TABLE 1 *Biogeoclimatic zones of the Columbia Basin region and associated grass species (adapted from species lists in Meidinger and Pojar 1991)*

Biogeoclimatic zone	Common name	Scientific name
Alpine Tundra above 2250 m elevation	Alpine Fescue	*Festuca brachyphylla*
	Rough Fescue	*Festuca campestris*
	Green Fescue	*Festuca viridula*
	Fuzzy-spiked Wildrye	*Leymus innovatus*
	Slender Wheatgrass	*Elymus trachycaulus*
	Glaucous Bluegrass	*Poa glauca*
	Purple Reedgrass	*Calamagrostis purpurascens*
	Timber Oatgrass	*Danthonia intermedia*
	Arctic Bluegrass	*Poa arctica*
Engelmann Spruce–Subalpine Fir from 1500 to 2300 m	Rough Fescue	*Festuca campestris*
	Green Fescue	*Festuca viridula*
Montane Spruce from 1250 to 1700 m	Pinegrass	*Calamagrostis rubescens*
	Bluebunch Wheatgrass	*Pseudoroegneria spicata*
	Idaho Fescue	*Festuca idahoensis*
Sub-Boreal Spruce from valley bottom to 1100–1300 m	Pinegrass	*Calamagrostis rubescens*
	Rough-leaved Ricegrass	*Oryzopsis asperifolia*
Interior Cedar–Hemlock from 400 to1500 m	Bluebunch Wheatgrass	*Pseudoroegneria spicata*
Interior Douglas-fir from 350 to 600 m	Bluebunch Wheatgrass	*Pseudoroegneria spicata*
	Pinegrass	*Calamagrostis rubescens*
	Idaho Fescue	*Festuca idahoensis*
	Rough Fescue	*Festuca campestris*
	Junegrass	*Koeleria macrantha*
	Kentucky Bluegrass	*Poa pratensis*
Ponderosa Pine lowland to 350 m	Bluebunch Wheatgrass	*Pseudoroegneria spicata*
	Sandberg's Bluegrass	*Poa secunda*
	Cheatgrass	*Bromus tectorum*
	Alkali Saltgrass	*Distichlis spicata*
	Rocky Mountain Fescue	*Festuca saximontana*
	Rough Fescue	*Festuca campestris*
	Junegrass	*Koeleria macrantha*

Within each of these zones, different grass species grow in different habitats, influenced by soil moisture, chemistry, and disturbance, such as fire, grazing, and human activity. Surprisingly, grasses are often associated with forests, especially open ones. It is very difficult to classify "open" forests. Are they forests or grasslands? Often the most abundant species are grasses but they grow under a canopy of trees, so we think of open forest as a forest type. In some sites, grassland continues right in under the trees and the same species appear in both communities, yet one is classified as forest and the other grassland. Consequently, though forests cover much of the Columbia Basin region, grasses constitute a major element of the flora.

In addition to the grass species naturally associated with forests, there are species that occur because of human activities. Habitats include pastures, lawns, improved rangeland, and weedy sites. Most of the species of these situations were introduced and have spread along roadside ditches, into abandoned fields, and in waste places. Of the 152 grass species in this study, 40 originated outside of North America, and in some cases these were planted to improve existing grassland or to stabilize slopes after road construction.

Grasses of wetlands Perhaps the most predominant, yet often overlooked, grassland communities in the Columbia Basin region are those that withstand repeated flooding. These are habitats that are broadly classified as bogs, fens, marshes, and swamps. A preliminary wetland classification for the region (W. MacKenzie, pers. comm., 1999), lists 22 wetland community types. Common wetland grass species are Bluejoint (*Calamagrostis canadensis*), Fowl Mannagrass (*Glyceria striata*), Reedgrass (*Glyceria grandis*), Wood Reed Grass (*Cinna latifolia*), Common Reed (*Phragmites australis*), Reed Canary Grass (*Phalaris arundinacea*), and Spike Bentgrass (*Agrostis exarata*).

TABLE 2 *Wetland types of the Columbia Basin region and associated grass species (adapted from preliminary draft data from wetland classification [W. MacKenzie, pers. comm., 1999])*

Wetland type	Plant association	Common name	Scientific name
Bog	Lodgepole Pine–Labrador Tea-Peat Moss	Bluejoint	*Calamagrostis canadensis*
	Lodgepole Pine–Interior Spruce-Bog Laurel–Peat Moss		none
Fen	Pine-Water Sedge–Peat Moss	Bluejoint	*Calamagrostis canadensis*
	Scrub Birch–Water Sedge	Spike Bentgrass	*Agrostis exarata*
		Bluejoint	*Calamagrostis canadensis*
	Scrub Birch–Buckbean–Peat Moss	Hair Bentgrass	*Agrostis scabra*
		Bluejoint	*Calamagrostis canadensis*
	Beaked Sedge–Water Sedge	Alpine Bentgrass	*Agrostis humilis*
		Bluejoint	*Calamagrostis canadensis*
		Slimstem Reedgrass	*Calamagrostis stricta*
		Reed Mannagrass	*Glyceria grandis*
	Tufted Clubrush–Star Moss	Bluejoint	*Calamagrostis canadensis*
		Timber Oatgrass	*Danthonia intermedia*
		Fescue	*Festuca* spp.
	Narrow-leaved Cottongrass–Shore Sedge	Bluejoint	*Calamagrostis canadensis*
		Common Sweetgrass	*Hierochloe odorata*
	Few-flowered Spikerush–Hook Moss	Hair Bentgrass	*Agrostis scabra*
		Bluejoint	*Calamagrostis canadensis*
		Alpine Timothy	*Phleum alpinum*
	Slender sedge–Buckbean	Bluejoint	*Calamagrostis canadensis*
	Slender sedge–Hook Moss	Bluejoint	*Calamagrostis canadensis*
		Reed Mannagrass	*Glyceria grandis*
Swamp/bench	Drummond Willow–Bluejoint	Bluejoint	*Calamagrostis canadensis*
		Nodding Wood-reed	*Cinna latifolia*
		Fowl Mannagrass	*Glyceria striata*

