Ecology of the Genus Carex

in the
Eastside Ecosystem Management
Project Area

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Preface

The following report was prepared by University scientists through cooperative agreement, project science staff, or contractors as part of the ongoing efforts of the Interior Columbia Basin Ecosystem Management Project, co-managed by the U.S. Forest Service and the Bureau of Land Management. It was prepared for the express purpose of compiling information, reviewing available literature, researching topics related to ecosystems within the Interior Columbia Basin, or exploring relationships among biophysical and economic/social resources.

This report has been reviewed by agency scientists as part of the ongoing ecosystem project. The report may be cited within the primary products produced by the project or it may have served its purposes by furthering our understanding of complex resource issues within the Basin. This report may become the basis for scientific journal articles or technical reports by the USDA Forest Service or USDI Bureau of Land Management. The attached report has not been through all the steps appropriate to final publishing as either a scientific journal article or a technical report.

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Introduction

This report is a summary of current knowledge regarding the ecology of the genus *Carex* in the study area of the Eastside Ecosystem Management Project (EEMP). A companion report (Brainerd et al. 1995) addresses the biogeography of *Carex* taxa in the study area.

The immediate objective of the EEMP as stated in the contract specifications is to assemble data to be used in modeling "changes in potential abundance of suitable environmental conditions given changes in vegetation types and conditions" and "species-environment relations that the EIS team can use to do further assessments." The longer term goal of the project is to produce an environmental impact statement addressing proposed management activities in the study area.

Study area. The EEMP study area includes the Columbia River Basin south of Canada, east of the crest of the Cascade Mountains, and west of the Continental Divide. It also includes small portions of the Klamath Basin in southern Oregon, and the Great Basin in southern Oregon and adjacent Nevada. Large portions of Idaho, Oregon, and Washington, parts of western Montana and Wyoming, northwestern Utah, and northeastern Nevada are within the study area.
Appendix A contains a map of the study area boundary.

Recognized taxa. A total of 159 *Carex* taxa (species, subspecies, and varieties) are recognized and are documented to occur within the study area (Appendix Bl; Brainerd et al. 1995).
Taxonomic synonyms are listed in Appendix B2.

Species Treated Individually and Species Groups

Criteria. Because individual treatment for each taxon occurring within the study area (159), or each taxon tracked by Natural Heritage Programs (67), would have resulted in a large number of "panel forms" and made tracking difficult, all but one taxa were grouped into habitat types (see following paragraph). Federal status was selected as the criterion for deciding which taxa, were to be treated individually. *Carex lenticularis* var. *dolia* is the only taxa which meets this criterion (federal status = C2), and is known in the study area only from Glacier National Park (Montana). This species also is included in the appropriate species group (wet meadows -subalpine to alpine) based on its habitat preferences. A panel form for this taxa is included with habitat type panel forms in Appendix D.

All other species occurring in the study area are grouped by habitat type according to individual habitat preferences. Habitat type was selected as the grouping category because habitat information for each taxon is much more complete than available information on ecological function/role, plant association, or cover type. The habitat type categories are based on general vegetative cover types, which are determined primarily by moisture and light regimes: meadow, forest, riparian, and steppe. If distinct species groups exist, the habitat types are further subdivided on gradients of moisture (wet, mesic, ephemeral, and dry) and elevation (low to moderate, and subalpine to alpine).

Taxa were assigned to habitat type groups based on extensive literature review and personal experience of the authors. Some taxa are listed in more than one group, either because they have a broad ecological tolerance, or because they occur in habitats which are transitional between two of the defined habitat types.

Habitat types and species groups. Definitions of the 17 habitat types are in Table 1. Lists of taxa ("species groups") occurring in each habitat type are in Appendix C.

Table 1. Definitions of *Carex* habitat types used for species groupings.

HABITAT TYPE	DEFINITION
1. Calcareous Peatland	Peatlands in which the presence of calcareous bedrock, till or outwash results in ground water with a circumneutral or alkaline pH. Outflow of water is restricted, resulting in standing water and/or saturated soils for much of the growing season. Calcareous peatlands are characterized by accumulation of organic debris which forms peat, usually 10 cm thick or more, and by high levels of dissolved nutrients and high species diversity. They generally occur at higher elevations and/or more northerly latitudes, and are limited in occurrence within the EEMP study area because calcareous substrates are uncommon. Like non-calcareous peatlands, these habitats are open to partially shaded. Mosses often occur in this habitat. Rich and very rich fens are included in this habitat type.
2. Non-calcareous Peatland	Like calcareous peatlands, non-calcareous peatlands are characterized by restricted outflow of water resulting in standing water and/or saturated soils for much of the growing season, and by accumulation of organic debris. Unlike calcareous peatlands, they have lower levels of dissolved nutrients, lower species diversity, and an acidic pH. Nutrient-poor snowmelt often flushes these areas in spring. This habitat type is open to partially shaded. *Sphagnum* spp. and other mosses are usually common. Intermediate and poor fens and ombotrophic, ombrogenous bogs (scarce in the study area) are included in this definition.
3. Wet Meadow low to moderate elevation	Low to moderate elevation habitats with open exposure and perennially saturated mineral soil. These meadows often occur in floodplains and riparian areas.
4. Wet Meadow subalpine to alpine	Upper mountain habitats with open exposure and anoxic to hypoxic soil conditions caused by saturation of the mineral soils (usually associated with high water tables). These meadows are often braided by small streams and rivulets formed from snowmelt.
5. Mesic meadow low to moderate elevation	Low to moderate elevation meadows characterized by mineral soils which are moderately moist well into the growing season. Mesic meadows may occur as a large, open landscape, or may be small forest openings.

HABITAT TYPE	DEFINITION
6. Mesic meadow subalpine to alpine	Subalpine to alpine meadows characterized by mineral soils which are moderately moist well into the growing season. Mesic meadows may occur within a large, open landscape, or as smaller forest openings.
7. Ephemeral Meadow low to moderate elevation	Low to moderate elevation habitats with open exposure. Ephemeral meadows are characterized by mineral soils which are saturated early in the growing season, then dry out and become parched by mid- to late in the growing season. Ephemeral meadows often occur as small catchments in valleys, flatlands, on ridgelines and in floodplains of ephemeral water courses. Soil drainage in ephemeral meadows is impeded either by a high clay content or by an underlaying impermeable layer.
8. Ephemeral meadow subalpine to alpine	Habitats of open exposure in subalpine to alpine areas. Ephemeral meadows are characterized by mineral soils which are saturated early in the growing season, then dry out and become parched by mid- to late in the growing season. Soils drainage in ephemeral meadows is impeded either by a high clay content or by an underlaying impermeable layer.
9. Dry meadow low to moderate elevation	Low to moderate elevation habitats with open exposure and xeric mineral soils. This habitat type includes pumice, ash, talus and scree. Dry meadows may occur within a large, open landscape, or may occur as forest openings.
10. Dry meadow subalpine to alpine	High elevation, subalpine to alpine habitats with open exposure and dry mineral soils. Rocky outcrops, talus and scree slopes, and alpine fell-fields are included in this habitat type.
11. Forest riparian	Habitats of partial to deep shade that border streams, rivers, and lakes. The bordering water body and forest canopy provide increased humidity and soil moisture during much of the growing season. These habitats receive high nutrient and organic inputs from the surrounding forests and occasional flood deposits.
12. Rocky streambed	Habitats that are open or partially shaded by riparian vegetation. The upper limit of the habitat is defined by the scour line of seasonal floods and ice scraping, beyond which woody vegetation easily can become established. The lower limit is the average low summer flow. The substrate is bedrock, boulders, cobbles, or gravel, as most finer material is swept away by water flows. Plants are rooted in material that is saturated most or all of the growing season.

HABITAT TYPE	DEFINITION
13. **Sagebrush steppe** wetland and riparian	Predominantly open habitats of moderate to high soil moisture for all or part of the growing season, in otherwise dry sagebrush steppe. These habitats are located along shorelines of streams and lakes, and also include areas around springs and seeps.
14. **Sagebrush steppe** dry	Arid open environments dominated by bunchgrasses and low shrubs. These harsh habitats are characterized by hot, dry summers and cold winters.
15. **Wet Forest**	Habitats shaded by a closed to partially closed forest canopy. Soils in these forests may remain saturated well into the growing season, and may be punctuated by small, sometimes ephemeral water channels. These forests may be dominated by conifers, deciduous species (e.g., *Alnus* spp.), or by a mixture of the two.
16. **Mesic Forest**	Habitats shaded by a closed to partially open forest canopy with moderate soil moisture. Mesic forests are characterized by their lack of extreme soil moisture conditions: they are neither saturated nor xeric.
17. **Dry Forest**	Forested habitats with a closed to somewhat open canopy on well-drained soils in areas receiving low levels of precipitation. Overstory is usually comprised of one or more drought tolerant coniferous species.

Panel forms and ecological information. Panel forms for each of the 17 species groups and the one individually-treated species discussed previously are contained in Appendix D. The forms include the following information:

- key environmental correlates
- key ecological functions
- threats/sensitivity to disturbance
- dispersal modes and requirements
- unknowns, monitoring and research needs
- assumptions
- comments
- population trends or habitat trends

Each form provides a concise listing of ecological information generally common to all species in a group. Loss of a certain amount of detail is inherent in the process of lumping species with slightly different habitat requirements and/or ecological functions. Significant issues that affect individual species uniquely are mentioned in the appropriate categories on the panel forms.

Structural classes. Species groups (habitat types) are listed by occurrence in structural stages in tables 2 and 3, following categories in the forest and rangeland structural stages tables provided

by EEMP staff (dated Oct. 20, 1994). Calcareous and non-calcareous peatlands and rocky streambed habitat types do not occur in any of the structural stages categories provided. Some habitat types, such as wet, mesic, ephemeral, and dry meadows are frequently scattered throughout forested ecosystems (as opposed to rangelands), but are considered as general "rangeland" categories in the tables because of their non-forested character. Because of limitations of the structural stages categories provided, the tables should be considered as generalizations.

Table 2. Occurrence of species groups in forest structural stages.

