do you make decisions when one ecosystem service has a major impact on another?
- Producer groups and industry should be involved in the assessment
- Additional activities or alternate activities to assess vulnerability could be to survey staff by email and to assess departmental strategies and priorities.

Following the vulnerability assessment, breakout groups presented and discussed their results. Day 1 then concluded with Ms. Claesson providing the agenda for the following day.

MORNING SESSION: December 1st, 2011

Test Lab 3: Risk Assessment

The second day of the workshop Ms. Claesson summarized events from day one, and gave a refresher summary of the risk assessment process. Following the brief introduction participants began performing the risk assessment on the cattle and forage sectors. The risk assessments involved creating "risk statements" which describe an impact on either cattle or forage resulting from climate change impacts which results in a specific risk for MAFRI (i.e. will MAFRI require more funding for BMP or BRM programs, will current programs be ineffective, will more education or research be required, will strategic planning need to change, etc.). The list of risk statements and risk analysis results obtained from the five breakout groups are summarized below in Table 3 & 4.

Feedback on Risk Assessment Process and Suggestions for Improvement:

Each breakout group provided feedback specific to the process of assessing risk. Their comments are summarized below:

- Presentations on existing programs, involvement of program managers, or assessment of various programs' current adaptive capacity (IISD adaptive capacity tool) would be beneficial throughout this assessment
- Bring in farmers/landowners to give truth to the existing risks/climate impacts
- Get opinion from farmers/landowners to determine which programs they think MAFRI will need based on the risks
- Collaboration with other provincial and federal departments are necessary for an effective vulnerability and risk assessment, possibly through an inter-departmental working group
- Aboriginal engagement regarding Crown Lands would be necessary
- The risk analysis would be better supported with different consequence categories
- Throughout the process it was difficult to see how the vulnerability assessment fit into the risk assessment. It doesn't seem like the same people have to do both the vulnerability assessment and then the risk assessment.
- Technical teams for each sector would be a good idea so that the people evaluating the risks are those that are experts within that sector. This would allow major issues to be identified and then we could expand the collaboration to other departments with structured facilitation.
- For "people" category it should reflect injury and damage to staff – stress
- Financial: >$100 million = catastrophic. Major = 50-100 million, Reasonable = 10-50 million, Minor = 5-10 million, Insignificant = 0-5 million.
- High, medium and low doesn't give enough distinction between categories. It is difficult to prioritize risks and make decisions at the policy level using this type of scale.
- Major concern – MAFRI and Conservation should work collaboratively in the development of their departmental strategies to ensure that cross-cutting issues are addressed in an efficient way.

- Should include a column regarding how it impacts other departments
- The model focuses more on a business plan. It should focus more on our clients and our resources
- When helping producers we need to do a market forecast for growing demand of cattle and forage

Table 3: MAFRI's Organizational Risk Assessment for the Beef Sector

ES	Risk Statement	Vulnerability Assessment Results	Risk Analysis						Risk Ranking
			Consequence					Likelihood	
			S	F	O	P	PC		
Cattle Production	The issue with water availability will boost the demand for increased funding for water supply programs	High	2.5	2.5	3	3	2	4	M
	Increased incidence of disease will increase the need for public education programs to cope with anxiety over diseased cattle		4	4	4	4	4	2	M
	Increased incidence of disease leading to decline in producer livelihood will cause MAFRI to extend more support programs		4	4	4	4	4	2	M
	Extreme drought will minimize MAFRI's ability to meet its strategic objectives because all resources will be shifted to ad hoc BRM programming		2	5	5	2	4	5	H
	Cattle production will likely move north along with forage production which will result in staff shifts		3	1	2	2	2	2	L
	Climate change impacts will require more collaboration between provincial departments		4	3	3	2	1	3	M
	Extremes in the short term will result in the need for education and a shift in resources to maintain animal welfare		2	3	2	2	5	4	H
	Extreme weather events resulting in the lack of available feed and potentially animal evacuation will require a shift in resources to maintain animal welfare		4	5	3	3	5	4	H
	Increased disease outbreaks will result in increased demand for vet services provided by MAFRI		1	5	4	5	5	4	H
	Water and land impacts will lead to increased demand for infrastructure (e.g dams, riparian protection)		5	5	3	3	2	5	M
	Increased disease will lead to increasing demand for food safety and tracking supply chain requirements		5	4	4	5	5	5	H

	Extreme events which deplete agri-recovery program will reduce resources to other areas		**5**	**5**	**3**	**1**	**5**	**5**	**H**

Table 4: MAFRI's Organizational Risk Assessment for the Forage Sector

ES	Risk Statement	Vulnerability Assessment Results	Risk Analysis						Risk Ranking
			Consequence					Likelihood	
			S	F	O	P	PC		
Forage Production	**Extreme events may cause overstocking of community pastures which could result in overgrazing (declining biodiversity)**	**High**	**2**	**2**	**2**	**3**	**1**	**5**	**L**
	A decline in forage production will result in MAFRI needing to provide continued support and extension of community pasture programs		**2**	**1**	**1**	**3**	**1**	**1**	**L**
	Increasing invasive species resulting in need to increase surveillance and extend control measures (e.g. Herbicides and potential impacts)		**1**	**3**	**3**	**3**	**2**	**2**	**L**
	Extreme events leading to a lack of stability and increased financial risk will require insurance programs to have increased funding and capacity		**4**	**5**	**4**	**4**	**4**	**4**	**H**
	Climate change will cause current programs to be ineffective and strategic planning will have to change		**3**	**3**	**3**	**2**	**2**	**3**	**M**
	Current location of offices may change due to change in farming practices (shifting vegetation patters and forage production moving north)		**3**	**1**	**2**	**2**	**2**	**2**	**L**
	Change in temperature trends will favour weed species and result in reduced yield and higher management costs MAFRI will have to provide more extension and research support to educate producers		**2**	**3**	**3**	**2**	**2**	**3**	**M**
	Decrease in yield and increase variability will boost the demand for financial support and resources		**5**	**5**	**4**	**2**	**2**	**5**	**M**

	Decreased yield will result in increased pressure for crown land management		**4**	**5**	**4**	**3**	**2**	**3**	**M**

AFTERNOON SESSION: December 1st, 2011

Test Lab 4: Adaptation Options

Over the lunch period Dr. Jeff Thorpe continued on with his presentation from the previous day which highlighted potential adaptation options for grasslands in Manitoba. This provided some background information for the afternoon session which focused on identifying adaptation options MAFRI to adapt to the climate impacts on the cattle and forage sectors. Table 5 below highlights the adaptation options from all 5 breakout groups sorted by category.