TABLE 2 *Continued*

Wetland type	Plant association	Common name	Scientific name
Swamp	Mountain Alder–Hardhack–Water Sedge	Bluejoint	*Calamagrostis canadensis*
		Reed Mannagrass	*Glyceria striata*
		Mannagrass	*Glyceria* spp.
	Spruce–Pine–Subalpine Fir–Skunkcabbage–Peat Moss	Bluejoint	*Calamagrostis canadensis*
	Sitka Willow–Small-flowered Bulrush	Bluejoint	*Calamagrostis canadensis*
		Nodding Wood-reed	*Cinna latifolia*
	Sitka Willow–Water Sedge	Hair Bentgrass	*Agrostis scabra*
		Bluejoint	*Calamagrostis canadensis*
		Slimstem Reedgrass	*Calamagrostis stricta*
	Reed Canary Grass-Cleared	Reed Mannagrass	*Glyceria grandis*
		Reed Canary Grass	*Phalaris arundinacea*
Marsh	Common Reed Marsh	Reed Canary Grass	*Phalaris arundinacea*
		Canada Bluegrass	*Poa compressa*
		Kentucky Bluegrass	*Poa pratensis*
		Brome	*Bromus* spp.
	Common Spike Rush	Spike Bentgrass	*Agrostis exarata*
		Little Meadow-foxtail	*Alopecurus aequalis*
		Northern Mannagrass	*Glyceria borealis*
		Reed Canary Grass	*Phalaris arundinacea*
		Fowl Bluegrass	*Poa palustris*
		Nuttall's Alkaligrass	*Puccinellia nuttalliana*
	Cattail	Redtop	*Agrostis gigantea*
			Phalaris arundinacea
	Bulrush		none

Horse paddock at Fort Steele

Grasses of disturbed sites Disturbed urban and suburban sites are great places to look for grasses.

Roadsides and railroad verges support a wide range of mostly introduced, invasive or foreign species. For example, at Revelstoke, in the zone between the rail bed and main street, common species are Quackgrass (*Elymus repens*), Kentucky Bluegrass (*Poa pratensis*), Orchard Grass (*Dactylis glomerata*), Green Bristlegrass (*Setaria viridis*), Timothy (*Phleum pratense*), and Reed Canary Grass (*Phalaris arundinacea*); found in the ditch, Smooth Brome (*Bromus inermis*), Common Witchgrass (*Panicum capillare*), and Redtop (*Agrostis gigantea*). Of these, Quackgrass is probably the most universal in its occurrence in urban lots, roadsides, and back alleys.

At Grand Forks, which has a drier and hotter climate, many of the same species occur in disturbed sites, especially Quackgrass. Other common grasses include several species of Bluegrass such as Kentucky Bluegrass (*Poa pratensis*), Canada Bluegrass (*Poa compressa*), and Bulbous Bluegrass (*Poa bulbosa*), as well as Cheatgrass (*Bromus tectorum*), Tall Wheatgrass (*Thinopyrum ponticum*), and Crested Wheatgrass (*Agropyron cristatum*) (abundant in dry stony sites), Stink Grass (*Eragrostis cilianensis*), and scattered annual Fescues (*Vulpia* spp.). The highway roadside and ditch west of Grand Forks supports a thriving population of Wild Oat (*Avena fatua*) and Wheat (*Triticum aestivum*).

An abandoned dumpsite in Nelson had a healthy population of Large Barnyard Grass (*Echinochloa crusgalli*), Wild Oat (*Avena fatua*), and Wheat (*Triticum aestivum*).

Historically, botanists have paid little attention to these weedy species mentioned above and have concentrated on the native species in undisturbed situations. The presence of these grasses is so common that we almost forget that they are there. These are the grasses that grow in most of our communities and they are a good way to get started when looking at grasses.

Grassland history

Today, in the Columbia Basin region, extensive grasslands occupy valley bottoms in dry or wet settings. In the past though, grasslands dominated the landscape. Following the retreat of the Cordilleran Ice Sheet about 13 000 years ago in the cool, Arctic-like climate, pioneering grasslands included sage, sedges, and grasses. Between 10 000 and 8000 years ago, grasslands extended above
1300 m during a climate warmer and drier than today. Sage (*Artemisia* spp.) and grasses occurred widely at this time. The initial tree stands developed into extensive forests as the climate began to moisten from 7000 to 4000 years ago. Later, much of the landscape was dominated by Douglas-fir (*Pseudotsuga menziesii*), larch (*Larix* spp.), lodgepole pine (*Pinus contorta*), and spruce (*Picea* spp.). Forest species expanded further downslope as the climate cooled 4000 years ago. Grasslands became confined to either the hot dry areas at low elevation, or places where trees could not grow, such as wetlands, slides, floodplains, or edges of meandering creeks.

Why grasses are well suited to extremes

Grasses are the only family of plants able to withstand cool-moist, hot-dry, or completely wet and almost submerged conditions because of their unique structural adaptations. They can also withstand grazing and fire. The fibrous roots of some annual grasses enable them to establish quickly in the wet mud of a marsh; other wetland grass species grow fibrous root masses to avoid being washed away in moving water. In dry situations, certain grass species grow in clumps (bunch grasses) to prevent the roots from drying out, and to prevent the soil from being lost around the root mass. In grass, the tissue responsible for growth (crown), is located toward the base of the leaf or shoot near the root, rather than at the tip as in other plants. This arrangement allows the grass to regenerate after it gets cropped or burned.

