Flathead Watershed Sourcebook

A Guide to an Extraordinary Place

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WHAT IS A WATERSHED?

Figure 1.7: 1964 Evergreen Floods. *Source: Flathead Planning & Zoning*

Figure 1.8: 1995 Evergreen Floods. *Source: Flathead Planning & Zoning*

and building, topsoil is disturbed and moved, potentially lowering the level of the land and increasing the potential for flooding. Extensive impermeable asphalt surfaces such as parking lots have replaced natural ground that once allowed water to percolate down from the land. New buildings and walls, and the debris left behind by their development become obstacles or dams for water moving along its natural course. Even clogged culverts can stop water from flowing away from parking lots and driveways. It is difficult to know how the movement of water in the next 100-year flood will be affected by the many changes that have occurred in the Flathead Watershed over the past decades.

Flooding Effects on Flathead Lake

As a natural freshwater lake, Flathead Lake reduces the flow of the river below the lake. The highest flow on record at the river gauging station at Polson was 82,100 cubic feet (2325 m^3) per second on May 28 & 29, 1928, only half of the flow of the river at Columbia Falls during the flood of 1964. Inflows to Flathead Lake are partially regulated by Hungry Horse Dam, located on the South Fork of the Flathead River. Flathead Lake's surface elevation is regulated by Kerr Dam, located on the Flathead River approximately 4.5 miles (7.24 km) below the lake's outlet.

The Flathead River flood of 1933 was the last great flood before Kerr Dam was built. The hydrograph in Figure 1.9 is natural, with a peak in early June. The flood of 1948 was the last great flood after the completion of Kerr Dam and before Hungry Horse Dam was built. Hungry Horse impounds the South Fork of the Flathead, controlling approximately 30% of the inflow to Flathead Lake. The hydrograph is no longer natural as a result of the dams, and the drawdown from October through April is fairly steady. The flood of 1964 occurred a decade after Hungry Horse dam began operating, producing the highest river peak on record. Although this was the highest crest on the river, it did not produce the highest peak on the lake because the duration of the flood was shorter and the total volume of water less than in 1933 or 1948.

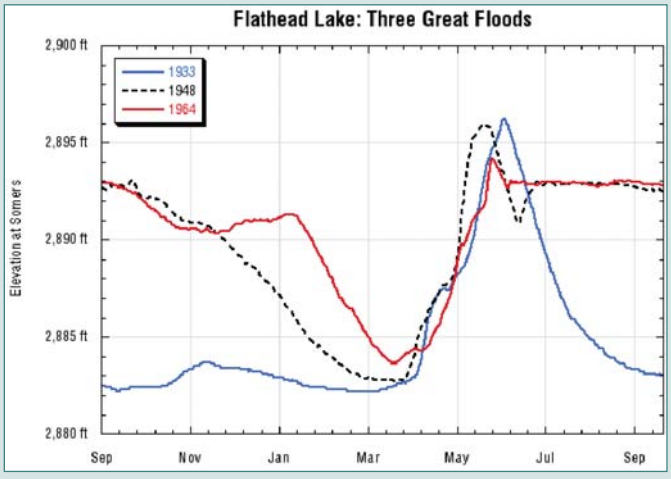


Figure 1.9: Three Floods Hydrograph. *Source: Flathead Lakers*

"If there is magic on this planet, it is contained in water." - Loran Eiseley, The Immense Journey, 1957

Hydrology of the Watershed

Contributed by: Craig N. Kendall, Hydrologist
Flathead National Forest

Hydrology is the study of the movement, distribution, and quality of water; it includes all components of the hydrologic cycle on the earth and in the atmosphere. A practitioner of hydrology is a hydrologist and may work in a variety of related fields such as earth or environmental science, physical geography, geology, or civil and environmental engineering. Sub-disciplines of hydrology include hydrometeorology, surface water hydrology, hydrogeology, watershed science, forest hydrology, and water chemistry.