FOREST STRUCTURAL STAGE	HABITAT TYPE
Stand Initiation	Dry forest Mesic forest
Stem Exclusion: Open Canopy	Dry forest
Stem Exclusion: Closed Canopy	Mesic forest Wet forest
Understory Reinitiation	Dry forest Mesic forest Wet forest Riparian forest
Young Forest: Multi Strata	Dry forest Mesic forest Wet forest Riparian forest
Old Forest: Multi Strata	Dry forest Mesic forest
Old Forest: Single Stratum	Dry forest Mesic forest

Table 3. Occurrence of species groups in rangeland structural stages.

RANGELAND STRUCTURAL STAGE	HABITAT TYPE
Open herbland	Dry meadow, low/moderate elevation Dry meadow, subalpine/alpine elevation
Closed herbland	*Carex lenticularis* var. *dolia* Peatlands, calcareous Peatlands, non-calcareous Dry meadow, low/moderate elevation Dry meadow, subalpine/alpine elevation Mesic meadow, low/moderate elevation Mesic meadow, subalpine/alpine elevation Wet meadow, low/moderate elevation Wet meadow, subalpine/alpine elevation Ephemeral meadow, low/moderate elevation Ephemeral meadow, subalpine/alpine elevation Steppe, wetlands and riparian
Open low-medium shrub	Sage steppe
Closed low-medium shrub	-
Open tall shrub	-
Closed tall shrub, single stratum	-
Closed tall shrub, multi-strata	-

Ecology

Ecological roles and relationships for each species group are addressed on panel forms in Appendix D. The following parts of this section contain expanded narratives on selected topics of *Carex* ecology relevant to land use managers. Important references to ecology of individual *Carex* species are summarized in Table 10, and to the genus in general in Table 11.

Morphology. Sedges exhibit typical graminoid growth forms. Two types of vegetative shoots are produced, the pseudoculm and the vegetative (or true) culm (Reznicek and Catling 1986). Pseudoculms grow near the base of the plant, and are composed of overlapping leaf sheaths. Pseudoculms possess nodes and short internodes, and usually comprise a minor portion of the total aboveground biomass in species which produce them. Vegetative culms contain nodes and internodes. Pseudoculms and vegetative culms may be annual or perennial, and may produce flowering culms or remain vegetative.

Rhizome behavior determines the growth form of *Carex* species. Based on rhizome configuration, three *Carex* growth-form patterns are recognized (Bernard 1990). Species with

long-spreading rhizomes are termed "matted." Species that produce only short, clumping rhizomes are termed "tussock." The third and most common growth form, "clumped," is produced through a combination of the two. Species with the clumped growth form appear as numerous caespitose shoots alternating with apparently uncolonized areas. While rhizome categories are helpful in understanding the growth form of *Carex* species, the terminology is not standardized in taxonomic treatments.

Rhizome morphology also may serve as a surrogate for life history attributes such as patterns of shoot emergence, mortality and flowering rates (Schmid and Harper 1985, Bernard 1990). Species which can dominate communities, such as *Carex obnupta, C. nebrascensis* and C. *utriculata* often propagate vegetatively through long-spreading rhizomes to form large clones.

Sexual reproduction. The sexual reproduction of sedges has received very little research. Through hybridization experiments, Whitkus (1988) discovered that the closely related members of the difficult Macloviana group, including *Carex pachysrachya, C. macloviana* and C. *preslii* were self-compatible and frequently autogamous (self-fertilizing). Self-compatibility has been speculated for species in which the perigynia and stamens are entirely enclosed by leafy bracts, such as C. *backii* (Catling et al. 1990). Standley (1985) found that *Carex aquatilis,* which does not have this feature, was only weakly self-compatible. *Carex* species are generally believed to be wind-pollinated.

Perigynia dispersal. The only dispersal method that has been studied extensively is ant dispersal in *Carex* species with small appendages on their perigynia called elaiosomes (Beattie and Culver 1981, Kjellsson 1985a, 1985b, Wheeler and Ownbey 1984). Ants are known to carry off the perigynia of a number of upland and mesic site *Carex* species, including close relatives of *Carex hendersonii, C. concinnoides,* and C. *concinna* (Handel 1976, 1978a, 1978b).

Other forms of dispersal have been inferred from perigynium morphology. Many fruits of wetland *Carex* species appear to be adapted for dispersal by floating in water. *Carex atherodes* perigynia float (Welling et al. 1988). The corky perigynial thickenings of *Carex stipata* and C. *vulpinoidea,* and the inflated, bladdery fruits of *Carex flava* and C. *retrorsa* also facilitate dispersal by floating (Mastrogiuseppe, pers. comm.).

Some sedges that grow in alpine environments, such as *Carex haydeniana,* have relatively large, flattened or winged perigynia that could enable airborne dispersal in a windy mountain-top environment. Small perigynia may adhere to animals (Ridley 1930), and thus, waterfowl may play an important role in long-distance dispersal of *Carex* (Proctor 1968a,b).

Although *Carex* perigynia are eaten, adaptations for intentional or incidental ingestion or dispersal by animals are largely unknown. The fleshy perigynia of *Carex aurea s.* str. are bright orange, succulent, and slightly sweet -- perhaps to attract animals and facilitate dispersal.

Range extensions of some *Carex* species occur along roads and railways. In the eastern U.S., the distribution of *Carex praegracilis* has extended rapidly along freeways that have received winter salting (Brunton and Catling 1982, Reznicek and Catling 1987). The range of *Carex eleocharis* also may have extended along roads (D. Sutherland pers. comm.). Transient populations of *Carex douglasii* (Steyermark 1963) and *C. vallicola* (specimen at OSC) have appeared along railroad tracks far outside their normal ranges. And at least four Eurasian *Carex* species have been found growing near the shipyards of Portland, Oregon.

Little research supports these putative dispersal methods attributed to *Carex* perigynia.

Seed banking. Because of their germination requirements and ability to remain dormant for a prolonged period, *Carex* perigynia can become important components of seed banks, particularly in alpine areas (McGraw et al. 1991; Roach 1985). Seed banks may be important reservoirs of genetic variation as well as sources of seedlings that cover the soil after disturbance.

Carex perigynia are difficult to germinate in the lab (Johnston et al. 1965; Wiesner et al. 1967). Wetland species often germinate in response to temperature fluctuations and light, stimuli which are more commonly present in dry years (Thompson & Grime 1983; Shipley et al. 1989). Upland species display a variety of germination requirements, often including exposure to light (Amen & Bonde 1964; Haggas et al. 1987; Johnston et al. 1965).

In undisturbed populations of adult plants, researchers often find no seedlings (Table 4). Where adult plants remain, seedling establishment is poor even if seeds germinate (Racine et al. 1987). However, seedling sedges are important in revegetation, for example, following bulldozing, vehicular traffic, construction, and fires in the Arctic (Racine et al. 1987), and during drawdowns in temperate-zone marshes (Welling et al. 1988).

Table 4 lists *Carex* taxa for which seed reproduction has been observed and reported on by researchers. Where available, information has been included about disturbance and whether the observations were of seedling occurrence within an established population of adult plants.

Table 4. Observations of *Carex* seedlings.

Carex taxon	Seedlings	Observation length	Comment	Reference
aquatilis	seen	?	Prudhoe Bay, Alaska	quote in Leck 1980
atherodes	many	?	during drawdowns	Welling et al. 1988
arenaria	rare	?	only established in microsites where soil surface remains damp and other plants offer little interference	Noble 1982
bigelowii	none	1 year	established population	Callaghan 1976
bigelowii	none	4 years	established population	Carlsson & Callaghan 1991
bigelowii	none	2 years	established population	Jonsdottir 1991
bigelowii	214/sq.m/yr	?	bulldozed area	Gartner et al. 1983

Carex taxon	Seedlings	Observation length	Comment	Reference
bigelowii	130/sq.m	?	within 2 years after a fire in non-tussock tundra	Racine et al. 1987
X flavicans	none	2 years	established population	Kootanen & Jeffries 1989
gracilis	seen one year	5 years	established population	Soukupova 1988
nebrascensis	none	2 years	established population	Ratliff 1983
paysonis	none	3+ years	in planted and untreated plots on mine tailings where scattered adult plants grow	Haggas et al. 1987
rostrata	none	?	established populations	Bernard 1976
vesicaria	some every year	5 years	established population	Soukupova 1988
Carex sp.	yes		became established between *Eriophorum* tussocks after fire; probably *C. bigelowii*	Racine et al. 1987

Low genetic diversity can result from the asexual (vegetative) reproduction so common in sedges, but long-lasting seed banks can preserve genotypes not found in adult plants. Few studies have compared seed bank or seedling genetic diversity with that of adults. In one study, seedlings of four species of *Carex* section *Phacocystis* displayed greater genetic diversity than adult plants of the same populations (Standley 1990). Seedlings produced by 200-year-old buried perigynia of *Carex bigelowii* differed from those produced by modern perigynia in almost every trait measured (Vavrek et al. 1991). Thus, seed banks may be important reservoirs of genetic diversity in sedges.

Demography/shoot life history. Some researchers have attempted to approximate the life spans of *Carex* genets (genetic individuals). Genets of *Carex comosa* were estimated to live 20 years (Bernard and Fiala 1986), while *C. stricta* tussocks were estimated to be 50 years old (Costello 1936). Tussock-forming members of the *C. echinata* ssp. *echinata (muricata)* complex were believed to persist until they were shaded out (David and Kelsey 1985). The availability of data on only three of the 159 species growing within the EEMP illustrates the paucity of research.

Shoot life span has also been studied. The bulk of demographic information on *Carex* species (see tables 10 and 11) concerns shoot life history, and provides a practical understanding of the timing of shoot initiation, age of shoots before flowering, mortality rates and timing. Many species have seasonal cohorts of shoots. The fall is a period of active meristem activity in many *Carex* taxa. Both inflorescence and vegetative initials are formed during the fall. Species within the EEMP area for which this growth cycle has been shown include *Carex comosa, C. lacustris, C. rostrata,* and *C. vesicaria.*

Nutrient cycling/productivity. Much research has investigated the nutrient cycling and productivity of sedges (see Table 11). These studies have shown that nutrients and photosynthate are transferred from the rhizomes into aboveground shoots during spring growth. This cycle reaches completion in the late summer and early fall when storage products are moved from the shoots back into the rhizomes (Auclair 1982, Bernard and MacDonald 1974, Bernard and Solsky 1977, Gorham and Bernard 1975, Gorham and Somers 1973, Pearsall and Gorham 1956). While productivity may be limited by nutrient supply (Cargill and Jefferies 1984), nutrient uptake efficiency may be greater when nutrient supply is low (Bernard et al. 1988). Determining the levels and controls on primary production has not been very conclusive (Auclair et al. 1976), but dominance by a particular *Carex* species may be correlated with habitat nutrient status (Verhoeven, et al. 1988).