Table 5: Adaptation Options for MAFRI to Support Adaptation within the Beef and Forage Sectors

Adaptation options	Timeline for implementation	Department(s) responsible
Maintenance of water quantity and quality		
Preserve water quantity and quality (agronomy and breeding)	Agronomy (1-5 years) Breeding (10+ years)	MAFRI/ Water Stewardship
MB Water Strategy (new and improved)	5 years	Interprovincial, International
Inspection and monitoring of water quality	Immediate	Local, Prov & Fed, NGO
Water availability strategy for cattle	1-2 years	Lead – MAFRI & WSD
Native Grassland Initiatives		
Sustainable forage management to maintain native and tame grasslands	Immediate – no net loss	MAFRI/ Conservation/ Private
Promote programs to maintain native grasslands. Management of conservation agreements.	1 year	MAFRI, MHHC, Nature Conservancy
Expanded native species seed supplies	10 years	MAFRI and Conservation together
Use wetland restoration program funding for EGS programs instead since its cheaper (* cheaper to maintain than re-create grasslands)	5 years	WS, MAFRI, Cons with DUC
Programs for management burning of native grasslands, prevents wildfires	5 years	Municipalities with MAFRI and Cons
Disease Prevention and Planning		
Surveillance and monitoring of diseases	Immediate (0-5 years) and long term (5-10 years)	MAFRI/ MHHL
Staff training on disease prevention	Immediate and long term	MAFRI/ MB Communications Group
Monitoring program for existing and emerging diseases	Now	MAFRI, EC
Develop emergency response for potential outbreak -> adapt to new threats	1-2 years	MAFRI, WSD
Develop a disease prevention plan with cc aspects	2-3 years	MAFRI
Planned grazing management programs (herd health benefits)	Now	MAFRI
Wetland Maintenance and Restoration and Flood Prevention		
Regulate loss of wetlands	Now	Water stewardship/ MHHC ->Conservation agreement

Change crop insurance: stop making flooded acres payments to areas where wetlands are drained (i.e. potholes)	April 2012	MAFRI and MASC
Use wetland restoration program funding for EGS programs instead since its cheaper (* cheaper to maintain than re-create grasslands)	5 years	WS, MAFRI, Cons with DUC
Soil moisture monitoring/ surveillance	3-5 years	MAFRI/ WS/ UofM
Coordinated drainage policy	10 years	MAFRI, WS, Local Gov't, IntraProvincial International
Community Pastures and Crown Lands Initiatives		
Maintain and improve existing Crown lands and existing government –owned community pastures	Now	MAFRI/Conservation
Crown land	Immediate and long-term	MAFRI/Conservation
If Crown land will be sold caveats should be in place to maintain wetlands, native grasslands and riparian areas	5 years	MAFRI and Conservation and WS
Conservation purchases land when it comes up for sale – land that has important ecological value	Ongoing	Cons
Soil Survey Expansion		
Soil survey data – expansion (detailed)	Now to 20 years+	MAFRI, AAFC
Improve soil mapping and analysis for future land use planning	5-10 years	MAFRI
Cattle Breeds and Breeding		
Heritage breeds (highland cattle – more resilient, needs less water, healthier)	Long-term	MAFRI
MAFRI education program on adaptive capacity of alternative cattle breeds	Within 3 years	MAFRI in collaboration with AAFC and other provinces
Other Forage Related Adaptation Options		
BRM programming to incent sustainable crop rotations (e.g., annual poly cropping perennial grains)	5-10 years	MAFRI
Long term funding programs for forage research (variety breeding and adaptability)	Now	MAFRI/ AAFC/ universities
Risk reduction programs (e.g., feed storage)	5+ years	MAFRI policy group
Change crop insurance: pay for fences around hay storage rather than paying for losses to wildlife (Hay yards for Habitat)	Jan 1 2012	MAFRI and MASC
Perennial grains/ poly culture	10 years	MAFRI, UofM, International
Maintain quality forage lands (e.g., fund research, land use planning, and education)	2-3 years	MAFRI, Crown lands, LG, Local Min, CDs
Find the ideal grass – Research i.e., grass that is naturally resistant and also ensures optimal cattle production w Kansas/ Nebraska	5-7 years	
Other Cattle Related Adaptation Options		
Extend ASI and ARDI to support R&D	Immediate	MAFRI

Livestock corridors to provide shade and biodiversity	Now	MAFRI/Conservation
Livestock herd demographics	Next 5 years; min annual basis	MAFRI, sector
Integrated production system closed loop	Now and ongoing	MAFRI, IISD, WS, Lake Wpg
Other Adaptation Options		
Regulate urban expansion	Now	Local government
Range land health assessment guide	1-5 years	MAFRI/ Conservation/ Water Stewardship/ AESB
LiDar expansion (hardware/software)	10 years	MAFRI, WS, Local government
Adaptive Policy Review	Progressive and ongoing	All depts.
EGS Policy and Program	2-5 years	MAFRI, WS, Cons, Conservation Districts plus Sector
Expansion of Conservation District programming	10 years	As above
MSAPP	10 years	MAFRI, AAFC, Sector
Climate Adapt Research – MB Specific	10 years	MAFRI, UofM, UofW, AAFC-BRC, etc.
Expansion of Internet/ Communications infrastructure (4G)	2-5 years	Fed/Prov
Info gathering for extreme events -> network with Kansas	1 year	MAFRI
Enable more applied research into policy and planning. Network with academics	Now	UofM, and others, BU, ACC
Network – interdepartmental and between provinces	Now	MAFRI, WSD, CON, LG, Sask Ag, AB Ag, etc.
Hire new adaptation staff or reassign	Now to 2 years	MAFRI
Align new innovation technology to mitigate cc	1 year	IEM, MAFRI
EGS incentive programs	5 years	MAFRI/ Cons/ Water St
EGS regulations	As above	As above
Training and development of staff to build capacity for climate change adaptation	Expand current activities	MAFRI and Cons individually

Each breakout group provided feedback on the process of identifying adaptation options. A summary of the feedback is provided below:

- Again, producers, program managers and experts in the field should be involved in this process, representation from other departments is also necessary.
- How can innovation in agriculture be brought in?
- Communication with MAFRI executive is necessary. It is not effective to wait until the end of the process.
- MASC, NGOs, MHHC, Livestock commodity groups, Forage council, researchers
- More multi-department workshops with on-the-ground staff to build relationships with those staff that will implement adaptation strategies
- More information on policies in place

- This will require a lot more time, meetings and focus groups to produce effective results
- We are missing outcomes of current programs
- Climate scenario modeling for agro Manitoba is the basis of the evaluation.
- Literature review of impacts to the various sectors under MAFRIs mandate
- We should consider “no-regrets” policies due to the uncertainty surrounding climate projections and impact. Should select programs with other co-benefits besides adaptation.

Tony Szumigalski policy analyst with MAFRI concluded Day 2 of the workshop by thanking all participants and presenters. He mentioned that the results from this workshop would be used in part for the development of an adaptation strategy for MAFRI.