Surface Water

Surface water generally consists of water that we can see in the forms of snow, ice, rivers, streams, lakes, wetlands, and soil moisture. The Flathead Watershed is home to spectacular surface water features that are rich in social, cultural, and resource values. Flathead Lake, the three forks of the Flathead River, and the numerous glaciers, snowfields, and lakes are notable surface water features. The thousands of lakes, ponds, and wetlands in the Flathead Watershed are the direct result of recent glaciation that scoured the landscape and left behind deposits that now impound surface water.

Surface water in the Flathead Watershed is in constant motion. Water held as snowpack in the mountains during the winter months begins to melt in the spring causing small streams to rise. Annual peak flows in lower rivers typically occur in May and June (Figure 1.17). Peak stream flows occur in response to snowmelt by itself, snowmelt mixed with rain, or direct rain-on-snow. As the snow melts during the spring months, it recharges soil moisture and ground water. As lower hillslopes become saturated they begin to generate surface water flow that feeds headwater streams. In general, the residence time of water in hillslopes increases with distance away from the ridge tops. In other words, water lower on the hillslope and close to streams is "older" than the water stored in the soil closer to the ridge tops. Because of this *residence time*, some of the water we see in streams and rivers may have fallen on the watershed years or decades earlier. Hillslopes store water for months to years and then release it to streams in minutes or hours.

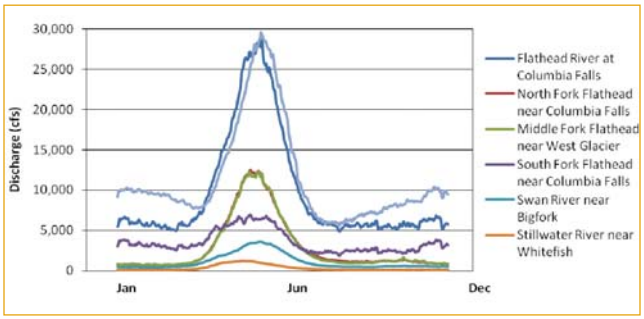


Figure 1.17: Average daily discharge of major rivers in the Flathead Watershed. *Source: C. Kendall, Flathead National Forest*

Most of the annual floods recorded at the USGS gaging stations around the Flathead Watershed have occurred in May, June, or early July. Extreme rain-on-snow events are more common on the eastern side of the watershed affecting Glacier National Park, and the Middle and South Forks of the Flathead River Drainages.

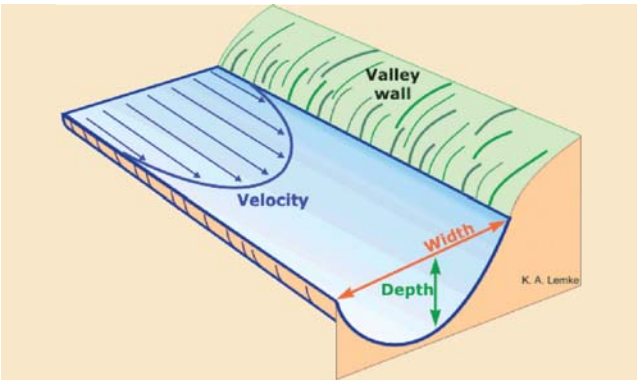


Figure 1.18: How to measure water discharge in a stream. *Source: Dr. Karen A. Lemke*

How is discharge measured in a river? *Discharge is typically expressed in cubic feet per second (ft^3/s) and represents the actual volume of water flowing past a given point. In general, discharge (Q) is equal to the product of the average depth (d), width (w), and velocity (v) at a cross-section of the river:*

$$Q = w \times d \times v$$

Usually, the cross-section is divided into sections or "cells" where depth, width, and velocity measurements are collected to calculate Q for each cell. Then the cells are added up to estimate the total discharge.

Once several measurements are taken at a given site, they are correlated with the water surface elevation or "stage" of the river. Then measurements of stage can be recorded by specialized instruments at a gaging station to provide continuous estimates of discharge.

Montana Watershed Coordination Council

Alicia Vanderheiden, Coordinator Montana Watershed Coordination Council

The Montana Watershed Coordination Council (MWCC) is an inclusive partnership to enhance, conserve, and protect natural resources and sustain the high quality of life in Montana for present and future generations using a collaborative watershed approach. MWCC works to expand the effectiveness of Montana's communities to manage natural resources.