Aquatic ecology/hydrological tolerance. Determining limitations on growth and distribution of *Carex* species has broad implications for their use in restoration as well as understanding the limits of their fitness. The relationship between hydrologic regime and species occurrence has received some study (see Table 11). The zonation of many wetland species within an inundated habitat such as a lake margin or within a floodplain may be correlated with water level tolerance of either adult plants or seedlings (Squires and van der Valk 1992). A similar correlation probably exists with rocky streambed species as they appear only in a limited habitat area defined primarily by water level. In some other species, shoot density is affected by water level of both the current growing season (Hultgren 1988) and the previous growing season (Bernard 1975). In one study, however, extended experimental drought of seasonally flooded wetlands did not affect stem density or height (Hogenbirk and Wein 1991a).

Livestock grazing. Research on the response of specific *Carex* taxa to grazing has resulted in few definitive conclusions, however, many authors have commented on the decline of riparian vegetation with livestock overgrazing. Riparian *Carex* species suffer directly from trampling, then indirectly from changes in channel morphology and subsequent downcutting (Elzinga et al. in prep.).

Some small upland sedges are relatively resistant to trampling (Table 5), although *Carex concinnoides* and *C. pensylvanica s.* str., which survive initially, are slow to recover from severe trampling damage (Cole 1988, 1993). Species resistant to trampling generally share the following characteristics: their buds are located at or below ground level; they are short, with wiry, flexible leaves; they have thick cell walls; they have a tufted growth form; and they reproduce vegetatively (Kuss & Graefe 1985; Speight 1973). Ground cover of *Carex bigelowii* and *C. rossii* has been found to increase after moderate trampling (Bayfield 1979; Cole 1992), perhaps from the release of lateral buds resulting from damage to the terminal shoots, or from reduced competition from species more sensitive to trampling. Although the species listed in Table 5 are more resistant to trampling than most other plants in the same habitats, they all declined when trampled severely (Cole 1985, 1987, 1988, 1993). Most of these species occur in alpine meadows, which are easily damaged by trampling (Bell & Bliss 1973; Willard & Marr 1970). Many species decline under moderate or light grazing as well (Table 7).

Information in Table 5, following, is derived from Cole (1988, 1993).

Table 5. Response of selected montane *Carex* taxa to trampling.

Abbreviations:

Location: CO - Colorado, MT - Montana, NC - North Carolina, NH - Hew Hampshire, WA - Washington

h - high, m - medium, l - low

Definitions:

Resistance: Immediate response to trampling. Based on how much trampling is required to reduce cover by 50%.

Resilience: Recovery one year after cover is reduced to near zero.

Tolerance: Based on maximum number of passes tolerated with cover remaining at 75% of undisturbed cover.

Carex taxon	Location	Resistance	Resilience	Tolerance
bigelowii	NH	h	m	m
concinnoides	MT	m	l	l
geyeri	MT	h	l	m
microptera	CO	h	m	m
nigricans	WA	h	m	h
norvegica	CO	m	h	m
pensylvanica s. str.	NC	h	l	l
phaeocephala	CO	m	m	m
rossii	CO	h	-	m

Tall plants and species of wet areas are more easily damaged by trampling (Kuss & Grafe 1985). Most *Carex* species within the EEMP area are in these categories, therefore, it could be expected that even moderate trampling could have a negative effect.

Plants of certain *Carex* species released from grazing have shown increased leaf longevity, decreased leaf production and turnover rates, but have not shown changes in leaf elongation rates (Kotanen and Jefferies 1988a, 1988b). Grazing by snow geese may stimulate higher rates of nutrient cycling, higher leaf-nitrogen contents, and reduced litter accumulation (Cargill and Jefferies 1984). Productivity analysis and studies of biomass trends failed to provide insights about the impacts of grazing on *Carex nebrascensis* (Ratliff and Westfall 1988), however, this species is much more tolerant of grazing than many others (Mastrogiuseppe, pers. comm.).

Literature references to livestock preferences for various species are shown in Table 6. The comments of some authors, such as Hermann (1970), appear to be anecdotal since no data were collected to support them. The data in Table 6 are from Hermann (1970) unless otherwise noted. Hermann's undefined categories are approximated.

Table 6. Commercial grazing of *Carex*.

Column headings:
G = high palatability
F = medium to low palatability
P = very low palatability; may be "valuable" in overgrazed lands
U = unranked (merely "grazed")

Livestock abbreviations:
C = cattle; S = sheep; G = goats; H = horses; L = livestock (unspecified)

Carex taxon	Forage quality				Notes
	G	F	P	U	
albonigra		S			
angustata	CH	S			
amplifolia				CHL	
aperta				L	hay sedge: Piper & Beattie 1915
aquatilis var. aquatilis	1-CH 2-L	2-L			1-Lewis 1958; 2-Elzinga et al. in prep
atherodes				L	Reynolds et al. 1978; Hogenbirk & Wein 1991
athrostachya	CH 1-L	1-L			1-Elzinga et al. in prep
atrata var. chalciolepis		CS			
atrata var. erecta	CH	S			
bigelowii	L				
brevior		L			
canescens	1-C 2-L				1-Lewis 1958; Elzinga et al. in prep
douglasii		1-L	L		1-Elzinga et al. in prep
ebenea		CSH			
egglestonii		CH		L	Lewis 1958
eleocharis			CH	L	Lewis 1958
elynoides	SL				
filifolia	CSHL				Lewis 1958, USDA 1937
geyeri		SH	C		Lewis 1958
haydeniana				L	

Carex taxon	Forage quality				Notes
	G	F	P	U	
hoodii		CH			Lewis 1958
illota		CS			Lewis 1958
inops ssp. heliophila				L	Abrams & Dickmann 1984
idahoa	CH				
jonesii				CSH	
lenticularis var. lipocarpa			L	S	
leporinella		C		S	
luzulina var. ablata	L				
mertensii	CH			S	
microptera		CSH			winter hay: USDA 1937
misandra				S	
multicostata	CH	S			
nardina				L	
nebrascensis	2-CH	2-S	1-?	1-L	1-Ratliff 1983; Steele et al. 1984; Lewis 1958; 2-Elzinga et al. in prep winter hay: USDA 1937
neurophora				L	
nigra				L	Magnusson & Magnusson 1991
nigricans				CS	
norvegica				CHS	
nova	L				
obtusata			CS		Lewis 1958
pachystachya	L				
paysonis		CSH			Lewis 1958
pellita	L 1-C	1-SH			1-Elzinga et al. in prep
petasata	L				
phaeocephala			S		Lewis 1958

Carex taxon	Forage quality				Notes
	G	F	P	U	
praegracilis	1-CH 2-C	2-SH			1-Lewis 1958; 2-Elzinga et al. in prep
praticola		SGL			
preslii	CH				
pyrenaica	CH	S			
raynoldsii	C	SH			Lewis 1958
rossii	CH	S			Schuller & Evans 1983; Rummell 1951; Lewis 1958
rostrata	1-C	2-L			1-Ingvason 1969; 2-Elzinga et al. in prep
rupestris		L			
saxatilis var. major		L			
scirpoidea var. pseudoscirpoidea	H	CS			Lewis 1958
scopulorum var. bracteosa		L			
scopulorum var. prionophylla	C			S	
scopulorum var. scopulorum		CSG			
siccata		CH			
spectabilis				CSH	
subfusca	CH	S			Lewis 1958
subnigricans				S	
sychnocephala				L	
utriculata		L			Kinney & Clary 1994
vernacula				S	
vesicaria var. vesicaria	1-L	1-L	CSH		1-Elzinga et al. in prep
xerantica		CL			Lewis 1958
Carex spp.				S	Thorhallsdottir & Rhorsteinsson 1993

Table 7 lists formerly important or dominant species that are now scarce or rare because of grazing. Their presence may indicate lands that have not been overgrazed.

Table 7. *Carex* taxa that decline with grazing.

Carex taxon	References	Notes
filifolia var. filifolia	Hall 1972a	Prineville BLM records substantiate this literature report
hoodii	Johnson 1964, Hermann 1970	"more abundant" where ungrazed or lightly grazed
microptera	USDA 1937, Hermann 1970	
petasata	Lewis 1958, Hermann 1970	only 2-3% cover without grazing, "not resistant to heavy grazing"
raynoldsii	Hermann 1970, Lewis 1958	"no longer as plentiful in some areas," "because of livestock...suffered a considerable reduction"
subfusca	Lewis 1958	"outside the plot...completely consumed by cattle"
vallicola	Lewis 1958, Hermann 1970	"was an important constituent of the mountain grasslands & sagebrush"

Wildlife uses. As primary producers dominant in some plant communities, members of the genus *Carex* are intricately involved in providing food, cover, nests and nesting material for many animals. Table 8 lists some research papers documenting this use.

Examples of birds using *Carex* species for food are (Martin, Zim, and Nelson 1951; Fassett 1969): ducks, rails, ruffed grouse, grouse sp., swamp sparrow, tree sparrow, Lincoln's sparrow, snow bunting, larkspur [sic; probably longspur] sp., and redpoll sp. Cargil and Jeffries (1984), Ehrlich et al. (1988), Fassett (1969), Martin et al. (1951), and McAtee (1939) note a number of waterfowl species that feed on seeds and foliage, including Canada geese, brant, mallard, green-winged teal, American widgeon, northern pintail, blue-winged teal, cinnamon teal, and wood duck.

