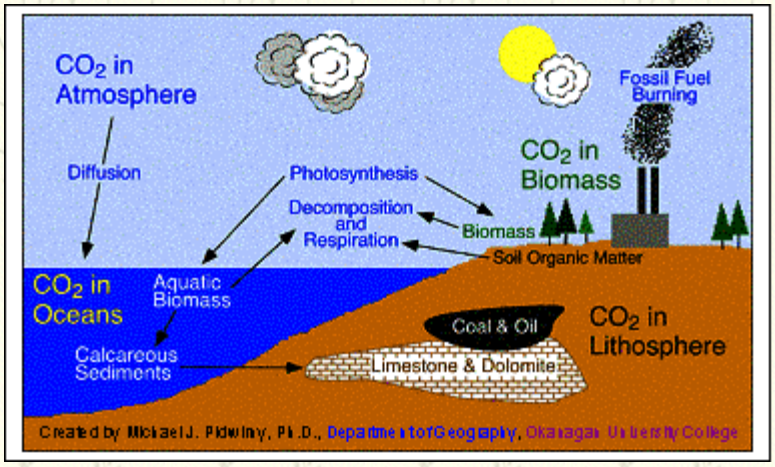
Links Between Grasslands and Carbon Storage

We often hear of the importance of forests as a biological sink to store carbon, but recent research has shown that grasslands (particularly native grasslands) are of comparable importance.

Carbon Dioxide and Our Environment

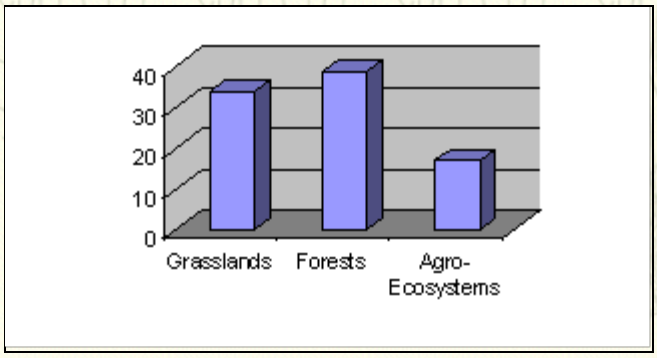
Carbon dioxide is one of many greenhouse gases that help warm the atmosphere by trapping heat radiating from earth. This trapped heat is called the greenhouse effect and without it the earth would be about 33 degrees C colder (Janzen et al. 2002). It is however possible to have too much of a good thing. Most troublesome has been the increase in concentration of carbon dioxide over the last century as a result of human activity. As we burn more and more fossil fuels to power our cars and trucks, keep our industry humming and make our homes more comfortable, we are increasing concentrations of greenhouse gases in the atmosphere. At present, human activity now adds about **seven billion tones of carbon dioxide into the air every year** (Janzen et al. 2002). Although there is uncertainty about how these changes will affect our climate, changes are taking place in the atmosphere. Alberta Environment (2002) states that the "average temperature of the Earth's surface has **increased by between 0.3 and 0.6 degrees C over the past 100 years**." For comparison purposes, during the last ice age, global temperature averages were only 4.3 degrees C cooler than they are today.

Global Carbon Cycle



The global carbon cycle is closely linked to the greenhouse effect. Carbon moves continuously among air, plants, and soils and changes to any of these three components invariably affects the other components. Globally, there is about two times as much carbon in soil organic matter than there is in the atmosphere and as a result, **a relatively small shift in soil organic matter can have a large impact on carbon dioxide in the air** (Janzen et al. 2002). To stop rising concentrations of carbon dioxide in the atmosphere, countries around the world are actively seeking ways to increase carbon storage on land. The large amount of land area covered by grasslands as well as the relatively unexplored potential for grasslands soils to store carbon has increased interest in the carbon cycles of these ecosystems. **Areas where more carbon is absorbed than given off are referred to as carbon sinks** and include areas such as native prairies, forests and wetlands.

Storage of Carbon in Grasslands

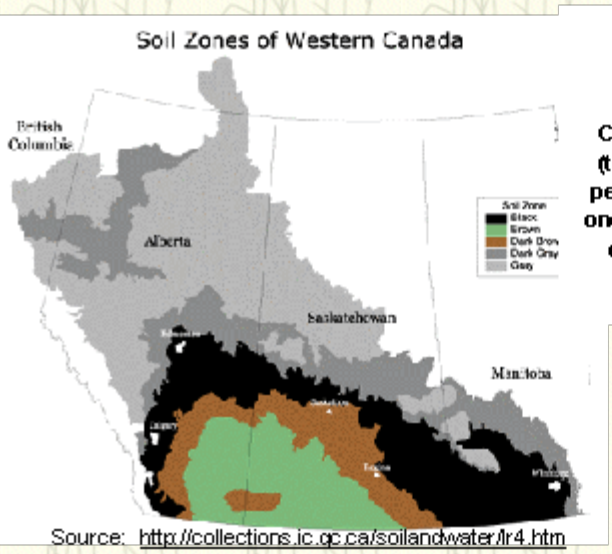


From a global perspective, **grasslands store approximately 34% of the global terrestrial stock of carbon** while forests store approximately 39% and agro-ecosystems approximately 17 percent (World Resources Institute 2000). Unlike forests where the vegetation is the primary source of carbon storage, most of the grassland carbon is stored in the soil (Janzen et al 2002).