MWCC works to accomplish these goals by promoting effective communication, coordination and networking between community-based groups and public agencies; providing mutual assistance through education and training; encouraging and supporting citizens to take a voluntary proactive, collaborative approach addressing natural resource issues and concerns; and serving as a statewide coordination network for Montana's communities, watershed groups, natural resource agencies, private organizations, conservation districts and water quality districts.

For more information please visit the MWCC website: www.mtwatersheds.org or contact the MWCC Coordinator Alicia Vanderheiden at info.mwcc@gmail.com or (406) 244-4420.

Source: A. Vanderheiden, 2009

Alicia Vanderheiden with son Corbin

"Find your place on the planet.
Dig in, and take responsibility from there."
- Gary Snyder, American Poet

Era	Period	Epoch	Millions of years ago (mya)	Event
Cenozoic	Quaternary	Holocene		• Present-day rivers rework glacial materials to form the modern river valley deposits and riparian areas. Landslides occur along valley margins.
			10,000 yrs.	
		Pleistocene		• Deglaciation—human occupation of North America. • Meltwater rivers deposit outwash sheets of sand and gravel. Winds form sand dunes. • Glacial Lake Missoula forms in Clark Fork and Flathead drainages. • Alternate advance and retreat of glaciers. Glaciers cover mountainous areas, carve alpine glacial features, and flow into major valleys. Ice deposits unsorted rock material (glacial till) as moraines and drumlins.
			2 mya	
	Tertiary			• Crust pulled apart, crustal blocks dropped to form major valleys. Deposition of sediments into down dropping valleys—Kishenehn Formation (Flathead North, Middle, and South Forks—modern fish fossils). • "Sliding" (overthrusting) of 5-10 mile thick slabs of rock up to 50-60 miles from west to east to emplace surface rocks of present northwest Montana and adjacent B.C. and Alberta. • Extinction of dinosaurs and much marine and terrestrial life.
			65 mya	
Mesozoic				• Uplift of broad region of western Montana, British Columbia, and Alberta. Folding, faulting, mountain building and volcanic activity. • Inland sea (Cretaceous Seaway) extends north-south from Gulf of Mexico. Deposition of sandstone, shale, and coal found east of the Rocky Mountains. Abundant marine life-forms—dinosaurs dominant. • Breakup of Pangea—Westward drift of North America. Mountain building activity (orogenesis) begins along ancient western margin of North America from Alaska to Mexico. Accretion of "exotic terrains" along western edge (Washington, Oregon, Nevada, California).
			225 mya	
Paleozoic				• North America/Europe/Africa/South America come together to form supercontinent Pangea. Formation of Appalachian Mountains as suture zone. Major biological extinctions. • Western U.S. quiet—deposition of limestone along continental margin (Whitefish Range and north). • Plant and animal life colonize land surface. • Major expansion of aquatic life forms—"Cambrian Explosion".
			600 mya	
Pre-cambrian	Proterozoic			• Breakup of ancient continent—Belt/Purcell rocks begin traveling to present locations in U.S./Siberia/Australia. • Deposition of sediments forming Belt/Purcell rocks.
			1500 mya	
	Archean			• Oldest evidence of life found in rocks—single-celled organisms (predecessors of algal stromatolites). • Oldest known rocks on earth (core areas of present continents). • Earth and other planets formed as solar system.
			4600 mya	

Figure 2.5: Geological Timescale of major events in the Flathead Watershed. *Source: Content, Lex Blood; Graphic, Walt Curtis*