B4 – LESSONS LEARNED AND NEXT STEPS

Overall, participants felt that the development of an adaptation strategy was an important initiative for the various provincial departments to have in place to mitigate future impacts of climate change. It was noted that we (i.e., public, producers, politicians) are caught in “crisis mode” and there is a lack of funding for staff to take on long-term projects which in turn leads to limited proactive programming. Business risk management programming was said to dominate political budgets (70-90%) leaving less funding available for adaptation.

Participants agreed that it is important that we include a wide variety of government of Manitoba employees and stakeholders (NGOs, producer groups, academics, etc.) that can identify the major issues within the agriculture, food and rural sectors. This process will likely be completed from the bottom-up, however it is important that there is support from executive and that they are updated on a regular basis with regards to the progress of the strategy. For this process to be effective, it must be included as part of the 10-year strategic plan and funding must be available to implement the strategy following the planning process.

Initial assessments should be done using focus groups composed of MAFRI employees, and stakeholders (producers, producer groups, NGOs, researchers) that are experts in the given sector. Following the initial assessment it would be necessary to include other departments (MWS, CON and Federal Government employees) to determine how the adaptation options may be implemented or how they may conflict with the other departmental mandates. It was highlighted multiple times throughout the workshop that interdepartmental collaboration was necessary, and an interdepartmental adaptation team should be created to organize these collaborative efforts.

Feedback regarding the use of the applied framework for Manitoba’s adaptation planning purposes was that the framework too technically intense, it does not provide quantitative results, it was difficult to relate the process to the departmental objectives and the timeline, and the vulnerability and risk assessments did not build off one another. The development of risk statements also seemed somewhat random and did not appear to capture all the issues of the various sectors being evaluated. This being

said the process was undertaken as more of a “test case” and does not reflect actual application of the framework. In the future, MAFRI along with other provincial departments may decide to proceed using a different adaptation framework more suited to the needs of Manitoba. Suggested options for alternate frameworks are:

- Simplified sector based risk assessment (i.e. no vulnerability assessment performed and less focused on individual ecosystem services) – Follows ISO 31000
- Survey based assessment of major issues and gaps in programming from MAFRI experts and stakeholders
- UKCIP Adaptation Wizard

A second workshop will be held in January with various stakeholders (producer groups, academics, etc.) to receive their input of the development of an adaptation strategy and the initial outputs obtained from this GOM adaptation workshop. Following this half day stakeholder workshop, decision makers will meet again to discuss necessary modifications to the SRD framework in order to increase its effectiveness in Manitoba and the possibility of proceeding with a different framework entirely will also be discussed.

The MAFRI adaptation team specifically will be reviewing various frameworks and the feedback from the two workshops in order to decide which framework is best suited to the organization. MAFRI’s adaptation team will be consulting with specialists within MAFRI, and other provincial departments to determine the sectors within MAFRI’s mandate that are considered most at risk from the impacts of climate change. It will likely be these sectors that are assessed first off and for which adaptation options are developed.

Future meetings will be required to determine how this process fits into the provincial and departmental planning process.

Appendix A – Participants

Greetings: Barry Todd (DM MAFRI), Fred Meier (DM CON)
Steering Committee: Randall Shymko (CON), Tony Szumigalski (MAFRI), Ainsley Little (MAFRI), Matthew Wiens (MAFRI), Ramon Sales (CON), Scott Stothers (MAFRI)
Presenters: Jeff Thorpe (SRC), Danny Blair (U of W), Paul Bullock (U of M)
Facilitators: Geneva Claesson (Deloitte), Joyanne Lizotte (Deloitte),
IISD: Jo-Ellen Parry Susan Taylor
MAFRI: Marla Riekman, Shane Tornblom, Rob Berry, Pam Iwanchysko, Glenn Friesen, Brittany Dyck, Elaine Gauer, April North, Eric Liu, Prabal Ghosh, Kim Brown-Livingston, Esther Salvano, Mike Lesiuk, Carolynn Osborn
Conservation: Dan Chranowski, Jessica Elliott, Jim Duncan
Local Government: Chris Leach
Water Stewardship: Alexandra Bourne, Rhonda McDougal

Appendix B – Workshop Agenda

AGENDA – Day 1:

8:30 – 9:00 a.m.	Registration , Coffee/Tea, Muffins
9:00 – 9:15 a.m.	**Agenda and Workshop Purpose & Outcomes** Geneva Claesson - *Deloitte*
9:15 – 9:35 a.m.	**Welcoming Remarks** • Dr. Fred Meier - *Deputy Minister, Conservation* • Dr. Barry Todd - *Deputy Minister, MAFRI*
9:35 – 10:10 a.m.	**Current and Projected Temperature and Precipitation Trends in Manitoba** • Dr. Danny Blair – *University of Winnipeg*
10:10 - 10:45 a.m.	**Future Impacts to Forage and Grassland Sectors** • Dr. Jeff Thorpe – *Saskatchewan Research Council*
10:45 – 11:00 a.m.	Health Break
11:00 - 12:15 p.m.	**Organizational Risk Management: The Alberta SRD Climate Change Adaptation Framework** • Geneva Claesson **-** *Deloitte*
12:15 – 1:15 p.m.	**Networking Lunch** Lunch Keynote (12:45): **Future Impacts to Manitoba's Crop Sector** • Dr. Paul Bullock – *University of Manitoba*
1:15 – 1:30	**Test Lab - Step 1: Scope and Preparation** • Geneva Claesson **-** *Deloitte*
1:15 – 3:00 p.m.	**Test Lab – Step 2: Organizational Vulnerability Assessment** • Group work to test the Climate Change Adaptation Framework
3:00 – 3:15 p.m.	Health Break
3:15 – 3:45 p.m.	**Test Lab – Step 2: Recommendations for Manitoba** • Group work to test the Climate Change Adaptation Framework
3:45 – 4:15 p.m.	**Group Discussion: Results and Recommendations** • Geneva Claesson and Joyanne Lizotte – *Deloitte*

4:15 – 4:25 p.m.	**Tomorrow's Agenda** • Geneva Claesson - *Deloitte*

AGENDA – Day 2:

8:00 – 8:30 a.m.	Coffee/Tea, Muffins
8:30 – 9:00 a.m.	**Today's Agenda and Q&A** • Geneva Claesson – *Deloitte*
9:00 – 10:30 a.m.	**Test Lab – Step 3: Risk Assessment** • Group work to test the Climate Change Adaptation Framework
10:30 – 10:45 a.m.	Health Break
10:45 – 11:15 a.m.	**Test Lab – Step 3: Recommendations for Manitoba** • Group work to test the Climate Change Adaptation Framework
11:15 – 12:00 p.m.	**Group Discussion: Results and Recommendations** • Geneva Claesson and Joyanne Lizotte – *Deloitte*
12:00 – 1:00 p.m.	**Networking Lunch**
1:00 – 2:45 p.m.	**Test Lab – Step 4: Adaptation Options** • Group work
2:45 – 3:00 p.m.	Health Break
3:00 – 3:30 p.m.	**Test Lab – Step 4: Recommendations for Manitoba** • Group work
3:30 – 4:00 p.m.	**Group Discussion: Results and Recommendations** • Geneva Claesson and Joyanne Lizotte - *Deloitte*
4:00 – 4:15 p.m.	**Closing Remarks** • Tony Szumigalski, *MAFRI*

Appendix C – Terms of Reference for the Vulnerability and Risk Assessment

Prior to the workshop the Steering Committee developed the terms of reference for the workshop. They are as follows:

- **Driver** – MAFRI Adaptation Strategy
- **Objective** – Conduct a high-level assessment of vulnerability and priority risks associated with cattle and forage production on Manitoba's grasslands in order to identify potential adaptation options for MAFRI to respond to future impacts of climate change.
- **Participants** – Representatives from MAFRI, PRAC, Conservation, Water Stewardship and Local Government
- **Boundaries** – Organizational: All policies and programs related to cattle and forage production in Manitoba); Geographic: grazing and forage lands within Agro-Manitoba; Climate change horizon: next 30 - 40 years; Adaptation horizon: next 10 years.

Appendix D – Provincial and federal policies and programs in place that may assist with adaptation

Initiative/Program/Policy	Objective	Activities	Instrument Type	Time Frame	Lead
Agricultural Sustainability Initiative (ASI)	Improve agricultural ecosystems in Manitoba by encouraging adoption of sustainable practices	Financial incentives for demonstrations of technology transfer projects or sustainable agriculture practices	Extension; Information	2009-2013	MAFRI
Agri-Extension Environment Program	Changes in practice to encourage the adoption of environmentally sustainable agriculture practices	Extension	Extension	2009-2013	MAFRI
Agri-Food Research and Development Initiative (ARDI)	Provides funding for research and development in agri-food production and processing in Manitoba	Provide an avenue for research and development for projects that result in new farm income streams, growth in the value-added sector, reduced costs for primary production and also those that expand knowledge, translate knowledge into new products and practices, or verify new technology and practices under Manitoba conditions.	Research & Development	2009-2013	MAFRI
Agri-Recovery	Help affected producers resume business operations and/or take actions to mitigate the impacts of a natural disaster as quickly as possible.	Payments to producers who have suffered from a natural disaster.	Financial assistance	2009-2013	MAFRI
Agri-Stability	Provides support when a large margin decline is experienced.	Payments to producers who suffer a large margin decline.	Financial assistance	2009-2013	MAFRI
Community Pastures Program	To provide off-farm grazing and to encourage alternative uses of farm land and expansion of herds.	Provides pasture services at cost to livestock producers.	Pasture services at cost	Ongoing	MAFRI & AAFC
Conservation Districts Programs	Empower local people to manage local land and water resources	BMPs, education, implement IWMPs	Incentive programming, education, technical support	Ongoing	Water Stewardship
Consevation Agreements	Permanent protection of welands, uplands, riparian areas and habitats demonstrated to be important to threatened and endangered species (SARs), with an emphasis on grasslands in southwestern Manitoba	Voluntary, permanent conservation agreements (easements) that run with the land.	Conservation Agreements (perpetual)	Ongoing	Manitoba Habitat Heritage Corp. (MHHC)
Critical Wildlife Habitat Program (CWHP)	The CWHP goal is to identify, preserve and manage remaining critical habitats, especially native grasslands and habitats of unique, rare and endangered species	Activities include development of species and landscape priorities for Manitoba, development and review of projects, review and recommendation of project funding. Mixed-grass Prairie Projects - Inventory and grazing demonstration projects.	Project funding; extension	Ongoing	Conservation

Drought Management Planning for Manitoba	To develop indicators and strategies for managing short, medium and long term drought including assuring resiliency for long term events associated with climate change	Collecting background information, analysis and identification of potential indicators for different types of drought, public consultation and development of draft drought management plan.	Information	Ongoing	Water Stewardship
Environmental Farm Action Program (EFAP)	Improved environmental performance and sustainability	Producer incentives for BMP adoption	BMP Incentive; Extension	2009-2013	MAFRI
Environmental Farm Plan (EFP)	Identify and reduce on-farm environmental risks	Information workshops, workbook completion and EFP verification	Extension; Information	2009-2013	MAFRI
Extremes of Moisture Response Team	Compile and communicate drought and excess moisture conditions to higher level decision makers	Provide regular updates on flood/drought conditions across Manitoba, assess current and potential impacts on livestock and crop production and facilitate programming requirements	Information	Ongoing when needed	MAFRI
Forage and Beef Research					
Integrated Watershed Management Planning (IWMP)	Create common goals for the watershed and a prioritized and targeted action plan	Public consultations, technical and advisory support	Planning; Incentives; Education	Ongoing	Water Stewardship
Livestock Manure Mortalities Management Regulation (LMMR)	The primary objective of the Livestock Section is to ensure consistent administration of the LMMMR across the province.	Regular inspection of storage facilities for manure and mortalities, inspection of manure storage facilities during construction, investigation of complaints, response to reports of manure spills and enforcement of regulations	Regulation	Ongoing	Conservation
MAFRI Growing Opportunities (GO) Teams	Provide front line service for MAFRI to the agricultural community in Manitoba	Provide agricultural extension, support and assistance to agricultural producers and industry	Extension; Information	Ongoing	MAFRI
Manitoba Agricultural Services Corporation (MASC)	To support the Manitoba's producers and rural communities, through innovative and targeted risk management and financial programs	Provide a variety of lending and insurance programs for agricultural producers in Manitoba	Loans; Insurance	Ongoing	MASC
Manitoba Agriculture Weather Program	Improve weather monitoring across agro-Manitoba and to develop agronomic decision support tools. These tools enhance risk management and input efficiency.	Establish climate stations and up to date information and tools for more effective weather forecasting	Information	Ongoing	MAFRI
Manitoba Sustainable Agriculture Practices Program (MSAPP)	On-farm climate change mitigation and adaptation	Funding to cost-share BMPs; R&D projects	BMP incentives; Extension; information	2008-1012	MAFRI
Protected Areas Initiative (PAI)	PAI contributes to long-term sustainable development by assembling a network of core protected areas designed to conserve ecosystems and maintain biodiversity across Manitoba.	Establish, for each of the 18 natural regions and sub-regions of the province, a network of protected areas containing an adequate and representative sample of the region's diverse landscapes	Regulation	Ongoing	Conservation