Silica bodies in the leaf cells prevent leaves from wilting in hot, dry conditions and these sharp silica bodies also protect the leaf. Remember the first time you ran your hand along the edge of a fresh blade of grass and got a cut? This doesn't stop cows, horses, sheep, and their wild counterparts, which have tough mouth parts, continuously growing teeth, and several stomachs, from digesting the tough fibres. Some grass species adapt to dry conditions by rolling their leaves inward or folding them to prevent water loss from the surface. A broad leaf surface means more surface area for evaporation.

Grasses are wind-pollinated, so they do not need showy flowers to attract insect pollinators. Grasses that grow in dry areas—where seeds need to be buried to ensure enough moisture for seed germination—tend to have long awns and a narrow cylinder-like form to allow the seeds to move along cracks in the soil particles. Grass seeds are dispersed by many methods, but grasses do not need to produce seed to disperse. Most grasses can spread vegetatively by forming tufts or by rhizomes. The tufted type of grass species move out from a central parent, and the younger plants occur around the outside of the parent plant. Rhizomes are the favoured mode of dispersal for a large number of wetland grasses. In high water levels, parts of the rhizome break off and float to new sites, along eroding banks and gravel bars. Other grass species form small "live" bulblets or plants that start growing when they fall off the mother plant. Some species of the Bluegrass (*Poa*) genus have only female plants and set seed without pollen. The flowers of the annual Fescues (*Vulpia* spp.) do not open for pollination; instead, the flower remains closed and the seed is set using pollen from the same plant. Using vegetative methods, grasses are not dependent on seed set but can get established in extreme areas before other pioneering species can set seed.

Although the leaf blades are the prime food source for many grazing animals, the seeds provide critical nutrition to rodents, birds and waterfowl, and humans. In fact, the fruit of one grass—Wheat—is central to our daily diet. Other important grasses in our diet are Rye, Rice, Corn, and Oats. Even sugar, which comes from Sugar Cane (*Saccharum officinarum*), is from a grass. Grasses were important to British Columbia's First Peoples for many household tasks such as making bedding, lining steam pits, covering berry baskets, decorating baskets, and making food-drying mats.

Why native grasslands are important in the Columbia Basin region

In the Montane Cordillera area of British Columbia, the grasses (Poaceae) are second only to the sedges (Cyperaceae) in numbers of species. Douglas et al. (1994) listed 243 species of grasses in British Columbia. The collection at the Royal British Columbia Museum has vouchers for 152 species in the Columbia Basin region. These numbers give the impression that grass species occur commonly in the Columbia Basin region, but these numbers hide the changes occurring in the region.

There are currently (1999) six grass species in the Columbia Basin region on the B.C. Conservation Data Centre's Red List. A Red-listed species is a candidate for legal designation as endangered or threatened. The Columbia Basin region Red-listed species are:

Blue Gramagrass (*Bouteloua gracilis*)
Water Hairgrass (*Catabrosa aquatica*)
Foxtail Muhly (*Muhlenbergia andina*)
Little Bluestem (*Schizachyrium scoparium*)
Prairie Wedgegrass (*Sphenopholis obtusata* var. *major*)
Prairie Wedgegrass (*Sphenopholis obtusata* var. *obtusata*)

There are also ten Blue-listed species in the Columbia Basin region. A Blue-listed species is a vulnerable grass that could easily become a candidate for the Red List in the future because of changes in its occurrence. The Blue-listed candidates are:

Plains Reedgrass (*Calamagrostis montanensis*)
Slender-spiked Mannagrass (*Glyceria leptostachya*)
Slender Mannagrass (*Glyceria pulchella*)
Oniongrass (*Melica bulbosa*)
Smith's Melic (*Melica smithii*)
Purple Oniongrass (*Melica spectabilis*)
Marsh Muhly (*Muhlenbergia glomerata*)
Rivergrass (*Scholochloa festucacea*)
Porcupine Grass (*Stipa spartea*)
Wolf's Trisetum (*Trisetum wolfii*)

Some species are placed on the Red and Blue Lists because they grow at the edge of their geographic range; others because they have very particular habitat needs (e.g., high alkalinity) or their habitats are being lost to development. Some rare species are being displaced by introduced species such as Knapweed (*Centaurea* spp.). Surprisingly, there are only 40 introduced species (brought into the area from outside North America) among the 152 species, representing about 25 percent of the grass flora. These numbers hide the fact that introduced grasses occupy a larger area than do the native grasses. In overgrazed grassland, a sea of Cheatgrass (*Bromus tectorum*) usually dominates, with scattered native species.

A native grassland has a majority of native grass species and has not been "improved" by the addition of introduced species. Today in the Columbia Basin region it is difficult to find native grassland because pasture grasses have been sown into natural open habitats. In an effort to re-establish native grass species on disturbed sites, native grass seed mixtures are now used to revegetate roadsides, campgrounds, streambanks, and some grasslands. It is only through this reintroduction of native grass species, and conscientious habitat management, that we can hope to restore the biodiversity of grasslands in the Columbia Basin region. Grasslands do not require a "hands off" policy to protect them, but they are vulnerable to development and over-management.

Past collection history in the region

Herbarium databases reflect the activity and movements of earlier botanists in a region. To a degree, the apparent distribution of a species from herbarium records reflects the ease of travel of botanists on the landscape. In general, maps stimulate questions about distribution gaps and the concentration of species data. The earliest recorded grass specimen collected in the Columbia Basin region in the Royal British Columbia Museum's database is one collection by J.R. Anderson in 1895. Collection growth remained slow until J.W. Eastham began collecting in the 1930s. This collection of grasses remains one of the Royal B.C. Museum's largest. George Hardy, past curator at the Museum, collected in the region in the 1940s. Fred Fodor, Marc Bell, and James Calder collected extensively in the 1950s and '60s. The bulk of the collection was amassed in the 1970s and '80s when curators such as Chris Brayshaw, Adolf Ceska, Robert Ogilvie, and Leon Pavlick spent time collecting in the Columbia Basin region, especially along the Rocky Mountain Trench. David and Alan Polster collected large amounts of material in 1975 and 1976 from the Akamina and Kishinena Creeks area. Hans Roemer, botanist with Provincial Parks, has deposited large collections of grass specimens from the region. In recent years, the Conservation Data Centre has added voucher material representing rare species.