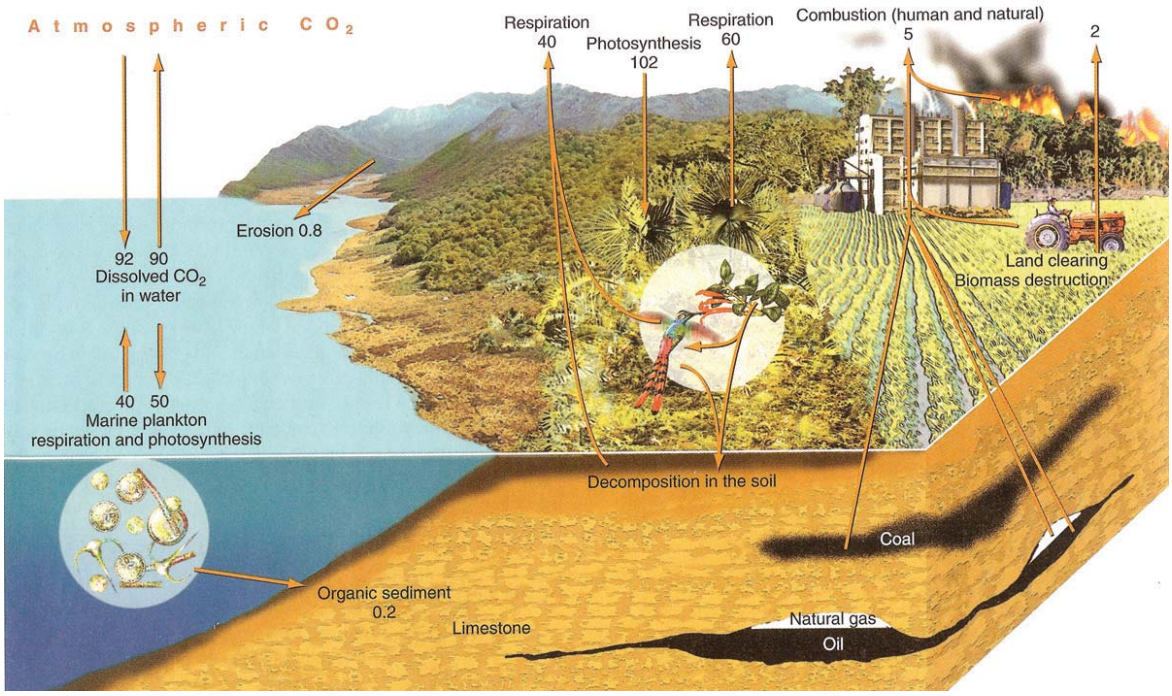


Figure 2.25: Carbon cycle. *Source: Author- Cunningham, W., et. al. 2007; Publisher - McGraw-Hill, N.Y. with permission of The McGraw-Hill Companies.* Numbers indicate approximate exchange of carbon in gigatons (Gt) per year. Natural exchanges are balanced but antthropogenic (human caused) sources product a net increase of CO2 in the atmosphere.

Nitrogen Cycle

Nitrogen, the most abundant element in the atmosphere, is essential to all life. It is necessary for numerous biological processes, and is a critical component of Deoxyribonucleic acid (DNA), the genetic instructions for all living things and Ribonucleic acid (RNA), biologically important molecules. Nitrogen is plentiful in the earth's atmosphere, but not in a form plants can use. Nitrogen must be converted from its gaseous form ("fixed" into nitrogen compounds such as nitrate) to be utilized by living organisms. The amount of fixed nitrogen determines how much food can be grown in a terrestrial environment, so it is—along with a combination of other nutrients—a critical consideration in food production.