Waterfowl also use *Carex* for cover, to disguise nests, and as a base for nests (McAtee 1939; Pojar & MacKinnon 1994; Elzinga et al. in prep.). Coarse wetland sedges such as *Carex obnupta* and *C. aperta* are reported to be important for nest sites and nest cover (Guard in prep.).

Many animals besides birds make use of *Carex* (Table 8). Some small mammals use *Carex* as nesting material (Elzinga et al. in prep). Native grazers such as elk, deer and bighorn sheep consume many species of *Carex*, occasionally impacting fragile meadows and wetlands where their numbers are high. Elk have been observed digging through 2 to 3 feet of snow to reach

the evergreen foliage of *Carex geyeri* (Lewis 1958). Large species of wet meadows, such as *Carex atherodes* and *C. rostrata*, can provide over half the forage consumed by bison (Meagher 1973; Reynolds et al. 1978), and also are eaten by moose (Fassett 1969). Foliage and underground parts of large wetland sedges are important in the diet of muskrats (Hamerstrom and Blake 1939). In arctic tundra, *Carex* foliage is a major component in the diet of small mammals such as lemmings (Shaver & Billings 1975). The role of *Carex* as food for small mammals and insects is not well documented.

Table 8. Wildlife use of *Carex* as food.

Taxon	Wildlife	References
C. aenea	bison	Reynolds et al. 1978
C. aperta	waterfowl	Guard in prep.
C. aquatilis var. *aquatilis*	waterfowl bison moose lemming big game	Bart & Earnst 1991; Fassett 1969; Elzinga et al. in prep Reynolds et al. 1978 Fassett 1969 Shaver & Billings 1975 Elzinga et al. in prep.
C. aquatilis var. *dives*	waterfowl	Pojar & MacKinnon 1994; Mathews 1988
C. atherodes	bison	Meagher 1973, Reynolds et al. 1978
C. atherostachya	geese	Elzinga et al. in prep
C. bigelowii	wildlife	Jonsdotter 1991
C. comosa	ducks	Fassett 1969
C. densa	marshbirds, shorebirds, songbirds, beaver, muskrat, deer, small mammals	Guard in prep
C. filifolia	*Citellus oreganus* OR ground squirrel	USDA 1937
C. geyeri	bear elk, deer	Lackschewitz 1991 Hermann 1970; Matthews 1988; Lackschewitz 1991; Lewis 1958
C. lanuginosa	elk, deer, waterfowl	Elzinga et al. in prep
C. lasiocarpa	birds	Fassett 1969
C. lenticularis	moose	Fassett 1969
C. luzulina var. *ablata*	elk, deer	Hermann 1970

Taxon	Wildlife	References
C. macrochaeta	wildlife	Fox 1991
C. microptera	elk, deer	Elzinga et al. in prep.
C. nardina	"rock rabbits," wildlife	Hermann 1970
C. nebrascensis	elk, mule deer, small mammals, waterfowl, songbirds, muskrats, geese	Elzinga et al. in prep.
C. neurophora	deer	Hermann 1970
C. obnupta	wildlife	Guard in prep.
C. parryana var. *parryana*	deer	Hermann 1970
C. pellita	deer elk	Hermann 1970 Elzinga et al. in prep.
C. praegracilis	elk, deer, waterfowl	Elzinga et al. in prep.
C. raynoldsii	elk	Hermann 1970
C. rostrata	bison muskrats birds	Meagher 1973; Reynolds et al. 1978 Fassett 1969; Hamestrom & Blake 1939 Fassett 1969
C. scopulorum var. *bracteosa*	elk	Hermann 1970
C. spectabilis	elk	Hermann 1970
C. utriculata	elk muskrat bison birds	Hermann 1970 Turner et al. 1990; Fassett 1969 Reynolds et al. 1978 Fassett 1969; McAtee 1939
C. vesicaria	waterfowl, small mammals	Elzinga et al. in prep.

Taxon	Wildlife	References
Carex spp.	birds	Martin et al. 1951, Ehrlich et al. 1988 Cargil 1984
	snow geese	McAtee 1939
	geese, lesser scaup, mallard, green-winged teal, blue-winged teal	Larter and Gates 1991; Meagher 1973; Fuller 1966
	bison	Kotanen and Jefferies 1989a,b
	wildlife	

Fire. Very little literature is available on the effects of fire on *Carex* species. Those species with a rhizomatous growth habit would be categorized as a "least susceptible fire life form" following classifications developed by Stickney (1991). In general, Stickney relates better fire resistance to growing points deeper in the soil, and better colonization after a fire to plants with small, light, wind-dispersed seeds. Although no species of *Carex* was rated by Stickney, both of these post-fire survival advantages would probably apply to most *Carex* species inhabiting uplands in the EEMP area.

Only a few references address particular species occurring within the study area. Stem density and height of *Carex atherodes* decreases with experimental burning (Hogenbirk and Wein 1991). The vegetative cover of established *Carex inops* was reduced by fire (Abrams and Dickman 1984), while *Carex rossii* seedlings were conspicuous following wildfires in the northern Rocky Mountains (Stickney pers. comm.) For at least two seasons after the 1988 Yellowstone fires, there were no *Carex* plants (seedlings or adult) in large areas where burning was intense (Mastrogiuseppe, pers. comm.). *Carex filifolia* yield, depending on the season of the burn, may be unaffected by fires set for management purposes (White and Currie 1983; Whisenant and Uresk 1990). *Carex geyeri*, *C. inops*, and *C. rossii* are all relatively fire tolerant (Patterson et al. 1985).

Our observations suggest that a few upland species, such as *Carex whitneyi* and *C. californica*, thrive in forest gaps, including burned areas. But it is not clear if they colonize these sites before or after fires.

Sedges in wetlands may be able to survive burns more easily than some upland species (Elzinga et al. in prep). Peatland species are probably more susceptible to fire because peatlands can dry out and burn for indefinite periods of time below ground level, raising soil temperatures to fatal levels. Many rare, relict or disjunct species of *Carex* are found in peatlands, where the small populations would not be easily replaced by normal seed dispersal.

Restoration/revegetation. Because of the recent recognition of wetland values, interest in using *Carex* species for wetland restoration and revegetation has increased in the United States. While the academic literature on this topic still is very sparse, the work of private sector and government agencies is increasing. Documentation of much of this work, unfortunately, remains difficult to find.

Outside of the EEMP boundaries, the USFS and US Army Corps of Engineers (COE) have been conducting riparian and wetland revegetation trials using *Carex* since 1971. Broadcast seeding of *Carex obnupta* has failed completely (Skeesiks 1978), while the success of *C. aperta* has been limited (Skeesiks 1978, Jim Caperso pers. comm.) Survival of vegetative plantings of *Carex aperta, C. lenticularis* and C. *obnupta* has been variable. Survival of *Carex aperta* at Blue River Reservoir (Oregon) inspired researchers to label this plant "an unqualified success" (Skeesiks 1989). Its establishment elsewhere has been less exemplary (Comes and McCreary 1986, Kuykendall 1994). The performance of *Carex obnupta* has been adequate for some applications (Comes and McCreary 1986, Skeesiks 1991), and disappointing in others (Kuykendall 1994). *Carex lenticularis* survived poorly in some applications (Skeesiks 1991), and better in others (Kuykendall 1994). Complete failure of hundreds of *Carex* transplants was witnessed in Lincoln County, WA (Mastrogiuseppe, pers. comm.).

Our observations suggest that some species help to control erosion along streams. Roots of *Carex nudata* and C. *interrupta* form a network anchoring cobbles and other substrate in fastmoving streams. Soil that accumulates in tufts of *C. nudata* can eventually provide habitat for the establishment of other vascular plants. Rhizomatous wetland species such as C. *nebrascensis* and other members of section *Acutae, C. rostrata, C. utriculata,* and *C. vesicaria* often form a fringe at the edge of lakes and streams and in wet meadows. Depending on the nature of the substrate and the speed of moving water, these species often appear to anchor soil.

Upland sedges, also, contribute to reduction of soil erosion. Because they generally form dense clumps or rhizomatous mats, they have intrinsic -soil-binding capabilities (Ratliff 1983; Shaver & Billings 1975, Shaver et al. 1979). Little research has been conducted using upland sedges for erosion control. This may be related to difficulties of propagating *Carex* because of their lower production (compared to grasses), and sometimes specialized germination requirements. The rhizomatous growth form of *Carex inops* can prevent soil erosion where it forms thick stands, but it often grows sparsely. *Carex rossii* binds tenaciously to loose soil, and can colonize barren sites susceptible to erosion. *Carex hoodii is* a good soil binder and (like many species of *Carex)* lays down a layer of dead leaves which cover soil above the root zone, protecting against surface erosion (Lewis 1958).

Some sedges are tolerant of environmental stresses (Thompson & Grime 1983), and are important soil binders in habitats where other species cannot become established. For example, *Carex paysonis is* often the only vascular plant to invade and grow on acidic mine tailings at high altitudes in Montana (Haggas et al. 1987). After mats up to 3 m in diameter are established, other vascular plants are able to colonize the mats. *Carex paysonis* shows promise for commercial use in reclaiming tailings and industrial sites, once artificial seedings can be accomplished reliably (Haggas et al. 1987).

Wetland indicator assignments. Many sedges are faithful to wet habitats, and may be indicators of near-surface hydrology, e.g. *C. nebrascensis* (Allen-Diaz 1991). Reed (1988, 1993) assigns wetland indicator categories to most *Carex* species occurring in US Fish and Wildlife Service (USFWS) Region 9, which includes all of the study area except the portions in Nevada and Utah. Table 9 contains definitions of categories and the assigned category for most species found in wetlands in the study area. Although the assigned categories are useful in determining general tolerance/preference of wet conditions, they should not be used as precise measurements because: 1) neither the taxa in the "upland" category nor unrecognized taxa are included on the list, and therefore, it is not possible to tell if a taxon not on the list is an upland species or not;

and 2) indicator assignments are based on frequency of occurrence in wetlands, not hydrological tolerance (i.e., tolerance/ preference of wet versus dry habitats). Because of this second factor, a bias towards drier ratings probably occurs, because wetlands occupy a much smaller land area than upland areas.

Nomenclature in Table 9 has been updated to be consistent with this report (Appendix B).