Provincial Flood Mitigation Strategy	To develop a province-wide flood mitigation strategy for flood proofing flood prone communities and individual residences	Flood forecasting initiatives, construction of dikes, feasibility assessment of flood infrastructure and other flood mitigation activities	Information; infrastructure	Phase 1 initiated in summer of 1997	Water Stewardship
Provincial Land Use Planning	To express the provincial interest in the use of land and resources to provide guidance to local planning authorities in the preparation of local land use plans	Advice and education to local planning authorities regarding the preparation of land use plans that integrate social, environmental, economic, and cultural considerations and support community sustainability	Extension	Ongoing	Local Government
Riparian Tax Credit	Encourage green practices on riverbanks and lakesides	Applicable to agricultural land only	Tax Credit	Renewed annually since 2003 (5-year agreements)	Manitoba Finance
Strategic Directions for Water	Three year action plan to develop policy and recommendations for Canada wide water strategy to protect aquatic ecosystems, promote wise use of water, water quality and water quantity management, adaptive strategies to reduce impact of climate change.	Promote positive changes to conserve water and water quality, transition science into policy, develop water valuation and guidance document for water managers. Develop tools to facilitate sharing of water data Canada-wide. Identify and share BMPs	Information	2010-2013	Water Stewardship
The Manitoba Benchmark Project Crown Lands	Verification of crown lands classification and provide basis for crop and livestock extension.	Monitor forage yield and quality on historically grazed native pasture in Manitoba taking into account different soil types and 4 different eco-regions in Manitoba.	Information	Introduced for 2004-2008; Ongoing	MAFRI

PART C – WORKSHOP: EXPLORING OPTIONS FOR MANITOBA'S FORAGE AND BEEF SECTORS TO ADAPT TO CLIMATE CHANGE

Winnipeg, Feb. 1, 2012

C1 - EXECUTIVE SUMMARY

On February 1st, 2012 Manitoba Agriculture, Food and Rural Initiatives (MAFRI) hosted a half-day workshop, which was facilitated by Deloitte as part of the Terrestrial (forests and grasslands) component of the Prairies Regional Adaptation Collaborative (PRAC) initiative. The workshop focused on soliciting stakeholder feedback on climate change impacts and responses for the beef and forage sectors identified in previous workshops. This workshop was attended by 25 participants, consisting of representatives from the Government of Manitoba, the Federal Government, academia, conservation organizations, and commodity groups within Manitoba. This workshop was the second in a series of workshops and intended to build upon the PRAC November 2011 workshop, and was followed by another Workshop geared toward Manitoba Government Decision-makers.

This workshop was designed to: 1) create awareness among stakeholders in the forage and beef sectors regarding impacts that may result from climate change; 2) to obtain feedback from stakeholders on additional climate impacts they are currently observing in the forage and beef sectors; 3) to allow stakeholders to share ideas on the risks faced by the forage and beef sectors resulting from climate change; 4) to communicate and discuss potential adaptation options to minimize these risks; and 5) to provide stakeholders with the opportunity to identify additional adaptation options and discuss how MAFRI could support these adaptation options.

The workshop began with Geneva Claesson, Sustainability and Climate Change specialist with Deloitte, providing introductions, workshop objectives and background on the November 2011 workshop geared toward Government of Manitoba decision-makers. Following introductions, presentations were given by Dr. Danny Blair and Dr. Jeff Thorpe on '*Current and Projected Temperature and Precipitation Trends in Manitoba*' and '*Future Impacts to the Forage and Grasslands Sectors'*, respectively (See Appendix B for agenda).

Participants reconvened following a break to discuss current impacts and risks to the forage and beef sectors related to climate change. Impacts and risks identified by stakeholders were very similar to those identified during the November workshop. Dr. Thorpe gave a second presentation on potential adaptation options for Manitoba grasslands. This was followed by a final session where participants were asked to identify adaptation options that they were currently applying and that MAFRI could potentially support to assist the forage and beef sectors to adapt to climate change. Adaptation options were heavily focused on water management and the identification of long-term adaptation options that will minimize the use of Business Risk Management (BRM) Programs. Overall, stakeholders were very engaged and interested in the process.

Outputs obtained from the workshop included: a list of impacts that stakeholders in the forage and beef sector are currently experiencing, a list of potential risks to the sectors

as a result of climate change, a list of sector based adaptation solutions, which includes research, on-farm adaptation, industry adaptation, and suggested adaptation options for MAFRI.
The following report gives a detailed summary of the stakeholder adaptive planning workshop.

C2 - BACKGROUND

Manitoba is a key partner in the Prairies Regional Adaptation Collaborative (PRAC), which is a joint partnership with Alberta, Saskatchewan and Natural Resources Canada. The PRAC has three main themes: water resource management, drought and excess moisture management, and terrestrial ecosystems adaptation. The PRAC was initiated to build capacity among decision-makers in order to incorporate adaptation in to current policies and programs, to encourage knowledge transfer, and to develop adaptation options that mitigate risks and enhance opportunities resulting from climate change in the three Prairie Provinces.

In November 2010, MAFRI and Manitoba Conservation held a successful Inter-departmental Workshop on Climate Change Adaptation in Winnipeg as part of the Terrestrial component of the PRAC. The purpose of this workshop was to demonstrate the use of an adaptation framework as a decision-making tool to four provincial departments (MAFRI, Conservation, Water Stewardship, and Local Government), and to develop adaptation options using this framework for the grassland and forest ecosystems using Manitoba's Parkland Region as a case study area. This workshop provided a preliminary assessment of the adaptation framework and in November, 2011 MAFRI hosted a second workshop geared toward Government or Manitoba decision-makers to build upon the November 2010 workshop.

In order to further develop the combined outputs from the prior decision-makers' workshops, MAFRI hosted a follow-up workshop to engage stakeholder's involved in Manitoba's forage and beef sectors. This workshop was held in Winnipeg on February 1st, 2012 where 25 participants (Appendix A) convened with representation from research scientists, industry, Conservation organizations, commodity groups, and producers. The workshop objectives were as follows:

5. Create awareness among stakeholders in the forage and beef sectors regarding impacts that may result from climate change;
6. Obtain feedback from stakeholders on additional climate impacts they are currently observing in the forage and beef sectors;
7. Allow stakeholders to share ideas on the risks faced by the forage and beef sectors resulting from climate change;
8. Communicate and discuss potential adaptation options to minimize these risks;
9. Provide stakeholders with the opportunity to identify additional adaptation options and discuss how MAFRI could support these adaptation options.

Material provided to participants prior to, during and following the workshop included:

7. The workshop agenda (Appendix B);
8. A summary of projected climate impacts for Southern Manitoba (Appendix C)
9. A copy of the presentations given by Dr. Blair and Dr. Thorpe.