The plant species checklist was developed using the specimen database at the Royal British Columbia Museum Herbarium. At the Herbarium, specimen data are maintained on a FOXPRO database that has been updated and annotated by specialists to reflect the recent changes in grass taxonomy. Each record in the checklist has an associated specimen housed at the Herbarium, except in the case of some of the Red- and Blue-listed specimens described in Douglas et al. (1998). In most cases, the names follow Douglas et al. (1994). The names of some genera were changed to reflect changes in taxonomic thinking and to reflect the changes that will be included in the Manual of Grasses of North America (to be released in the near future by Barkworth et al.).

The maps were generated using a Geographic Information System (ArcView 3.0a) from the geographic coordinates in the database records. The base map is from the Watershed Atlas data available in digital format from the Ministry of Environment, Lands and Parks website. The base map data were digitized from nts 1:50 000 mapsheets and converted to nad 83 format in 1996. It is in Albers Equal Area Conic projection. The watershed base map was clipped to the study area determined by the Living Landscapes program at the Royal British Columbia Museum. Point data from the database were added to the base map, and a distribution map was generated for each species. The points represent actual specimen locations and can be traced back to the database and a herbarium sheet. Many species that show limited distribution may prove to be more widely distributed as a result of more extensive field work. The maps should be used as a guide to where specimens have been collected but in no way reflect the only places where the species can be observed.

There are four main parts to a grass plant, roots, stem (culm), leaves, and flowerhead (inflorescence). Each part has diagnostic features that help in correct identification. It is often the combination of several characters that eventually leads you to the correct name. The grass descriptions in this guide are designed to point out important features of each of these parts. It is very important to get as much information on each part of the plant to help identify the grasses. In other words, it is best to have the entire plant, roots and all, to identify a grass.

Roots

Grasses grow from fibrous root masses, but sometimes there is a below-ground root-stem structure called a rhizome (Photo 1), which is often mistaken for a root. It is important that you observe whether the specimen has a rhizome or not. Often the root mass may appear to have no rhizome but if you squeeze the mass you can detect a hard, branch-like projection that is the end of a rhizome that got broken when the plant was removed from the soil. Annual grasses do not have a rhizome, they have only a mass of fibrous roots (Photo 2).

PHOTO 1

PHOTO 2

Stems (Culms)

Stems in grasses are actually called culms in grass keys, but we have retained the term “stem” to make it easier for laypeople. Stems sometimes assume varying forms that may at first seem confusing. These forms are very important to grass identification. The single upright stem with a few leaves at the base is the most familiar form, but stems can also originate from clusters (cespitose) or tufts of leaves at the base. Stems can be found below ground (rhizomes) or above ground (stolons), and may trail on the ground. In some species, these trailing culms root at the nodes.

Stems arise from the crown, which is the base of the leafy part of the grass plant. It is from this crown that leaves and stems regenerate after grazing or fire. Some grasses, such as Onion Grass (*Melica bulbosa*) have swollen stem bases that look like bulbs at the crown. At the end of the first season, the dead stem often remains standing, and dried leaves from the previous year also remain around the base. It is important to note the presence of old stems and leaves at the crown. This feature provides a clue to whether the grass is annual (living for one growing season) or a perennial (living for more than one season). Some grasses are biennials (they grow vegetatively the first year, and produce a flowerhead during the second year).

Leaves

Leaves arise either from the crown at the base of the stem or from swellings along the stem called nodes (Photo 3). Nodes are often a dark colour, and in some cases, they may be barely noticeable. Some nodes have small hairs on them. The spaces between nodes are called internodes.

PHOTO 3

Each leaf consists of a sheath, which wraps around the stem, and a free portion, called a blade. The sheath may be open or closed, an important diagnostic feature with some grasses. If it is closed, it appears like the V in a V-neck shirt. If it is open, the edges of the sheath appear to meet or overlap.

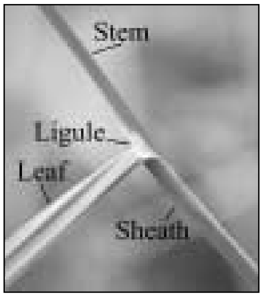


PHOTO 4

The leaf blade often diverts or bends away at right angles from the stem and the sheath. Often a distinct ridge of tissue develops at the bend. From this ridge of tissue (or collar) there arises the ligule (derived from the word tongue because in many species it looks like a little tongue sticking out) (Photo 4). The ligule sticks up from the ridge and is thought to protect the stem from insects. The sheath is an enclosed surface, and insects could easily move from the flat blade down into the sheath, but the ligule forms a small barrier to this. Ligules have two common forms, consisting either of a membrane or a ring of hairs. At the point where the ligule meets the leaf blade there is usually a narrowing or thickening of the leaf known as the collar (Photo 5).

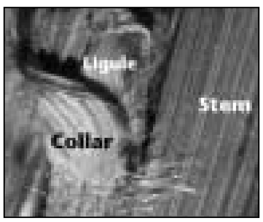


PHOTO 5

Ligule form is often critical to the identification of a species. The ligule is also a useful structure to observe when identifying a grass without flowers. The auricle (little ear)—another distinctive structure—occurs in many species at the edges of the collar, sometimes even wrapping around the stem. These auricles range from long pointed flaps of tissue to no more than a few hairs. Many species have no auricle at all. Wheat (*Triticum aestivum*) has well-developed and easily seen auricles (Photo 6).