Table 9. USFWS Region 9 wetland indicator assigmments for *Carex* species in the EEMP area (based on Reed 1988, 1993).

Key to indicator categories:

OBL (Obligate). Occurs almost always (estimated >99%) under natural conditions in wetlands.
FACW (Facultative Wetland). Usually occurs in wetlands (est. 67-99%), but occasionally found in non-wetlands (uplands).
FAC (Facultative). Equally likely to occur in wetlands or uplands (est. 34-66%).
FACU (Facultative Upland). Usually occurs in uplands (est. 67-99%), but occasionally found in wetlands (est. 1-33%).
UPL (Upland). Occurs in wetlands in another region, but occurs almost always (est. >99%) under natural conditions in uplands in Region 9.
NI No indicator status assigned in Region 9.
+ Indicates transitional towards wetter end of category.
- Indicates transitional towards drier end of category.
? Indicator category of UPL, or taxon not recognized in Reed (1988, 1994).

TAXON	CATEGORY		
aboriginum	OBL	brainerdii	?
abrupta	?	brevicaulis	?
aenea	FACW	brevior	OBL
albonigra	FAC	breweri var. breweri	?
amplifolia	FACW+	breweri var. paddoensis	?
angustata	?	brunnescens	OBL
aperta	FACW	buxbaumii	OBL
aquatilis var. aquatilis	OBL	californica	OBL
aquatilis var. dives	OBL	canescens	FACW+
arapahoensis	?	capillaris	FACW
arcta	OBL	capitata	FAC
atherodes	OBL	chordorrhiza	NI
athrostachya	FACW	comosa	OBL
atrata var. atrosquama	NI	concinna	FAC
atrata var. chalciolepis	?	concinnoides	?
atrata var. erecta	FAC	conjuncta	?
aurea	FACW+	crawei	FACW
backii	?	crawfordii	FAC
bebbii	OBL	cusickii	OBL
bigelowii	FAC	densa	OBL
bipartita	OBL	deweyana ssp. leptopoda	FACU

diandra	OBL
dioica var. gynocrates	OBL
disperma	FACW
douglasli	FAC-
ebenea	?
eburnea	?
echinata ssp. echinata	NI
egglestonli	?
eleocharis	9
elynoides	?
feta	FACW
filifolia var. erostrata	?
filifolia var. filifolia	?
flava	OBL
fracta	?
geyeri	?
halliana	?
haydeniana	FAC-
hendersonii	FAC
hoodii	FAC
hystericina	OBL
idahoa	FACW
illota	FAC
incurviformis var. danaensis	?
incurviformis var. incurviformis	?
inops ssp. heliophila	?
inops ssp. inops	?
integra	?
interior	FACW-
interrupta	OBL
jonesii	FACW+
lacustris	?
laeviculmis	FACW
lasiocarpa var. americana	OBL
lenticularis var. dolia	FACW+
lenticularis var. impressa	?
lenticularis var. lenticularis	?
lenticularis var. lipocarpa	FACW+
leporinella	FAC
leptalea	OBL
limosa	OBL
livida	OBL
luzulaifolia	?
luzulina var. ablata	?
luzulina var. atropurpurea	?
luzulina var. luzulina	FACW
macloviana	NI
mertensii	FAC
microptera	FAC
misandra	FACU
multicaulis	?
multicostata	?
nardina	FACU
nebrascensis	OBL
nervina	FACW
neurophora	FACW
nigricans	FACW
norvegica ssp. norvegica	FACW
nova	FAC
nudata	FACW
obnupta	OBL
obtusata	?
occidentalis	?
ovalis	FACW
pachystachya	FAC
parryana var. parryana	FAC+
pauciflora	?
paupercula	OBL
paysonis	FACU
pellita	?
petasata,	?
phaeocephala	FACU
praeceptorum	FACW+
praegracilis	FACW
praticola	FACW
preslii	FACU
proposita	?
pyrenaica	FAC
raynoldsii	FACU
retrorsa	FAC
rossii	?
rostrata	OBL
rupestris	FACU
sartwellii var. sartwellii	OBL
saxatilis var. major	FACW+
scirpoidea. var. pseudoscirpoidea	FAC
scirpoidea var. scirpoidea	FAC
scoparia	FACW
scopulorum var. bracteosa	FACW
scopulorum var. prionophylla	FACW
scopulorum var. scopulorum	?
sheldonii	OBL
siccata	NI
simulata	OBL
spectabilis	FACW
stenoptila	?
stipata var. stipata	?
straminiformis	?
subfusca	FACU
subnigricans	FAC

sychnocephala	FACW
tenera	FACW
tenuiflora	?
tincta	?
torreyi	FAC
tribuloides	FACW
tumulicola	FACU
unilateralis	FACW
utriculata	?
vallicola	?
vemacula	FAC +
vesicaria var. major	?
vesicaria var. vesicaria	?
viridula	FACW+
vulpinoidea	OBL
whitneyi	?
xerantica	?

Special Habitats

Special habitats in the study area which are utilized by *Carex* species are peatlands (calcareous and non-calcareous) and high elevation meadows-(wet, mesic, ephemeral, and dry).

Peatlands. Peatlands are wetlands which share the following characteristics:

1) are limited in occurrence (acreage) within the study area;
2) have peculiar pH, soils, and hydrology (see Windell et al. 1986);
3) have unusual vegetation communities and disjunct and/or rare flora and fauna; and
4) function as carbon sinks.

Peatlands provide habitat for a number of rare species of *Carex* in the study area. Examples include *Carex buxbaumii, C. livida, C. chordorrhiza,* and *C. flava* (which also may occur in other calcareous habitats). Depending on the nature of the groundwater, the flow of nutrients into and out of the peatland, and the slope, peatlands are graded into ombotrophic bogs, minerotrophic bogs, fens, mires, raised bogs, forested bogs, patterned peatlands, etc. The international literature contains many precise and sometimes complicated or unclear definitions. Botanists recently investigated peatland resources in Idaho (Moseley et al. 1994; Bursik 1993; Caicco 1988) and Montana (Chadde and Shelly 1994; Lesica 1990), and their work should be consulted for highly detailed accounts of individual peatlands. Peatlands and their biota, in particular, are at long-term risk from climate change because they are disjunct, cold wet habitats (see Gorham, 1994; Moore 1994; Wieder & Yavitt 1994).

Protection issues for peatlands include:

1) Prevention of direct ground disturbance by logging, grazing and road-building.
2) Preservation of the hydrology of the (usually small) watershed above the peatland.
3) Minimize publicity and visitor use of peatlands, as they are susceptible to trampling and degradation.

4) Inventory for rare species and unusual community types.
5) Connection to natural corridors of vegetation and animal movement.

High elevation meadows. The other special habitat that faces long-term risks is high elevation meadows (subalpine to alpine), which are rich in unusual *Carex* species. These areas have many similar characteristics of peatlands (except unusual pH), and also are threatened by climate change and human impacts -- particularly mining, grazing, and recreation (especially unofficial hiking trails).

Issues for Analysis

Impacts of management activities. Impacts of grazing by livestock and managed big game species, timber harvest (including salvage thinning) and other management activities need continued and expanded analysis especially regarding rare or potentially rare *Carex* species. Dam building, water diversions (for agriculture, mining, etc.), ground water extraction (for recreational/residential development, etc.), and logging and grazing in riparian areas can greatly affect the diversity and fitness of *Carex* in wetlands and riparian areas.

To help insure the continued existence of the many rare *Carex* species found in jurisdictional wetlands such as wet meadows and forest springs, all management activities in wetlands should be evaluated for compliance with the Clean Water Act.

The use of prescribed fire to restore and maintain native communities should be addressed in management planning.

Recreational planning needs to include adequate consideration of biological impacts and all associated long-term costs. Comprehensive planning can help avoid problems such as those occurring in Glacier National Park, where one population of *Carex lenticularis* var. *dolia* (C2 candidate) was declining rapidly in the 1960s in heavily visited Logan Pass (Hermann 1970), and another population was bisected by an unauthorized hiking trail (MNHP files).

Impacts of non-native plants and animals. Impacts of invasive weeds, as well as non-native species introduced for short-term revegetation goals, should be evaluated for their potential effects on *Carex* species and communities. In addition to impacts from grazing by domestic animals (discussed previously in this report), impacts of feral horses and asses should be considered in Basin and Range territory where they may have access to RNAs and other sensitive areas.

Common species. To insure that common species do not become rare, analysis and use of techniques for avoiding potential negative effects of individual and cumulative management activities should be undertaken.

Research Needs

Bioindicators or measures of biodiversity. Representative species which indicate a rich *Carex* diversity or overall biodiversity have not been identified and should be a topic of future research. It may not be possible to determine indicator species except on a very local basis, however, given the great diversity of species, geology, land use history, and habitats. The presence of one or two rare species might be used as a proxy, but the presence of several rare

species of different genera probably would be a better indicator of biologically diverse areas.

Many *Carex* species are hydrophytic (see Table 9), and can be used as indicators of the presence of a water table at or near the surface. For example, *Carex echinata* ssp. *echinata* (*angustior*) grows where the water table is always within 55 cm of the surface (Allen-Diaz 1991).

Carex flava, which in our region only grows in calcareous peatlands, could be used as an indicator of that habitat type and substrate. Because *Carex nudata* grows only in streambeds, its presence on an inventory list would be an indicator of that habitat type.

Biology and ecology. Research into Carex life history is greatly needed. Our literature search found mention of less than 30 of the 159 species that occur within the EEMP (see Table 10). Basic knowledge of each species and its ecology is essential for successful management. Recent developments in transition matrix models have improved population-trend monitoring (Caswell 1989, Ferson 1991, and Menges 1986). These enhanced analysis methods allow better comparative evaluation of management techniques. Life history attributes, such as the timing of shoot initiation, age of shoots before flowering, and rates and timing of mortality can provide practical information upon which management decisions can be based. For example, the growth and flowering of some *Carex* species may be impeded if growth initials are grazed off during the previous fall. And if we understand how sympatric *Carex* species partition resources through the timing of shoot initiation (Soukupova 1988), we may be better able to assemble species lists for revegetation of degraded habitats.