C3 – SUMMARY OF WORKSHOP PROCEEDINGS

Geneva Claesson initiated the workshop by providing the objectives for the two days, the agenda and the background information obtained from the prior adaptation workshops. She then introduced the two morning presenters, Dr. Danny Blair, and Dr. Jeff Thorpe, who provided the background on projected temperature and precipitation trends and future scenarios for Manitoba's grasslands, respectively.

Presentations on Temperature and Precipitation Trends, and Climate Change Impacts on Grasslands

The two presentations provided workshop participants with background information required to help identify impacts and risks to the forage and beef sectors in Manitoba.

Dr. Danny Blair
Acting Associate Dean of Science, Principle of the Richardson College for the Environment
University of Winnipeg
Presentation: *Current and Projected Temperature and Precipitation Trends in Manitoba*

Dr. Blair began his presentation by highlighting that 2011 was the 9th warmest year on record globally, at 0.51ºC warmer than the 1951-1980 baseline temperatures. He indicated that the climate system is complex and has many drivers of variability such as El Niño and La Niña, volcanic eruptions, and the sun, however he emphasized that these additional factors are not driving climate change. He indicated that atmospheric CO_2 has now reached 390 ppm and rising, and that there is no quick solution to minimize the warming. He also indicated that Canada will experience greater warming than the rest of the world. He went on to provide information on current and projected temperature and precipitation trends in Manitoba. He highlighted the expected increase in overall variability of weather patterns, increased annual temperatures, increased risk of excess moisture, flooding and drought. He ended by indicating how these changes in climate may impact the agriculture industry.

Following Dr. Blair's presentation participants were interested in knowing whether the climate models have ever been applied on a regional basis. Dr. Blair indicated that very little has been done in Manitoba and that there are large differences between western and eastern Manitoba. They are hoping to do more regional modeling in the future. Dr. Blair projected that Manitoba would resemble Western Nebraska and Colorado by the end of the century.

Dr. Jeff Thorpe
Principle Research Scientist
Saskatchewan Research Council (SRC)
Presentation: *Grasslands and Climate Change: Vulnerability and Adaptation Options*

Dr. Thorpe presented on the vulnerability of native grasslands to future climate change based on different temperature and precipitation scenarios for the 2080s. He explained that even in the coolest scenarios vegetation types from the US may expand into Canada, and that even in the warm-dry scenarios the decrease in grassland productivity is not as great as expected. He highlighted the impact of extreme events, indicating that past droughts have caused a shift in prairie grassland species and contributed significantly to tree mortality. Additionally, there is much more research currently focused on drought compared to excessive moisture. Typically moisture is associated with increased forage production; however excess moisture can be detrimental to forages, which includes compromising the quality and productivity of forages. A problem that was highlighted was invasive species and their improved ability to adapt to climate change.

Dr. Thorpe's presentation generated many questions from participants surrounding the grassland/forest interface, such as how it may manifest and how grassland species would move northward. Dr. Thorpe indicated that with general climatic drying, some aspen groves may die out and there may be patches of shrubs where trees once were. He indicated that prairie grass species differ from forest grass species and that in order for these grassland species to replace the forest species there would need to be good tracts of native prairie adjacent to the forest land, however the problem is that there tends to be poor native grassland connectivity and that forest islands are often surrounded by tame pasture.

Following the two presentations, participants took part in a discussion surrounding the identification of impacts and risks to the forage and beef sectors. They were provided with the following outputs from the November 2011 workshop (Tables 1 & 2) and asked to build on the list of climate impacts and risks. Their results are summarized and provided in point form below.

Table 1: Climate Impacts to Manitoba's Forage and Beef Sectors as Identified during MAFRI's November 2011 Agricultural Climate Change Adaptation Workshop

Impacts to the Forage Sector in Manitoba	Impacts to the Beef Sector in Manitoba
• Decrease in quality and palatability • Increase in winter rainfall impacting yields • Increase variability in the yield • Impact to storage capabilities • Increase in invasive species • Increase risk of disease • Increase in grassland acreage • Longer growing season	• Access to forage during freezing rain • Decreased availability of high quality water • Increase in parasites due to mild winters • Heat stress to pastures or crops • Access to water and/or storage • Potential opportunities to look at new cattle types • Longer grazing season • Reduction in feed requirements during milder winters

Table 2: Projected Risks to MAFRI as a Result of Climate Change Impacts to Manitoba's Forage and Beef Sector - Identified during MAFRI's November 2011 Agricultural Climate Change Adaptation Workshop

Risks due to Forage Sector Impacts	Risks due to Beef Sector Impacts
• Extreme events leading increased use of BRM programs requiring MAFRI to secure more funding and capacity.	• Increasing incidence of disease leading to decline in farmer livelihood means MAFRI has to extend support programs.

- Current location of offices may change due to shifting vegetation patterns causing a change in regional farming practices
- Less able to provide regular forage extension programs because staff are responding to crisis situations
- Increasing public demand for food safety and tracking supply chain requirements. This will impact existing budgets.
- Increasing disease outbreaks resulting in increased demand for vet services provided by MAFRI (more staff and funds required).

Climate change impacts as identified by beef and forage stakeholders:
Participants were asked: "What climate change-related impacts are you currently experiencing? The following reflect the stakeholder responses:

- More frequent extreme events
- Lost forage acreage
- High moisture events
- Flooding
- Back-to-back events (droughts, floods, excess moisture)

Risks and opportunities as identified by beef and forage stakeholders:
Participants were asked: "What are the risks and opportunities to your sectors based on current and projected climate change impacts? (e.g., economic, social, environmental). Table 3 reflects the stakeholder responses.

Table 3. Risks and Opportunities to the Forage and Beef Sectors Resulting from Climate Change - Identified by Workshop Participants

Opportunities for Forage and Beef Sectors	Risks to Forage and Beef Sectors
• The warming climate will provide more opportunity to take part in other markets • Internalize ideas such as EG&S into the larger economy. • Decreased amount of feed required in the winters • Decreased costs associated with overwintering cattle (e.g., because cattle are in the fields more often in warmer winters, the manure is on the landscape and does not need to be moved – saving time, fuel and money) • Incorporation of fringe land into agricultural land may allow increased production	• Water management systems will be required in order to deal with projected drought and excessive moisture to maintain productivity in the future. • Variability in weather is more of a problem than gradual warming • Need for increased food production in the future • If government mandates policies to reduce emissions this could lead to decreased financial viability. • Research will be required to help farmers plan, however, there is limited access by producers to the latest research. Increased extension and knowledge sharing between producers, industry, government and academics will be required. • Reduced pasture productivity will lead to reduced livestock numbers, this net reduction in production per acre will require more extensive range management. • Financial viability becomes a problem during back to back events because BRM programs are focused on 5 year incomes. If margins are constantly going down, then the existing programs can work counter to adaptation • More risk management will be required, however; producers will be required to obtain the skills and knowledge to do this.