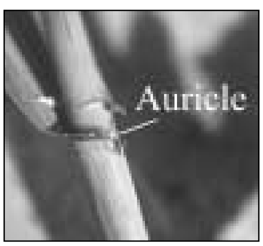


PHOTO 6

Length and width of the leaf blade are often used in keys to help distinguish species. A good metric ruler with a clear millimetre scale is an invaluable tool to grass identification. In addition, the blade may be flat, "folded lengthwise"(conduplicate), or inrolled (involute). Sometimes the form of the leaf tip is a useful feature. For example, Bluegrasses (*Poa* spp.) have keeled or prow-like tips, like the prow of a canoe. It is important to check several leaf tips because young leaves are the favoured food of many animals, and that strange tip may have been nibbled into shape.

Flowerheads (Inflorescences)

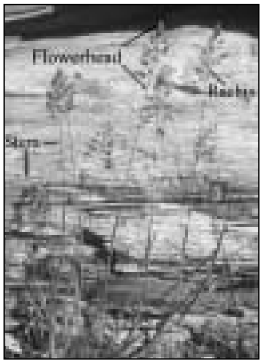
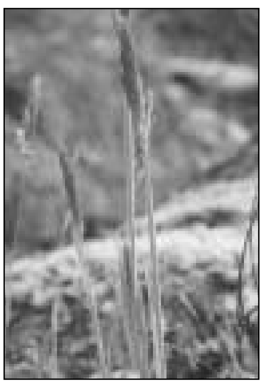


PHOTO 7


PHOTO 8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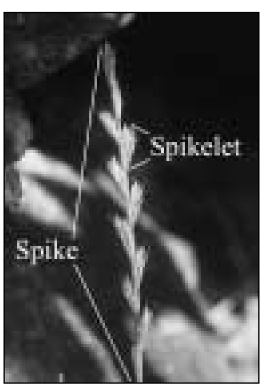


PHOTO 10

At the point where the inflorescence (flowerhead) begins, the stem officially ends and the stem axis above this point is called a rachis (Photo 7). Sometimes there is a noticeable node at this point or branches begin to point either upward or outward. In this treatment the measurements for the length of the flowerhead are taken from this node to the top of the flowerhead. The branching pattern and the general form of the flowerhead is a useful feature for field recognition. The rachis of the flowerhead may be obviously branched or unbranched. The branched (Photo 8) inflorescence in this treatment has spikelets attached to the rachis, and any branching can be clearly observed. Flowerheads that have spikelets attached directly to the rachis are classified as spikes. It is important to note whether you are looking at a fully extended flowerhead because an immature specimen can look spike-like. An example of this can be observed in Photo 7 and Photo 9. They are actually the same species, Yorkshire Fog (*Holcus lanatus*).

The nitty gritty of grass identification gets down to the structural details of the flowering units called spikelets and the flowers within them (Photo 10). Grasses bear their flowers on highly modified side branches called spikelets. At the spikelet base, closest to where the spikelet meets the main branches of the flowerhead, there are two highly modified leaves called glumes (Photo 11). The glumes hold the flower or flowers, which are arranged alternately along the rest of the branch above them. The form of the glumes, their size (length), whether or not they exceed the inner flowers in length, and surface texture are all useful features to observe. A good hand lens, or in some cases a binocular dissecting microscope, is very useful to view these characteristics. In the key we have added an illustration of a magnifying glass to indicate where you will need additional magnification.

Awns are pointed extensions of either the tip, back, or base of the glume (Photo 12). They can be long or short, straight, curved, or even bent. In some species, the glume is also modified such that it is awn-like for its entire length.

The reproductive parts are arranged on the branch above the glumes. For the purpose of this guide we are calling florets "flowers". Flowers can be widely separated along the spikelet, or jammed tightly together (Photo 13). The number of flowers in a spikelet is an important feature to note. Some genera and species have only one flower in each spikelet, whereas others bear 10 or more within the spikelet. Some flowers in the spikelet are sterile (empty). It is important to note whether these sterile flowers are above or below the fertile flowers. Some species have an empty flower at the end of the spikelet and others have a small extension of the branch of the spikelet.

Non-grasses have petals surrounding the flower to attract the attention of pollinators, but grasses are wind-pollinated. Instead they bear small, leaflike bracts or scales to protect the seed until it is mature. The grass seed used to seed a lawn is actually naked, but in nature most seed, when it is dispersed, retains two leaf-like covers. The outside (located away from the stem) and sometimes larger leaf-like part is called the lemma (Photo 14), and the inside (closest to the stem), usually smaller, part is called the palea. The palea may be reduced in size or missing entirely but the lemma is always there. The lemma cuddles or holds the palea and the stamens and pistil inside. Lemma and palea form, size, and hairiness are critical features in grass identification. These parts often absorb water and hold it close to the seed for germination.

One of the most useful features of the lemma is the character of the awns. It is important to note first of all whether an awn is present or not. Its length