Little research has-been conducted with species of *Carex* that grow exclusively in wet forest or riparian habitat types. Much of the available research on *Carex* has been conducted in northern Europe where large wetlands are an important feature of the landscape. These studies tend to be academic in nature but may be useful in natural resource planning and management within the EEMP area. Most of this literature focuses on productivity rates, biomass accumulation, and nutrient cycling.

Some research has been conducted addressing habitats in which *Carex* species grow, such as lake margins (see Aquatic ecology\hydrologic tolerance in Table 11), Unfortunately, the presence of sedges has been merely incidental to this research. As a result, we found very little information on response to environmental conditions of particular *Carex* species which might be useful in making management decisions.

Biological reserves. To provide areas for baseline data collection and other studies, additional public lands need to be identified and permanently protected from resource extraction and management activities. The present RNA system is inadequate in representing meadow communities with diverse *Carex* assemblages, and existing wilderness areas are often disturbed by livestock grazing (including recreational pack strings). Areas that should be protected wherever possible to meet this need include: nomenclatural type localities; areas containing undisturbed populations of both rare and common species; and headwater wetlands at all elevations.

Restoration potential. The recent interest in habitat restoration and creation may stimulate more *Carex* research. Currently, however, little information is available on the use of *Carex* for restoration purposes (see Restoration in Ecology section). Because much of the research has

occurred without formal study in federal and state agencies and the private sector rather than an academic setting, adequate documentation and access is sometimes a problem. It was not possible to obtain for review much of this information.

Biogeography. Management of *Carex* would be greatly facilitated by research that documents the environmental correlates and other factors which determine ecological limits and range of occurrence. Studies that examine factors which limit or promote occurrence of particular species and assemblages within individual habitats and across a landscape would greatly facilitate their management.

Literature Review

Introduction. The literature review for this report consists of three parts:

1) an introduction;
2) references to ecology of *Carex* species by topic (Table 10), and generic references to *Carex* ecology by topic (Table 11); and
3) a comprehensive bibliography (following section) applicable to this report and the companion report by Brainerd et al. 1995.

References. The following tables list references addressing ecology of *Carex* species by topic (Table 10), and generic references to *Carex* ecology by topic (Table 11).

Table 10. References to ecology of Carex species by topic.

1. REPRODUCTION/GENETICS

Carex species	Reference
albonigra	Amen and Bonde 1964; Andersen 1968
aquatilis	Johnson, Blankenship, and Brown 1965
bigelowii	Heide 1992; Johnson, Blankenship, Brown 1965; McGraw, Vaavrek, and Bennington 1991; Vavrek, McGraw, and Bennington 1991
ebenea	Amen and Bonde 1964; Anderson 1968
eburnea	Hogenbirk and Wein 1992
lasiocarpa	McClintock and Waterway 1993; McClintock 1994
pellita	McClintock and Waterway 1993; McClintock 1994
rostrata	Wiesner, Carleton, and Bailey 1967
scoparia	Johnson, Blankenship, and Brown 1965; Larson 1990
scopulorum	Johnson, Blankenship, and Brown 1965
stipata	Johnson, Blankenship, and Brown 1965

2. LIFE HISTORY/SHOOT DYNAMICS

Carex species	Reference
aquatilis	Bernard and Macdonald 1974
bigelowii	Jonsdotter 1991
capillaris	Jonasson and Callaghan 1992
diandra	Konings, Verhoeven, and Degroot 1992
eleocharis	Hazlett 1992
lacustris	Bernard and Macdonald 1974
paupercula	Nicholson and Vitt 1990
nebrascensis	Ratliff 1983
rostrata	Konings, Verhoeven, and Degroot 1992

3. PRODUCTIVITY

Carex species	Reference
aquatilis	Bernard and Macdonald 1974; Gorham and Somers 1973
atherodes	Bernard, Solander, and Kvet 1988
diandra	Aerts, De-caluwe, and Konings 1992
lacustris	Bernard and Macdonald 1974; Bernard, Solander, and Kvet 1988; Gorham and Bernard 1975
lasiocarpa	Aerts, De-caluwe, and Konings 1992; Bernard, Solander and Kvet 1988; Gorham and Bernard 1975; Sjors 1991
lenticularis	Elzinga et al. in prep
limosa	Sjors 1991
nebrascensis	Ratliff and Westfall. 1988
rostrata	Aerts, De-caluwe, and Konings, 1992; Bernard, Solander and Kvet 1988; Gorham and Bernard 1975; Gorham and Somers 1973
trichocarpa	Bernard, Solander, and Kvet 1988
vesicaria	Bernard, Solander, and Kvet 1988; Elzinga et al. in prep

4. NUTRIENT CYCLING

Carex species	Reference
Aquatilis	Auclair 1982; Auclair, Bouchard and Pajaczkowski 1976
Diandra	Aerts, De-caluwe and Konings 1992; Verhoeven and Arts 1992
Disperma	Ohlson and Hogbom 1993
lasiocarpa	Aerts, De-caluwe and Konings 1992
lacustris	Auclair 1982; Auclair, Bouchard and Pajaczkowski 1976; Bemard and Solsky 1977
rostrata	Aerts, De-caluwe, and Konings 1992; Auclair 1982; Auclair, Bouchard, and Pajaczkowski 1976

5. FIRE/DROUGHT

Carex species	Reference
aquatilis	Elzinga et al. in prep
atherodes	Hogenbirk and Wein 1991
inops	Abrams and Dickmarin 1984

6. DISTRIBUTION WITHIN A HABITAT/HABITAT REQUIREMENTS

Carex species	Reference
angustata	Allen-Diaz 1991
atherodes	Welling, Pederson, and van der Valk 1988; van der Valk 1994
canescens	Milette, Fontaine, and Grandtner 1992
echinata	Hayati and Proctor 1991
geyeri	Riegel, Miller, and Krueger 1992

inops	Crins and Ball 1983
lyngbyei	Pidwirny 1990
nebrascensis	Allen-Diaz 1991
rostrata	Milette, Fontaine, and Grandtner 1992
spectabilis	Evans and Fonda 1990

7. PATHOGENS

Carex species	Reference
canescens	Ericson, Burdon, and Wennstrom 1993
rostrata	Dencev 1993

8. SOIL BINDER/WATER QUALITY/ FISHERIES

Carex species	Reference
aquatilis	Shaver, Chapin, and Billings 1979; Elzinga et al. in prep
douglasii	Elzinga et al. in prep
geyeri	Hermann 1970
hoodii	Hermann 1970
lacustris	Bernard 1975, 1990; Bernard & Fiala 1986a,b
lanuginosa	Elzinga et al. in prep
nebrascensis	Ratliff 1983
paysonis	Hermann 1970
praegracilis	Elzinga et al. in prep
rostrata	Elzinga et al. in prep
simulata	Elzinga et al. in prep
vesicaria	Elzinga et al. in prep

9. WILDLIFE VALUES/GRAZING

Carex species	Reference
atherodes	Reynolds, Hansen, and Peden 1978; Hogenbirk and Wein 1991
bigelowii	Jonsdotter 1991
inops	Abrams and Dickmann 1984
nebrascensis	Ratliff 1983; Elzinga et al. in prep
nigra	Magnusson and Magnusson 1991

10. REVEGETATION/RESTORATION

Carex species	Reference
lenticularis	Elzinga et al. in prep
microptera	Elzinga et al. in prep
nebrascensis	Elzinga et al. in prep
preagracilis	Elzinga et al. in prep
rostrata	Elzinga et al. in prep

simulata	Elzinga et al. in prep
vesicaria	Elzinga et al. in prep

Table 11. Generic references to Carex ecology by topic.

1. REPRODUCTION

Amen and Bonde 1964
Andersen 1968
Elzinga et al. in prep.
Evans and Etherington 1991
Gerritsen and Greening 1989
Gray and Bolen 1987
Heide 1992
Hogenbirk 1992
Hogenbirk and Wein 1992
Johnson, Blakenship, and Brown 1965
Keddy and Constabel 1986
Keddy and Ellis 1985
Kjellsson 1991
Larson 1990
McClintock and Waterway 1993
McClintock 1994
McGraw, Vavrek, and Bennington 1991
Ratliff and Westfall 1992
Shipley and Parent 1991
Standley and Dudley 1991
Thompson and Grime 1983
van der Valk 1981
Vavrek, McGraw, and Bennington 1991
Welling, Pederson, and van der Valk 1988
Whitkus 1988, 1991, 1992
Wiesner, Carleton, and Bailey 1967

2. DEMOGRAPHY/SHOOT LIFE HISTORY

Bartlett and Noble 1985
Bernard 1975, 1976, 1990
Bernard and Fiala 1986
Bernard and Macdonald 1974
Bernard and Soukupova 1988
Carlsson and Callaghan 1991
Catling Reznicek, and Crins 1990
Elzinga et al. in prep.
Fagerstedt 1992
Hazlett 1992
Hultgren 1988
Jonsdotter 1991
Kotanen and Jefferies 1989
Noble, Bell, and Harper 1979

Ratliff 1983
Shaver and Billings 1975
Soukupova 1988
Verhoeven, Schmitz, and Pons 1988.