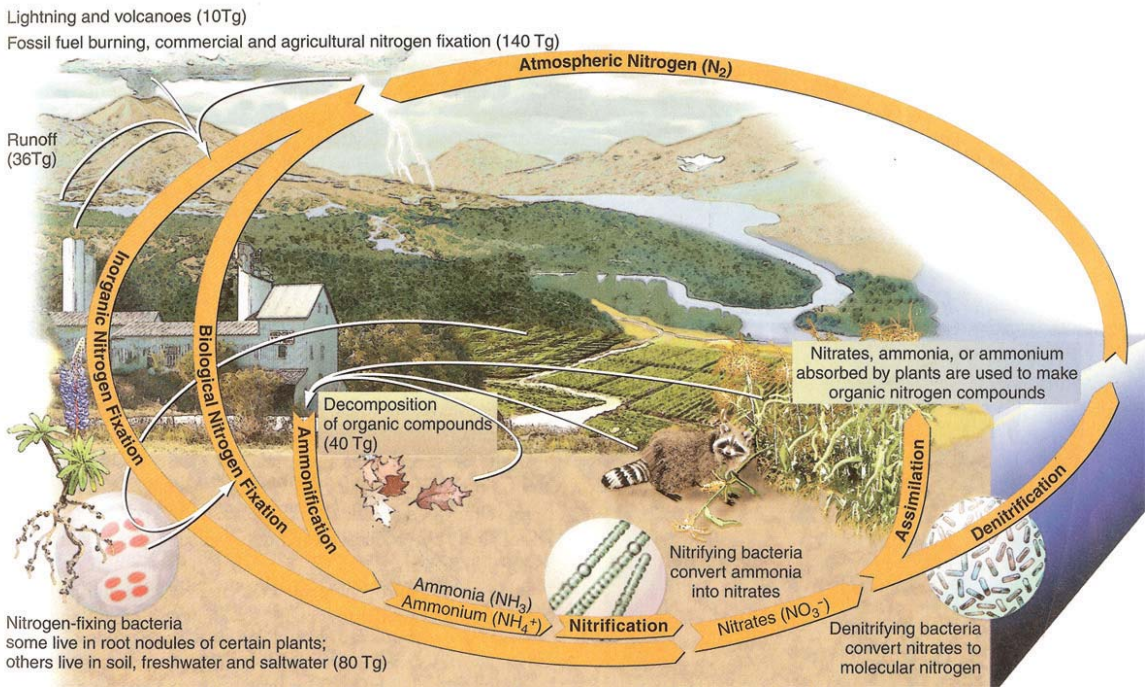


Figure 2.26: Nitrogen cycle. *Source: Author - Cunningham, W., et. al. 2007; Publisher - McGraw-Hill, N.Y. with permission of The McGraw-Hill Companies.*

Encounters with Grizzlies
Interagency Grizzly Bear Committee

Figure 2.51: Grizzly sow with cubs. *Source: U.S. Forest Service*

In the Field

If you encounter a bear, there are actions you can take to avoid escalating the situation. Maintaining a safe distance and acting in a manner that does not threaten the bear provides options for you and the bear. If you encounter a grizzly, you should first try to back out of the situation. Keep calm, avoid direct eye contact, back up slowly, and speak in a soft monotone. Never turn your back on the bear and never kneel. Most encounters end with the bear leaving at this point.

Never run, and do not climb a tree unless you have time to climb at least ten feet before the bear reaches you. Remember, bears can run very fast. If you do have to climb, you might want to drop a non-food item, such as a camera, to distract the bear while you climb. If the bear charges, stand your ground. Bears often "mock charge" or run past you. The bear may charge you several times before leaving the area. Shooting a bear when it is charging is not recommended. The bear almost always lives long enough to maul the shooter severely. As a last resort, play dead. Curl into a ball, covering your neck and head with your hands and arms. If you have a backpack, leave it on as it will help protect your back. If the bear swats you, roll with it. Stay in a tucked position and do not try to look at the bear until you are sure it is gone. Many people have survived bear attacks using this tactic.

In Camp

Bears that come into your camp are a completely different situation. They have chosen to approach you and have most likely become habituated to human food and garbage. These bears are more dangerous because they are no longer avoiding confrontations with humans. It is important that you store your food properly. If the bear does not get a food reward, it will be more likely to leave quickly.

Stay calm, avoid direct eye contact and speak to the bear. Get to safety as quickly as possible by slowly backing out of the area while looking for suitable trees to climb. Climb a tree as high as you can since some grizzlies can climb trees. Stay in the tree until you are sure the bear is gone. If the bear attacks you, fight back by punching, slapping or using any object available for a weapon. Try to evade the bear by climbing up a tree or onto a boulder. Playing dead will NOT work in this situation. The bear has made a conscious choice to attack you. Before retiring for the night, note climbable trees in the area. Sleep in tents large enough to stack gear between you and the tent wall. If a bear attempts to enter your tent, there are spray repellants marketed for bear confrontations that may be useful. Always report any bear incident as soon as possible, even one that just walks through a campsite.