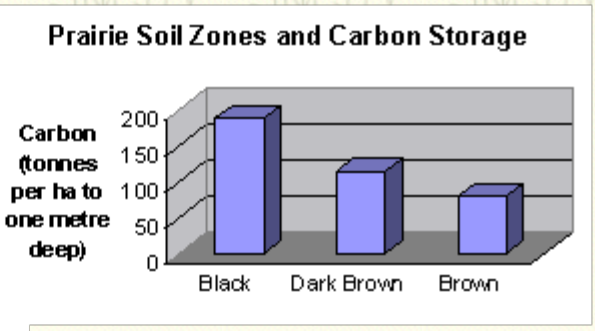
Role of Temperate Grasslands

Within Canada, temperate grasslands, like those found in the Great Plains of Alberta, Saskatchewan and Manitoba, play a significant role in the global carbon cycle because of their vast areas and high soil carbon density. Janzen et al. (2002) estimates that soils under native grasslands in western Canada may contain up to 200 tonnes of carbon per hectare within the first metre under fescue prairie, with estimates of perhaps **two to three billion tonnes of carbon within the uncultivated grasslands of western Canada**. For perspective, the carbon underfoot in a good grassland soil may exceed the amount of carbon in all above-

ground portions of a temperate forest, even though nearly half the dry weigh of plant material is carbon. **Prairie wetlands are even more productive than grasslands** (Janzen et al. 2002).



Source: http://collections.ic.gc.ca/soilandwater/lr4.htm



Graphic: Darcy C. Henderson 2003

* Black = Foothills Fescue, Foothills Parkland
* Dark brown = Mixedgrass, Northern Fescue
* Brown= Dry Mixedgrass

For comparison purposes, the amount of carbon stored under one hectare of unbroken fescue is equivalent to removing approximately 150 cars from the surface of the earth for one year. Alternatively, breaking the site and reseeding with crested wheatgrass is equivalent to removing approximately 35 cars from the surface ofthe earth for one year.

= 35 cars

*(These figures are based on the average car emitting 4.5 tonnes of carbon dioxide per year (Climate Change Central 2002) which translates into 1.227 tonnes of carbon per year.)

Grassland Management and Carbon

Graphic: Darcy C. Henderson 2003

The amount of carbon stored in the soil is largely affected by the management. A recent study compared the amount of carbon stored under undisturbed native prairie with areas that have been reseeded with crested wheatgrass, a perennial tussock grass introduced from northern Asia. **The results indicated that the amount of stored carbon was 25% less in soils under reseeded crested wheatgrass than under successional prairie** (Christian and Wilson 1999). Furthermore, the same study estimates that the planting of crested wheatgrass over millions of hectares of the Great Plains may have left 3.3 to 4.8 billion tonnes of carbon in the atmosphere that would otherwise have been stored as solid organic matter by native grasses. **Converting native grasslands to cultivated farmland has the potential for even larger losses of carbon**. Janzen et al. (2002:14) estimate that converting native prairie to cultivated farmland results in large losses of carbon, typically about 20 – 35% of that originally present in the surface 30 cm within a few years or decades. For the wheatgrass, different growth strategies may help explain the discrepancy. Christian and Wilson (1999) noted that the wheatgrass produces more above ground shoots and a shallow root system; the native grasses are shorter above ground but have an extensive extensive below ground root network. It is this root network that acts as an important storage area for carbon.

Concluding Points

Grasslands, because of their expanse and high carbon density, are a prominent part of that global carbon cycle. One of the most significant roles of native grasslands is that they act as a repository of carbon already stored. Therefore, where possible, **leaving large tracts of native prairie intact will likely have the greatest overall benefit**. Although a great deal of work has been done in recent years, estimates of carbon storage in terrestrial ecosystems worldwide vary widely and more work is still required.

Links for More Information

Government of Canada Climate Change

World Resources Institute Grasslands Ecology Systems

Albertan & Climate Change, Government of Alberta

Department of Geography, Okanagan University College

Intergovernment Panel on Climate Change

References

- Alberta Environment 2002. Albertans & Climate Change: What Can Individual Albertans Do? Brochure. Alberta Environment, Government of Alberta, Edmonton, Alberta.
- Christian J.M. and S.D. Wilson. 1999. Long-term ecosystems impacts of an introduced grass in the Northern Great Plains. Ecology 80(7): 2397-2407.
- Climate Change Central. 2002. Alberta Forests: Sink or Source for Carbon Dioxide? Discussion paper prepared for Climate Change Central, Edmonton, Alberta. 12pp.
- Janzen H.H., B. H. Ellert, J.F. Dormaar and *D.C. Henderson 2002. Rangeland s. A Storehouse of Carbon. Paper presented to the Western Range Management Seminar, Alberta Agriculture and Agri-Food Canada, Lethbridge, Alberta, Canada, *University of Alberta, Edmonton Alberta. 4pp.
- World Resources Institute 2000. World Resources 2000-2001: People and Ecosystems: The Fraying Web of Life. Canada. World Resources Institute. 389pp.