Participants were asked: "What adaptation options do the forage and cattle sectors need to respond to climate risks? What has been done to-date to adapt? (e.g., research, on-farm, and industry – producer groups). How can MAFRI support the flexibility, resiliency and economic viability of Manitoba's forage and beef sectors?" Table 4 reflects stakeholder responses.

Table 4. Stakeholder Identified Adaptation Options for the Sector and for MAFRI to Implement

Sector-based adaptation solutions	Ideas for MAFRI adaptation options
• Increased collaboration between farmers and ranchers • Short term response to feed shortage would be to carry over 1/3 feed supply • Growing forage during drought years does better than annuals – complete shift in agricultural practice • Wetland restoration, enhancement and protection to provide multiple EG&S benefits • Directing aquifer recharge to build water reserves as buffer for future water stress conditions • Increased perennial forages to improve water management • Shallow pipelines for drier field (for livestock drinking water) • Canadian Cattlemen's Association (CCA) supports education on climate change	**Research** • Maintain quality forage lands (e.g., fund research, land use planning, and education) • Improve soil mapping and analysis for future land use planning • Long term funding programs for forage research (variety breeding and adaptability) • Ecological Goods and Services (EG&S) Policy and Program • Heritage breeds (highland cattle – more resilient, needs less water, healthier) • Collect on farm research/facilitate sharing of solutions • Information required – climate change impacts at a meaningful scale (eg. Local, regional, etc.) • Conduct research on water stressed regions in other jurisdictions and potentially applicable solutions. • Partnerships with other jurisdictions on research agendas • More research on sector profitability with climate scenarios • Applied research – demo sites, pilots, adoption on farms **BRM Programming** • BRM programming to incent sustainable crop rotations (e.g., annual poly cropping; perennial grains) • Change crop insurance: pay for fences around hay storage rather than paying for losses to wildlife • Integrate adaptation and risk management considerations in all policies and programs to prevent unintended consequences • Include long term options – awareness of pressure to maintain status quo but stress that adaptive planning must occur • Examine program effectiveness – ensure right and timely information is disseminated on the ground • Examine existing policies that may discourage adaptation **Crown Lands** • Work with federal government to continue community pasture programs • Support for community pasture programs – they are under used now but may be a valuable buffer in the future • Crown land in the North with potential for multi-use system/land use **Other Policies** • Water availability strategy for cattle

	• Monitoring program for existing and emerging diseases • Range land health assessment guide • Multi-use land use planning (e.g., water, biodiversity, agriculture uses, etc.) • Infrastructure support (e.g. build permanent roads in northern regions) • Quantify EG&S benefits of land management practices • Support for diverse agricultural landscape – communicate benefits to producers and develop pilot landscapes to show benefits • Support shift in ag-producer mindset that they only produce ag-commodities – other income generating options would help diversify their income • Support improved market connections for producers • Support other ag-sectors (e.g. sheep) • More collaboration with other departments and industry

Tony Szumigalski, Policy Analyst with MAFRI concluded the workshop by thanking all participants and presenters. He mentioned that the results from this workshop would be used in part for the development of an adaptation strategy for MAFRI.

C4 – LESSONS LEARNED AND NEXT STEPS

Overall participants appreciated being included in the discussion on the development of an adaptation strategy for the province. Similar to the November 2011 'decision-maker's workshop', participants felt that government is very much caught in crisis mode, and that the reliance on government BRM programming did not provide producers with the long term solutions that they required. It was brought up on multiple occasions that government policies should be reviewed for their likelihood to produce unintended consequences and to dis-incent producers from adapting to environmental changes. Other policy recommendations included: providing incentives for young farmers, and providing incentives for ecosystem good and services (EG&S).
Collaboration, research, information sharing, and the use of community pastures were other topics that participants focused on. It was emphasized that focus on information and research should given to regional climate modeling, and the impact of climate on water resources. It was also suggested to investigate how other jurisdictions handled severe drought situations to determine whether the same adaptive actions could be applied in Manitoba. Information sharing between producers and knowledge transfer from academics to the producer level were thought to be of increasing importance to allow producers to make educated management decisions. Additionally, on-farm research, possibly using community pastures was suggested and in this case could be used to display the benefits of certain management practices for extension purposes. The information obtained during this stakeholder workshop was very valuable and will be used to inform MAFRI on future adaptation work and policy analysis. In the coming

months, the MAFRI adaptation team specifically will be reviewing various adaptation frameworks and planning for future climate change adaptation work. The adaptation options suggested during this stakeholder workshop and the previous decision-maker adaptation workshop will inform implementation of future adaptive actions following departmental risk assessments. MAFRI's adaptation team will be consulting with specialists within MAFRI, and other provincial departments to determine the sectors within MAFRI's mandate that are most at risk from the impacts of climate change. Adaptation options will be developed for those sectors and sub-sectors which are deemed most at risk.

Future meetings will be required to determine how this process fits into the provincial and departmental planning process.

Appendix A – Participants

Steering Committee: Randall Shymko (CON-WS), Tony Szumigalski (MAFRI), Ainsley Little (MAFRI), Matthew Wiens (MAFRI), Ramon Sales (CON-WS), Scott Stothers (MAFRI), Roselle Miko (MAFRI)
Presenters: Jeff Thorpe (SRC), Danny Blair (U of W)
Facilitator: Geneva Claesson (Deloitte)
Other Participants: Kim Ominski (Department of Animal Science, U of M), Martin Entz (Department of Plant Science, U of M), Hushton Block (AAFC), Stan McFarlane (AAFC), Henry Nelson (Manitoba Forage Council), Brent McCannell (Manitoba Forage Council), Lorne Rossnagle (KAP), Dave Koslowsky (MB Beef Producers), Kevin Teneycke (Nature Conservancy), Stephyn Carlyle (MHHC), Greg Bruce (DUC),

Appendix B – Workshop Agenda

8:15 – 8:45 a.m.	Registration , Coffee/Tea, Muffins
8:45-9:00 a.m.	**Agenda and Workshop Purpose & Outcomes** • Geneva Claesson - *Deloitte*
9:00 – 9:35 a.m.	**Current and Projected Climate Trends** • Dr. Danny Blair – *University of Winnipeg*
9:35 – 10:15 a.m.	**Future Impacts to Forage and Grassland Sectors** • Dr. Jeff Thorpe – *Saskatchewan Research Council*
10:15 – 10:30 a.m.	Health Break
10:30 – 11:00 a.m.	**Discussion on Climate Impacts and Risks to the Forage and Beef Sectors** • Facilitation: Geneva Claesson **-** *Deloitte*
11:00 – 11:20 a.m.	**Potential Adaptation Options** • Jeff Thorpe **–** *Saskatchewan Research Council*
11:25 – 12:15 p.m.	**Discussion on Potential Adaptation Options and MAFRI's Support for Adaptation** • Facilitation: Geneva Claesson - *Deloitte*
12:15 – 12:20 p.m.	**Closing Remarks** • Tony Szumigalski - *MAFRI*
12:20 – 1:20 p.m.	**Networking Lunch**