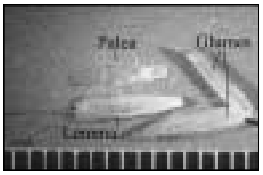


PHOTO 11

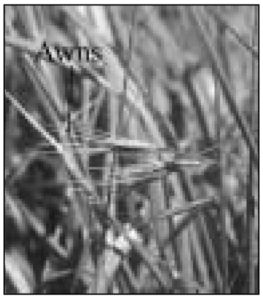


PHOTO 12

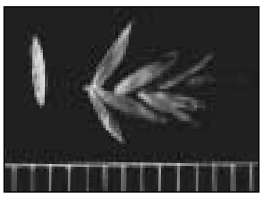


PHOTO 13

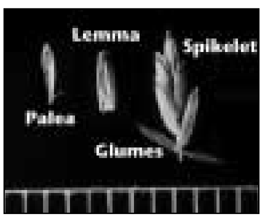


PHOTO 14

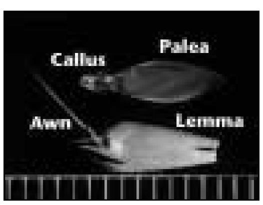


PHOTO 15

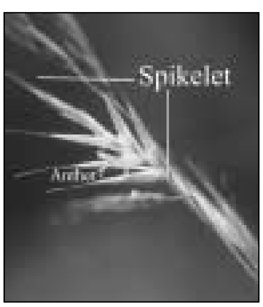


PHOTO 16

is measured from the tip to the point where the awn joins the lemma or glume. Is the awn straight or bent, or, as in the case of California Oatgrass (*Danthonia californica*), twisted several times (Photo 15)? Note whether the awn is attached at the end, middle, or base of the lemma or glume. If you think awns are not important, recall how after running through a meadow or field you had to pull out the spikey bits of grass from your socks or pants. The spikey bits may well have been florets jabbed into your clothing by the awns. Dog owners will be familiar with the various types of awned grasses; some of these can inflict pain and infection to soft body parts. Needle-and-thread Grass (*Stipa* spp.) is a nuisance to cattle owners. Other useful awn features to note are whether it arises at the tip of the lemma, or between a couple of teeth, as in Bromes (*Bromus* spp.). Sometimes the base of the lemma is modified into a structure called a callus. The callus may have no hair, be covered by a short tuft of hairs called a beard, or have long wavy hairs that appear web-like. The web-like callus is particularly important in deciding which Bluegrass (*Poa* spp.) you have. The awn and the callus may actually be very important in orienting the seed and helping to work the seed deeper into the soil. Experiments have shown that some grass seeds show reduced germination if the awn is removed in various soil types. In some soils, awns are necessary for successful germination.

Finally we get to the reproductive heart of the matter, the anthers (pollen part) and the stigma (ovary) within the palea and the lemma of each flower. Sometimes the grass floret may have already ripened and there will be only a hard fruit called the caryopsis. Perhaps the most important feature to note is whether both are present or not. Some species may have several flowers in a spikelet but only one may be fertile—that is, having either anthers or ovary. In some species the flowers are unisexual, having separate sexes in separate flowers. Because of this, the ideal time to collect grasses is when they are in full flower. In most grass species the anthers hang down between the palea and lemma of the spikelet (Photo 16). This is the most colourful time in the flowering of the grass: most anthers are yellow or rust coloured.

All three groups of the grass-like plants (grasses, sedges, rushes) are monocotyledons—plants that have one seed leaf. All three groups produce mostly narrow leaves with parallel veins. The flowers are relatively obscure and difficult to work with at first glance.

To decide whether a plant is a grass, sedge, or rush, begin by looking at the stem. Observe first whether the stem is hollow or solid. Generally, if the stem is hollow you have a grass. There are very few grasses that have solid stems. To be certain that the stem is hollow, cut it open between the nodes (Figure 2a). If the specimen has a solid stem, it is likely not a grass. Peel back the leaves, if there are any, and note whether the stem is round (i.e., if it easily rolls between your fingers) or whether it is angular. Plants with angular stems are usually sedges; those with round stems are rushes. Hence the simple maxim is "rushes are round and sedges have edges" (Figure 2b).

Technically speaking, the Sedge family (Cyperaceae) has many genera, not all of which have angular stems. The "sedges have edges" character applies mostly to true sedges in the genus *Carex*. Many bulrushes or tules in the genus *Scirpus* have round stems. To be certain that a plant is a member of the Sedge family you must examine the flower. The individual flowers are borne in the axil (inside face) of a single scale-like bract. This contrasts with grasses, which have two bracts immediately associated with the individual flower (lemma and palea). Sedges and grasses have one seed for each flower, in contrast to the rushes, which have a three-part capsule filled with many small, black seeds.

Rushes (*Juncus*) and wood rushes (*Luzula*) in the Rush family (Juncaceae) have solid stems as mentioned. The flowers usually consist of two series of three petal-like structures, which surround the pistil (Figure 2c). Using a hand lens you can see that these look like the petals of a miniature brownish lily.

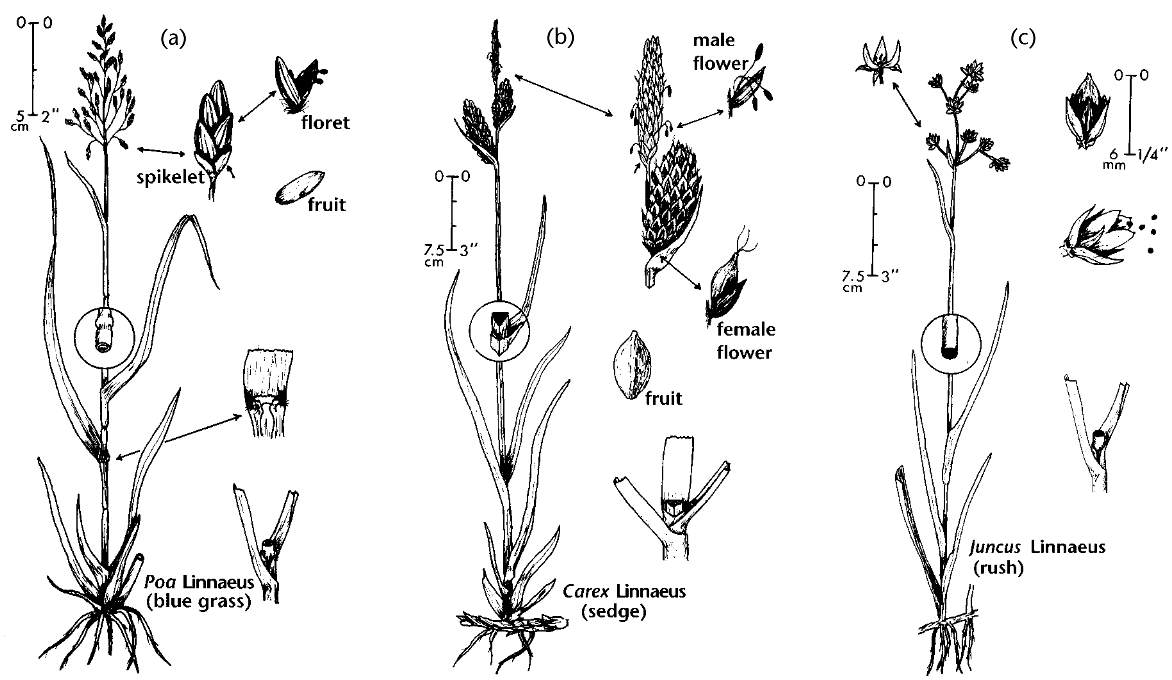
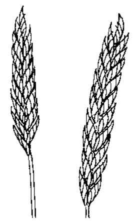