3. AQUATIC ECOLOGY/HYDRO LOGIC TOLERANCE

Allen-Diaz, 1991
Bedford, Bouldin, and Beliveau 1991
Charman. 1993
Crawford 1991, 1993
Day, West, and Tupacz 1988
Detenbeck, Johnston, and Niemi 1993
Elzinga et at. in prep.
Gerritsen and Greening 1989
Hejny and Hroudova 1987
Henszey, Skinner, and Wesche 1991
Hultgren 1988
Santelmann 1991
Shipley, Keddy, and Lefkovitch 1991
Squires and van der Valk 1992
van der Valk 1994
van der Valk, Squires, and Welling 1992
Welling, Pederson, and van der Valk 1988
Wilson and Keddy 1985, 1986

4. NUTRIENT CYCLING/PRODUCTIVITY

Aerts, De-caluse, and Konings 1992
Auclair 1982
Auclair, Bouchard, and Pajaczkowski 1976
Bernard and Macdonald 1974
Bernard, Solander, and Kvet 1988
Bernard and Solsky 1973, 1977
Cargill and Jefferies 1984
Elzinga et al. in prep.
Gerritsen and Greening 1989
Gorham and Bernard 1975
Gorham and Somers 1973
Hayati and Proctor 1991
Helm, McKendrick, and Collins 1987
Konings, Verhoven, and DeGroot 1992
Ohlson and Hogbom 1993
Pearsall and Gorham 1956
Ratliff and Westfall 1988
Riegel, Miller, and Krueger 1992
Schalles and Shure 1989
Sjors 1991
Verhoeven and Arts 1992

5. ALPINE/ARCTIC

Cargill and Jefferies 1984
Carlsson and Callaghan 1991
Crawford and Abbott 1994
Crawford, Chapman, Abbot, and Balfour 1993
Day, Keddy, and McNeill 1988
Evans and Fonda 1990
Evans and Fonda 1990
Fox 1991
Jonasson and Callaghan 1992
Jonasson and Callaghan 1992
Kotanen and Jefferies 1989

6. PEATLANDS

Chadde and Shelly 1994
Cooper 1991
Elzinga et al. in prep.
Hayati and Proctor 1991
Konings, Verhoeven, and DeGroot 1992
Milette, Fontaine, and Grandtner 1992
Neuhausl 1992
Nicholson and Vitt 1990
Santelmann 1991
Sjors 1991
Veikko, Perittinen, and Sarkka 1992
Verhoeven and Arts 1992
Windell et al. 1986

7. RIPARIAN/FORESTED WETLANDS

Day, Keddy, and MacNeill 1988
Ehrenfeld and Schneider 1993
Elzinga et al. in prep
Jean and Bouchard 1993
Windell et al. 1986

8. REVEGETATION

Marrs and Lowday 1992
Ratliff and Westfall 1992

9. CLIMATE CHANGE

Crawford and Abbott 1994
Crawford, Chapman, Abbott, and Balfour 1993
Hogenbirk and Wein 1992
Grabherr, Gottfried, and Paull 1993

10. PATHOGENS

Dencev 1993
Ericson, Burdon, and Wennstrom 1993

11. FIRE AND DROUGHT

Abrams and Dickmann 1984
Elzinga et al. in prep.
Hogenbirk and Wein 1991
Stickney 1991

12. WILDLIFE/GRAZING

Abrams and Dickmann 1984
Bart and Earnst 1991
Cargill and Jefferies 1984
Elzinga et al. in prep.
Fox 1991
Gibbs 1993
Gray and Bolen 1987
Hogenbirk and Wein 1991
Jonsdotter 1991
Kotanen and Jeffries 1989
Larter and Gates 1991
Martin, Zim, and Nelson 1951
Ratliff 1983 Reynolds, Hansen, and
Peden 1978

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- Wyoming Natural Diversity Database

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*Reviewer

Appendices


Counties in Columbia Basin Assessment
Bureau of Land Management
National Forests
National Park Service
Tribal Lands
National Wildlife Refuges
Columbia Basin Assessment Boundary
State Boundaries
OKANOGAN
PERRY
PEND OREILLE
BOUNDARY
LINCOLN
FLATHEAD
STEVENS
BONNER
CHELAN
DOUGLAS
LINCOLN
SPOKANE
KOOTENAI
SANDERS
LAKE
KITTITAS
GRANT
ADAMS
WHITMAN
BENEWAH
SHOSHONE
MINERAL
MISSOULA
LEWIS
YAKIMA
FRANKLIN
GARFIELD
LATAH
CLEARWATER
GRANITE
POWELL
SKAMANIA
BENTON
COLUMBIA
NEZ PERCE
KLICKITAT
WALLA WALLA
ASOTIN
LEWIS
RAVALLI
IDAHO
UMATILLA
WALLOWA
SHERMAN
MORROW
GILLIAM
UNION
WASCO
LEMHI
ADAMS
JEFFERSON
WHEELER
GRANT
BAKER
VALLEY
WASHINGTON
CLARK
CROOK
CUSTER
FREMONT
PAYETTE
BOISE
JEFFERSON
TETON
DESCHUTES
GEM
MADISON
CANYON
BUTTE
BONNEVILLE
ADA
ELMORE
CAMAS
BLAINE
BINGHAM
HARNEY
MALHEUR
OCCIDENTAL
LINCOLN
CARIBOU
LAKE
JEROME
POWER
JACKSON
KLAMATH
MINIDOKA
OWYHEE
TWIN FALLS
CASSIA
ONEIDA
HUMBOLDT
ELKO
BOX ELDER

Appendix BI. Recognized Carex taxa within the EEMP study area.

* = tracked by Natural Heritage Program in at least one state

Carex (159 taxa)

aboriginum
abrupta
aenea *
albonigra
amplifolia
angustata
aperta
aquatilis var. aquatilis
aquatilis var. dives
arapahoensis
arcta
atherodes
athrostachya
atrata var. atrosquarna
atrata var. chalciolepis
atrata var. erecta
aurea
backii
bebbii
bigelowii
bipartita
brainerdii
brevicaulis
brevior
breweri var. breweri
breweri var. paddoensis
brunnescens
buxbaumii *
californica *
canescens
capillaris
capitata
chordorrhiza
comosa *
concinna
concinnoides
conjuncta*
crawei *
crawfordii
cusickii
densa *
deweyana ssp. leptopoda
diandra
dioica var. gynocrates
disperma
douglasii
ebenea
eburnea
echinata ssp. echinata
egglestonii
eleocharis
elynoides
feta
filifolia var. erostrata
filifolia var. filifolia
flava
fracta
geyeri
halliana
haydeniana
hendersonii
hoodii
hystericina
idahoa
illota
incurviformis var. danaensis
incurviformis var. incurviformis
inops ssp. heliophila
inops ssp. inops
integra
interior
interrupta
jonesii
lacustris
laeviculmis
lasiocarpa var. americana
lenticularis var. dolia *
lenticularis var. impressa
lenticularis var. lenticularis
lenticularis var. lipocarpa
leporinella
leptalea
limosa
livida
luzulaifolia
luzulina var. ablata
luzulina var. atropurpurea
luzu1ina var. luzulina
macloviana
mertensii
microptera
misandra

multicaulis
multicostata
nardina
nebrascensis
nervina
neurophora
nigricans
norvegica ssp. norvegica
nova
nudata
obnupta
obtusata
occidentalis
ovalis
pachystachya
parryana var. parryana
pauciflora
paupercula
paysonis
pellita
petasata
phaeocephala
praeceptorum
praegracilis
praticola
preslii
proposita
pyrenaica
raynoldsii
retrorsa
rossii
rostrata
rupestris
sartwellii var. sartwellii
saxatilis var. major *
scirpoidea var. pseudoscirpo idea
scirpoidea var. scirpoidea
scoparia *
scopulorum var. bracteosa
scopulorurn var. prionophylla
scopulorum var. scopulorum
sheldonii
siccata
simulata
spectabilis
stenoptila
stipata var. stipata
straminiformis *
subfusca
subnigricans
sychnocephala *
tenera
tenuiflora
tincta
torrevi
tribuloides
tumulicola
unilateralis
utriculata
vallicola
vernacula
vesicaria var. major
vesicaria var. vesicaria
viridula
vulpinoidea
whitneyi
xerantica

Note: Authors of the species are readily available in standard references such as Hickman (1993), Gleason and Cronquist (1991) and Kartesz (1994a,b).

Appendix B2. Synonymy for Carex taxa within the EEMP study area.

Authors of the species are readily available in standard references such as Hickman (1993), Gleason and Cronquist (1991) and Kartesz (1994a,b).

NOTE: format of synonymy is: (synonym accepted name for this report)

Carex

ablata = luzulina var.
aboriginum
abrupta
aenea
albo-nigra = albonigra
albonigra
amplifolia
angustata
angustior = echinata ssp. echinata
aperta
apoda = atrata var. atrosquama
aquatilis var. aquatilis
aquatilis var. dives
arapahoensis
arcta
atherodes
athrostachya
atrata var. atrosquarna
atrata var. chalciolepis
atrata var. erecta
atratiformis (sensu Davis)? atrata
atrosquama = atrata var. atrosquarna
aurea
backii*
backii var. subrostrata =.backii
bebbii
bigelowii
bipartita
bolanderi = deweyana ssp. leptopoda
bonanzensis
brainerdii
brevicaulis
breviligulata
brevior
brevipes = rossii
breweri var. breweri
breweri var. paddoensis
brunnescens
buxbaumii
californica
campylocarpa = scopulorum var. bracteosa
canescens
canescens var. disjuncta = canescens
capillaris
ablata capitata
cephalantha = echinata ssp. echinata
chimaphila = scopulorurn var. scopulorum
chordorrhiza
comosa
concinna
concinnoides
conjuncta
constancearia = petasata
crawei
crawfordii
cusickii
deflexa (sensu Davis) = rossii
densa
deweyana ssp. leptopoda (all deweyana vars.)
diandra
dioica var. gynocrates (all dioica)
disperma
douglasii
drummondiana = rupestris
durifolia = backii
duriuscula = eleocharis
eastwoodiana = phaeocephala
ebenea
eburnea
echinata ssp. echinata
egglestonii
eleocharis
eleusinoides (of Hitchcock & Cronquist)
praeceptorum lenticularis var. dolia
elynoides
emoryi (sensu Davis) = ? section acutae
densa engelmannii = breweri var. paddoensis
epapillosa = atrata var. erecta
eurycarpa = angustata
exserta = filifolia var. erostrata
exsiccata = vesicaria var. major
festivella = microptera
feta
filifolia var. erostrata
filifolia var. filifolia
fissuricola = luzulina var. luzulina
flava
foenea = siccata