PART D – WORKSHOP: ADAPTING AGRICULTURE TO CLIMATE CHANGE – NEXT STEPS PLANNING SESSION

Winnipeg, Feb. 1, 2012

D1 - EXECUTIVE SUMMARY

On the afternoon of February 1st, 2012 Manitoba Agriculture, Food and Rural Initiatives (MAFRI) and Manitoba Conservation and Water Stewardship hosted a half-day workshop for staff involved in adaptive planning within the two departments. The workshop was held as part of a larger initiative, the Prairies Regional Adaptation Collaborative (PRAC) which is a joint initiative with Alberta, Saskatchewan and Natural Resources Canada. This workshop was organized to summarize the findings from the previous government- and stakeholder-focused workshops which examined MAFRI's organizational adaptive capacity and the sectors adaptive capacity to deal with future impacts of climate change, respectively.

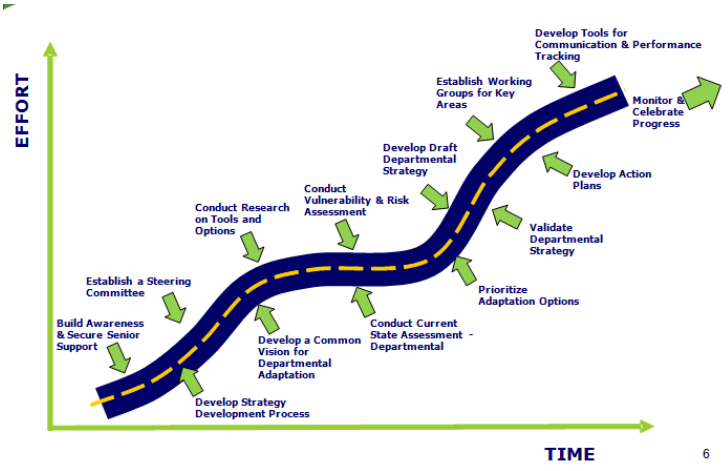
Objectives:

1. To provide the Government of Manitoba an overview of different types of adaptation strategies
2. To review the results of the two recent MAFRI-led workshops on Agricultural Climate Change Adaptation
3. To discuss MAFRI's progress to date on developing an agricultural adaptation strategy
4. To decide on next steps for MAFRI's and Manitoba's climate change adaptation strategies

The workshop began with Geneva Claesson (Sustainability & Climate Change specialist from Deloitte and session Facilitator) providing a high-level introduction to the various type of climate change adaptation strategies a government can develop. She indicated that within Canada and in other countries, adaptation strategies varied from high-level general overviews to very detailed action plans with timelines. At the workshop hard copies of various strategies from British Columbia, Australia, New Zealand, and Ontario were provided to attendees to review as examples.

Ms. Claesson proceeded to lead a discussion on how strategies are developed. Figure. 1, below was provided to participants to illustrate the various steps in the development of an adaptation strategy. Ms. Claesson emphasized that the "road map" to complete a strategy does not follow a clear path and that the steps indicated in the figure may be completed in a different order. Each organization needs to tailor a 'road map' for their purposes, objectives and available resources.

Figure 1. Adaptation Strategy 'Road-Map' (Claesson, G. Feb. 2012, Adapting Agriculture to Climate Change, Winnipeg Winter Club)



Following Ms. Claesson's discussion, Ainsley Little, the Climate Change Specialist for MAFRI, provided a brief presentation on MAFRI's progress with the departmental Climate Change Adaptation Strategy.
Adaptation options identified by previous Manitoba Climate Change Adaptation Workshops were used in the development of MAFRI's draft Climate Change Adaptation Strategy. Participants provided input on the details of the draft strategy and indicated that they thought it was an important issue. Clarity of objectives was the main focus of the discussion. The idea of an inter-departmental adaptation working group was suggested and, overall, participants thought it was necessary in order to address the cross-cutting issues between departments. It was also noted that adaptation to climate change may be approached as a provincial strategy with individual departmental strategies as components of a coordinated larger strategy. This way there will be a common approach to vulnerability and risk assessments among provincial departments.
The next steps for MAFRI and the province are to communicate to departmental executive management committees that adapting to climate change is a priority in Manitoba, and to secure funding for work on climate change adaptation. After these two steps are completed, MAFRI can begin prioritizing high risk areas to climate change and developing adaptation options to assist with mitigating risks. MAFRI and Manitoba will need to select the adaptation framework and types of tools that will be employed to evaluate adaptation options.

Appendix A - Participants

Ainsley Little, Climate Change Specialist, MAFRI
Tony Szumigalski, Policy Analyst, MAFRI
Matthew Wiens, Protocols and Quantification – Climate Change, MAFRI
Roselle Miko, Policy Analyst, MAFRI
Scott Stothers, Strategic Planning Directorate, MAFRI
Esther Salvano, Acting Director Agri-Environment Knowledge Centre, MAFRI
Eric Liu, Business Development Specialist – Fibre and Composites, MAFRI
Glenn Friesen, Forage Specialist, MAFRI
Randall Shymko, Manitoba Conservation and Water Stewardship
Ramon Sales, Manitoba Conservation and Water Stewardship
Jeff Thorpe, Saskatchewan Research Council
Geneva Claesson, Deloitte Facilitator

Appendix B - Links to Example Adaptation Strategies

Preparing for and adapting to climate change (New Zealand):
http://www.mfe.govt.nz/publications/climate/preparing-for-adapting-climate-change-jul07/preparing-adapting-climate-change-jul07.pdf

Adapting to Climate Change in Australia:
http://www.climatechange.gov.au/government/adapt.aspx

Climate Change Adaptation Strategy for Atlantic Canada:

http://www.gnb.ca/0009/0369/0018/0002-e.pdf

Finland's National Strategy for Adaptation to Climate Change:
http://www.mmm.fi/attachments/ymparisto/5kghLfz0d/MMMjulkaisu2005_1a.pdf

Ahead of the Storm – Preparing Toronto for Climate Change:
http://www.toronto.ca/teo/pdf/ahead_of_the_storm.pdf

Preparing for Climate Change – British Columbia's Adaptation Strategy:
http://www.livesmartbc.ca/attachments/Adaptation_Strategy.pdf

Danish Strategy for Adaptation to a Changing Climate:
http://www.kemin.dk/Documents/Klima-%20og%20Energipolitik/klimatilpasningsstrategi_UK_web.pdf