FIGURE 2 *Illustrations of (a) grass, (b) sedge and (c) rush anatomy.*

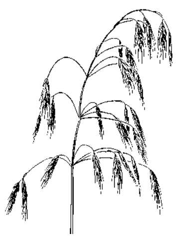
Adapted from Douglas et al. 1994 and Pojar and MacKinnon 1994

Agropyron fragile



Flowerhead a spike (no branches or very short branches) . . . . Group 1

Bromus vulgaris

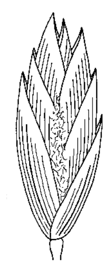


Flowerhead with branches (either open and spread, or pressed close to the flowerhead axis) . . . . Group 2

Agrostis scabra

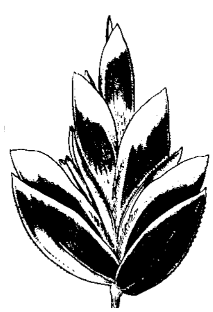
Each spikelet with one fertile flower (may have additional sterile flowers) 2a

Poa arctica



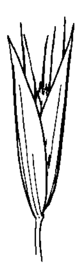
Each spikelet has two to many flowers . . . . Group 3

Poa alpina



Glumes shorter than the first flower 3a

Danthonia intermedia



Glumes as long as or longer than the first flower 3b

Group 1 (Flowerhead a spike or several spikes)

Spike or spikes cylindrical and bristly or feathery

1a. Flowerhead consists of several spikes . . . 2
- **2a.** Spikes not branching, but with spikelets on one side of the axis . . . 3
  - **3a.** Spikelet with one perfect flower and several modified flowers. . . *Bouteloua*
  - **3b.** Spikelets without modified flowers . . . *Spartina*
- **2b.** Several branching spikes with spikelets along the branches . . . 4
  - **4a.** Spikelets awnless . . . *Digitaria*
  - **4b.** Spikelets with long, bent awns . . . *Schizachyrium*

1b. One spike with spikelets around the axis (not only on one side) . . . 5
- **5a.** Annual . . . 6
  - **6a.** Spikelets of two types that look different from each other (one sterile, one fertile) . . . *Cynosurus*
  - **6b.** All spikelets similar at each node . . . 7
    - **7a.** Bristles below the flowers . . . *Setaria*
    - **7b.** Awns, not bristles, on the lemmas or glumes . . . 8
      - **8a.** Spikelet one-flowered . . . *Polypogon*
      - **8b.** Spikelets multiflowered . . . 9
        - **9a.** Two spikelets at each node; glumes keeled . . . *Triticum*
        - **9b.** One spikelet at each node; glumes rounded across the back . . . *Secale*
- **5b.** Perennial . . . 10
  - **10a.** Spikelets easily observed as two or more at each node . . . 11
    - **11a.** Spikelets three at each node (two sterile, one fertile). . . *Hordeum*
    - **11b.** Two or more fertile spikelets at each node . . . *Elymus*
  - **10b.** Flowerhead large and feathery with spikelets obscured by extremely long, silky hairs . . . *Phragmites*

Spike cylindrical and not bristly

1a. Annual; two spikelets at each node; glumes keeled . . . *Triticum*

1b. Perennial . . . 2
- **2a.** Each spikelet with one flower . . . 3
  - **3a.** Glumes noticeably broad, round, not hairy on the glume keel . . . *Beckmannia*
  - **3b.** Glumes broad with keel fringed with hairs . . . 4
    - **4a.** Glumes tipped with stiff awns; as well as on the keel with fringe of hairs . . . *Phleum*
    - **4b.** Glumes without stiff awn, but lemma with bent awn. . . *Alopecurus*
- **2b.** Each spikelet with several flowers . . . 5
  - **5a.** Glumes as long as or slightly shorter than the first flower. . . . *Koeleria*
  - **5b.** Glumes shorter than the first flower . . . 6
    - **6a.** Plants tufted . . . *Elymus*
    - **6b.** Plants with rhizomes, leaf blades prominently ribbed . . . *Leymus*

Spike not cylindrical, but appears as a series of flattened spikelets along the axis

1a. Several spikelets per node 2
2a. Flowerheads consist of all male spikelets or all female spikelets; small branches may be observed . . . . *Distichlis*
2b. Flowerheads consist of sterile flowers, anthers do not open. . . . . x *Elymordeum*
1b. One spikelet per node. 3
3a. Spikelet with narrow side facing the axis . . . . *Lolium*
3b. Spikelet with broad side against the axis 4
4a. Spikelet length more than three times spike internode length. . . . . *Agropyron*
4b. Spikelet length one to three times the length of the internode. . . . 5
5a. Glumes lance-shaped with a sharp point, stiff and shorter than the spikelets but longer than 5 mm. . . . . *Pascopyrum*
5b. Glumes oval-shaped, or blunt lance-shaped but shorter than 5 mm 6
6a. Glumes stiff, brittle, and blunt. . . . . *Thinopyrum*
6b. Glumes flexible, acute to awned 7
7a. Spikelets spread out along the axis, scarcely reaching the base of the spikelet above . . . . *Pseudoroegneria*
7b. Spikelets closely spaced, usually reaching midpoint of the spikelet immediately . . . . *Elymus*