Grizzly Bear Behavior

The bear that stands on his hind feet is investigating an unknown situation. *This is not an aggressive posture.* It simply means that the bear is unsure of what is in front of him. By standing on its hind feet it can get a better look and smell, and thus can better identify whatever is in front of him. A bear that swings its head from side to side, or presents a side view of its body, is expressing a reluctance to charge. It is looking for a way out of the situation. If the bear looks at you directly and has its ears back, it is warning you that you are too close and it feels threatened. The bear may make a barking, woofing or moaning sound to further indicate its distress.

If the bear "pops" its jaws, the bear is very agitated and likely to charge. Charges are often a test of your resolve and are often "mock charges" where the bear stops short of you, veers off or runs past you. A bear may mock charge many times before leaving. A bear that does charge and knocks you down is attempting to remove a threat. The bear will use as much force as it believes is necessary to remove that threat. This is why lying down and playing dead is often the best thing to do in an attack situation.

Ungulates - Hoofed Mammals

The Flathead Watershed has one of the most diverse populations of ungulates in North America. The **bison** (*Bos bison*) is the largest animal in the watershed and in North America, weighing over 2200 pounds (1000 kg). They have enormous horned heads supported by a hump of muscle on their necks, and they are covered with a thick coat of fur that works to protect them from summer sun and winter cold. Now absent from most of their historic range, bison once roamed the mountains and grasslands in huge herds.

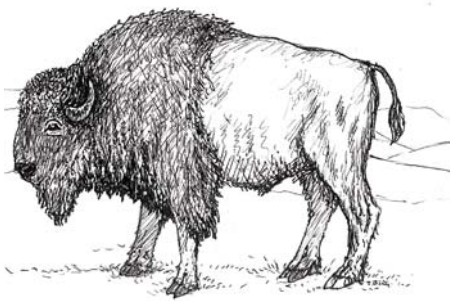


Figure 2.54: Bison. *Source: Todd Berget*

Where an estimated 60 million bison once grazed the North American plains in the seventeenth century, they were slaughtered—primarily for sport—until 1890 when fewer than 1,000 animals survived. Their grazing and movement through the territory once helped to distribute and determine the location and growth of grassland vegetation. Bison are now restricted to the National Bison Range in Montana and are found in small herds in Waterton Lakes National Park. Administered by the U.S. Fish and Wildlife Service as part of the National Wildlife Refuge System, the National Bison Range is home to between 350 and 500 bison.

The largest member of the deer family, the **moose** (*Alces alces*), survives well in the deep snow of high altitude coniferous, deciduous, and mixed forests, as well as the wet bogs, lakes, and riparian areas at low altitudes. They stand 5 to 6 feet (1.5 to 1.8 m) tall and are 6.5 to 9 feet (2 to 2.7 m) in length. Moose find nourishment browsing on trees and shrubs, and grazing on grasses and other terrestrial and aquatic plants. Their strong, long legs allow them to move with ease through up to 30 inches (76.2 cm) of snow.

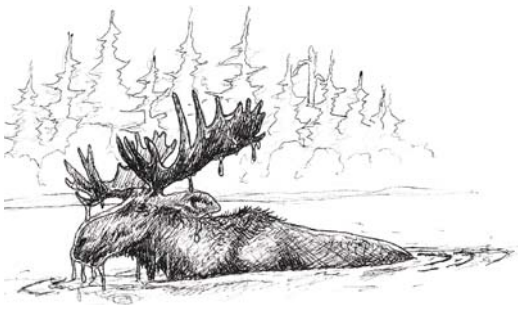


Figure 2.55: Moose. *Source: Todd Berget*

Elk (*Cervus elaphus*) are shy forest and meadow inhabitants, feeding in two feet (61 cm) of snow or less in open meadows and at lakes, from dusk to dawn. Elk are generalists, and are biologically adapted to eating a combination of high and low nutrition foods. They eat grasses as well as some of the same shrubs as deer, and their size allows them to outreach deer for many food sources. At 4 to 5 feet (1.2 to 1.5 m) high and 6 to 9 feet (1.8 to 2.7 m) long, they are smaller than the moose. Elk are a prized big game species for hunters in the Flathead Watershed. Montana Fish, Wildlife & Parks uses hunting as a management tool for elk conservation.

Figure 2.56: Elk. *Source: U.S. Forest Service*

Woodland caribou (*Rangifer tarandus*) are found only in small numbers in old-growth coniferous forests and alpine tundra in B.C. They are the only member of the deer family in which both sexes grow antlers, though male and female antlers are shaped differently. Standing 3.5 to 4 feet (1 to 1.2 m) tall, they reach lengths of 4.5 to 7.5 feet (1.4 to 2.3 m). Caribou have many adaptations for surviving harsh winters, including their long throat mane and thickly furred muzzle.

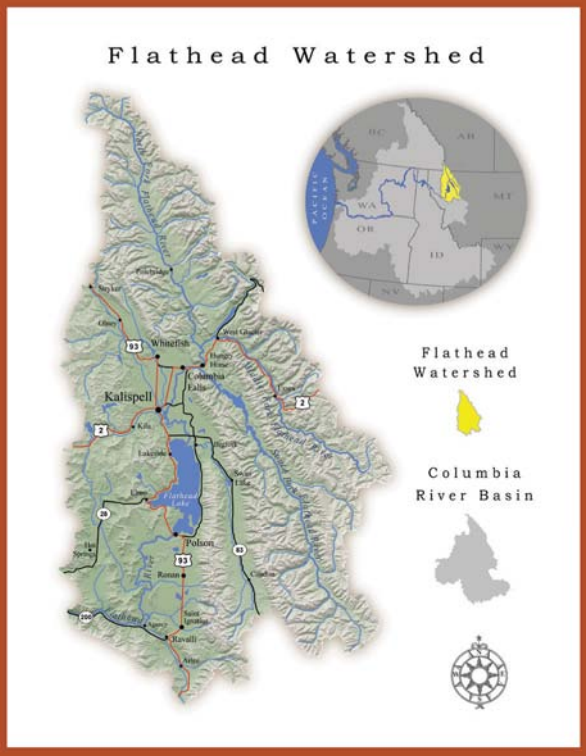
Figure 2.57: Caribou. *Source: U.S. Department of Agriculture*

White-tailed deer (*Odocoileus virginianus)* require high energy, easily digestible food. They prefer areas where snow is the shallowest, typically beneath the thick canopy of stands of coniferous trees that prevent snow from building up. Standing at 3 to 3.5 feet (91.4 cm to 1 m) high and with a body length of 5.5 to 7 feet (1.7 to 2.1 m), the white-tailed deer is found

Figure 2.58: White-tailed deer fawns. *Source: Lori Curtis*

Read over 50 ***Watershed Perspectives***, short individually contributed vignettes that help tell the story of the watershed from a variety of viewpoints.

The Flathead Watershed Sourcebook: *A Guide to an Extraordinary Place* is a "must have" book for long-time residents as well as new community members and visitors. And it is an essential sourcebook for the development of learning tools by Flathead Watershed resource educators. This book weds science and art, nature and human nature into an appealing and informative publication.



Contact information:
www.flatheadwatershed.org
www.flatheadcore.org

Flathead Watershed Sourcebook: *A Guide to an Extraordinary Place*

This book serves as a primer to the Flathead Watershed. Viewed from a bioregional perspective, it discusses the many people and systems that make up the Flathead Watershed—one of the most biologically intact ecosystems in North America.

Within these pages, you will find:

- a glimpse into the history of our cultures and the lives and economies of today's citizens
- a view of the watershed's deep geological timeline as well as a window onto current conditions
- descriptions of the habitats and biodiversity of the watershed
- an explanation of land ownership and resource management
- details of our food production and natural resources
- a look at the pressures of human development on resources and the creative community efforts that minimize resource stress
- year-round recreational opportunities and tips for sustainable recreation

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