Group 2 (Flowerhead branched; branches may be open or pressed against the flowerhead axis)

Each spikelet with one flower

1a. Lemma hard or like a thick membrane (hard as a fingernail) 2
2a. Awns split into three branches. . . . . *Aristida*
2b. Awns unbranched. 3
3a. Callus sharp and 1–6 mm long; greater than 1/5 the length of the flower; awns 4–30 cm long. . . . . *Stipa (Hesperostipa*)
3b. Callus shorter, not as sharp; less than 1/5 the length of the flower. 4
4a. Stem leaves less than 1 cm long; basal leaf blades green over winter. . . . . *Oryzopsis*
4b. Stem leaves longer than 1 cm; basal leaves drying over winter. 5
5a. Flowers are compressed; callus 0.1–0.6 mm long, rounded . . . . *Piptatherum*
5b. Flowers rounded to slightly compressed; callus 0.2–2 mm long, pointed but not sharp . . . . *Stipa (Achnatherum)*
1b. Lemmas membrane-like (not hard) 6
6a. Glumes equalling or longer than the first flower. 7
7a. Glumes unequal in length; lemmas one- to three-nerved, awnless. . . . . *Sporobolus*
7b. Glumes nearly equal; lemmas three- to five-nerved 8
8a. Lemmas awned. 9
9a. Awn arising from a minutely cleft tip . . . . *Muhlenbergia*

9b. Awn arising from the back or just below the tip, awn 5.5 mm long. . . . . *Apera*

8b. Lemmas unawned or minutely awned. . . . . *Cinna*

10a. Callus obviously bearded . . . . *Calamagrostis*

10b. Callus of flower minutely bearded or not at all. . . . *Agrostis*

6b. Glumes shorter than the first flower 11

11a. Glumes sharply pointed and callus bearded. . . . . *Calamovilfa*

11b. Glumes blunt or rounded 12

12a. Glumes less than 1/2 the length of the first lemma 13

13a. Lemma nerves parallel, not converging toward the blunt tip . . . . *Catabrosa*

13b. Lemma nerves converging toward a rounded or slightly pointed tip. . . . . *Panicum*

12b. Glumes almost as long as the first flower, but very dissimilar in shape; lemma nerves not parallel . . . . *Sphenopholis*

Group 3 (Flowerhead branched; each spikelet with two to many flowers)

Glumes shorter than the first flower

1a. Callus of the flower bearded 2

2a. Lemmas awnless 3

3a. Spikelets less than 10 mm long . . . . *Poa*

3b. Spikelets greater than 10 mm long. . . . . *Scolochloa*

2b. Lemmas awned. . . . . *Schizachne*

1b. Callus of the flowers not bearded 4

4a. Lemmas keeled 5

5a. Spikelets strongly compressed, crowded in dense, one-sided flowerhead . . . . *Dactylis*

5b. Spikelets compressed but not as above; lemmas unawned or awned from a cleft tip . . . . *Bromus*

4b. Lemmas rounded on the back and spikelets not strongly compressed 6

6a. Glumes papery; stems may be bulb-like at the base. . . . . *Melica*

6b. Glumes not papery 7

7a. Nerves of the lemma parallel; not meeting at the tip 8

8a. Lemma nerves barely visible, usually five. . . . . . . *Puccinellia*

8b. Lemma nerves prominently ridged, usually five to seven. 9

9a. Leaf sheaths open, their edges free and overlapping. . . . . *Torreyochloa*

9b. Leaf sheaths (upper ones) closed for entire length. . . . . *Glyceria*

7b. Nerves of the lemma converging or meeting at the tip 10

10a. Lemmas sharply pointed and awn-tipped; leaf sheaths open. 11

11a. Plants annual . . . . *Vulpia*

11b. Plants perennial. . . . . *Fescue*

10b. Lemmas not so sharply pointed and, if awned, from a cleft in the tip 12

12a. Spikelets greater than 15 mm long; lemmas, if awned, from a cleft tip . . . . *Bromus*
12b. Spikelets less than 15 mm long, lemmas awnless. . . . . *Poa*

Group 4 (Flowerhead branched; each spikelet with two to many flowers)

Glumes equal to or longer than the first flower

1a. Lemmas awnless 2
2a. Flowerhead with a distinct pyramid shape and few spikelets, mostly at the ends of long branches . . . . *Hierochloe*
2b. Flowerhead with branches densely covered with spikelets right to the base of the branch . . . . *Phalaris*
1b. Lemmas awned 3
3a. Lemmas awned from the tip 4
4a. Lemma awns arising from between two lobes at the tip. . . . . *Danthonia*
4b. Lemma awns arising from a narrow pointed tip . . . . *Vulpia*
3b. Lemmas awned from the back rather than from the tip 5
5a. Spikelets large; glumes 8–30 mm long . . . . *Avena*
5b. Spikelets small; glumes 2–9 mm long 6
6a. Lemma awns attached above the middle closer to the tip. . . . . *Trisetum*
6b. Lemma awns attached below the middle 7
7a. Plants delicate annual; spikelet axis not extended beyond the upper flower . . . . *Aira*
7b. Plants perennial; spikelet axis extended beyond the upper flower as a small projection 8
8a. Leaf blades flat; spikelets purplish. . . . . *Vahlodea*
8b. Leaf blades folded or inrolled; spikelets greenish or tawny. . . . . *Deschampsia*