foetida var. vernacula = vernacula
fracta
garberi = aurea
geyeri
gymnoclada = scopulorum var. bracteosa
gynocrates = dioica var. gynocrates
halliana
hallii parryana
hassei aurea
haydeniana *
haydenii (reports in OR by Peck)
haydeniana microptera var. crassinerva
heliophila = inops ssp. heliophila
hendersonii
hepburnii = nardina
heteroneura = atrata var. erecta
hindsii = lenticularis var. limnophila
hoodii
hystericina
hystricina = hystericina
idahoa
illota
incurviformis var. danaensis
incurviformis var. incurviformis
inflata = utriculata
inops ssp. heliophila
inops ssp. inops
integra
interior
interrupta
jepsonii whitneyi
jonesii
kelloggii = lenticularis var. lipocarpa
lachenalii = bipartita
lacustris
laeviconica (sensu Davis) vesicaria
laeviculmis
lanuginosa = pellita
lasiocarpa var. americana
lenticularis var. dolia
lenticularis var. impressa
lenticularis var. lenticularis
lenticularis var. lipocarpa
lenticularis var. pallida = var. lenticularis
leporina = ovalis
leporinella
leptalea
leptopoda = deweyana ssp. leptopoda
limnophila = microptera
limosa
livida
luzulaifolia
luzulina var. ablata
luzulina var. atropurpurea
luzulina var. luzulina
luzuiaefolia = luzulaifolia
macloviana
macloviana ssp. subfusca = subfusca
magellanica ssp. irrigua = paupercula
maritima var. incurviformis = incurviformis
var. incurviformis
media = norvegica
mertensii
microptera
microptera
microptera var. limnophila microptera
misandra
miserabilis scopulorum var. prionophyllum
montanensis = spectabilis
multicaulis
multicostata
muricata (of authors) = echinata ssp. echinata
nardina
nebrascensis
nebraskensis = nebrascensis
nelsonii = nova
nervina
neurophora
nigricans
norvegica ssp. norvegica
norvegica var. stevenii = ssp. norvegica
nova
nova var. pelocarpa = nova
nubicola = haydeniana
nudata
obovoidea = cusickii
obnupta
obtusata
occidentalis
oederi = viridula
oederi var. recterostrata. = viridula
oregonensis = halliana
ormantha = echinata ssp. echinata
ovalis
oxycarpa = angustata
pachycarpa = multicostata
pachystachya
pachystachya ssp. compacta = pachystachya
parryana ssp. idahoa = idahoa
parryana var. parryana
parryana var. unica = var. parryana
paucicostata = lenticularis var. impressa
pauciflora
paupercula
paysonis
pellita

pelocarpa = nova
pensylvanica var. digyna = inops ssp. heliophila
pensylvanica var. vespertina = inops ssp. inops
petasata
phaeocephala
phyllomanica = echinata ssp. phyllomanica
physocarpa = saxatilis var. major
piperi = praticola
platylepis = pachystachya
plectocarpa lenticularis var. dolia
podocarpa paysonis in OR; type may spectabilis
polytrichoides = leptalea
praeceptorium = praeceptorum
praeceptorum
praegracilis
prairea (sensu Davis) = ?cusickii or diandra
pratensis = praticola,
praticola
preslii
prionophylla = scopulorurn var. prionophylla
proposita
pseudoscirpoidea = scirpoidea var. pseudoscirpoidea
pyrenaica
raynoldsii
retrorsa
rossii
rostrata
rupestris
sartwellii var. sartwellii
saxatilis var. major
saximontana backii
scirpiformis = scirpoidea var. scirpoidea
scirpoidea var. pseudoscirpoidea
scirpoidea var. scirpoidea
scirpoidea var. stenochlaena = scirpoidea var. scirpoidea
scoparia
scopulorurn var. bracteosa
scopulorum var. prionophylla,
scopulorurn var. scopulorum
sheldonii
siccata
simulata
sitchensis = aquatilis var. dives
specifica (of OR reports) = fracta
spectabilis
stellulata (of OR reports) = echinata ssp. echinata
stenophylla = eleocharis
stenoptila
s terilis (of OR reports) = echinata, ssp. echinata.
stipata. var. stipata
straminea, = brevior, or feta, or straminiformis, or tenera
straminiformis
subfusca
subnigricans
suborbiculata = nudata.
suksdorfii = aquatilis var. aquatilis
sychnocephala tenella, = disperma
tenera
teneraeformis = subfusca
tenuiflora
teretiuscula = diandra
tincta
tolmiei = spectabilis
torreyi
tracyi = leporina
tribuloides trichocarpa var. aristata atherodes
tumulicola
unilateralis utriculata
vahlii = norvegica
vallicola
vernacula
vesicaria var. major
vesicaria var. vesicaria vespertina = inops ssp. inops
vicaria = densa viridior = ?atrata vars. viridula
vulpinoidea
whitneyi
xerantica

Appendix C. Species groups by habitat type.

Species of Peatlands with Calcareous Substrates

abrupta
amplifolia
aquatilis var. aquatilis
aquatilis var. dives
aurea
canescens
capillaris
chordorrhiza
comosa
cusickii
diandra
dioica var. gynocrates
disperma
echinata ssp. echinata
flava
interior
lasiocarpa var. americana
lenticularis var. lipocarpa
leptalea.
livida
luzulina var. ablata
luzulina var. luzulina
norvegica ssp. norvegica
sartwellii
saxatilis var. major
utriculata
vesicaria var. major
vesicaria var. vesicaria

Species of Peatlands with Non-Calcareous Substrates

amplifolia
angustata
aquatilis var. aquatilis
aquatilis var. dives
arcta
aurea
bipartita
brunnescens
buxbaumii
canescens
capitata
cusickii
disperma
echinata, ssp. echinata
illota,
integra
laeviculmis
lasiocarpa var. americana
lenticularis var. lipocarpa
leporinella
leptalea
limosa
livida
luzulina var. ablata
luzulina var. luzulina
pauciflora
paupercula
pellita
praeceptorum
rostrata
saxatilis var. major
simulata,
tenuiflora
utriculata
vesicaria var. major
vesicaria var. vesicaria.
viridula

Species of Wet Meadows at Low to Moderate Elevations

aenea
amplifolia
angustata
aperta
aquatilis var. aquatilis
aquatilis var. dives
arcta
atherodes
athrostachya
aurea
bebbii
brevior
brunnescens
buxbaumii
canescens
capillaris
comosa
conjuncta
crawei
crawfordii
cusickii
densa
diandra
dioica var. gynocrates
disperma
echinata ssp. echinata
feta
flava
haydeniana
hystericina
idahoa
integra
interior
jonesii
lacustris
laeviculmis
lasiocarpa var. americana
lenticularis var. impressa,
lenticularis var. lenticularis
lenticularis var. lipocarpa
leporinella
leptalea
limosalivida
luzulaifolia
luzulina var. ablata
luzulina var. atropurpurea
luzulina var. luzutina
mertensii
microptera
nebrascensis
nervina
neurophora
norvegica ssp. norvegica
obnupta
ovalis
pachystachya
parryana var. parryana
paupercula
pellita
praegracilis
praticola,
retrorsa.
rostrata
sartwellii
saxatilis var. major
scirpoidea var. pseudoscirpoidea
scoparia
scopulorum var. bracteosa
scopulorum var. prionophylla
sheldonii
simulata
spectabilis
stipata. var. stipata
sychnocephala
tribuloides
unilateralis
utriculata,
vesicaria var. major
vesicaria var. vesicaria
viridula
vulpinoidea

Species of Wet Meadows at Subalpine to Alpine Elevations

angustata
aquatilis var. aquatilis
athrostachya
aurea
bigelowii
bipartita
breweri var. paddoensis
brunnescens
buxbaumii
canescens
capillaris
capitata
cusickii
dioica var. gynocrates
disperma
ebenea
echinata ssp. echinata
haydeniana
illota
incurviformis var. danaensis
incurviformis var. incurviformis
integra
jonesii
lenticularis var. dolia
lenticularis var. lipocarpa
leporinella
leptalea
luzulina var. ablata
luzulina var. atropurpurea
luzulina var. luzulina
mertensii
nardina
nervina
nigricans
norvegica ssp. norvegica
nova
pachystachya
parryana var. parryana
paysonis
praeceptorum
rostrata
saxatilis var. major
scirpoidea var. pseucloscirpoidea.
scopulorum var. bracteosa
scopulorum var. prionophylla
scopulorum var. scopulorum
spectabilis
utriculata
vesicaria var. vesicaria

Species of Mesic Meadows at Low to Moderate Elevations

aenea
athrostachya
bebbii
brevior
californica
concinna
concinnoides
crawfordii
eleocharis
fracta
haydeniana
hoodii
inops ssp. heliophila
inops ssp. inops
microptera
multicostata
pachystachya
petasata
praticola
preshii
raynoldsii
scirpoidea var. pseudoscirpoidea
scopulorum var. bracteosa
scopulorum, var. prionophylla
siccata
subfusca
tenera
torreyi
tumulicola
vallicola
xerantica

Species of Mesic Meadows at Subalpine to Alpine Elevations

athrostachya
atrata var. atrosquama
atrata var. erecta
bigelowii
bipartita
breweri var. breweri
breweri var. paddoensis
capitata
concinna
concinnoides
ebenea
egglestonii
fracta
haydeniana
hoodii
inops ssp. inops
macloviana
microptera
misandra
multicostata
nigricans
pachystachya
petasata
phaeocephala
praticola
preslii
pyrenaica
raynoldsii
scirpoidea var. pseudoscirpoidea
scirpoidea var. scirpoidea
scopulorum var. bracteosa
scopulorum var. prionophylla
scopulorum var. scopulorum
siccata
subnigricans

Species of Ephemeral Meadows at Low to Moderate Elevations

aboriginum
abrupta
aperta
arcta
atherodes
athrostachya
aurea
densa
douglasii
feta
jonesii
lenticularis var. impressa
lenticularis var. lipocarpa
leporinella
luzulina var. ablata
microptera
nervina
obnupta
ovalis
pachystachya
petasata
praegracilis
retrorsa
scoparia
scopulorum var. bracteosa
sheldonii
stipata var. stipata
subfusca
sychnocephala
tenera
tumulicola
unilateralis
viridula

Species of Ephemeral Meadows at Subalpine to Alpine Elevations

abrupta
athrostachya
aurea
bipartita
jonesii
lenticularis var. lipocarpa
leporinella
luzulina var. ablata
microptera
nervina
nigricans
pachystachya
petasata
pyrenaica
scirpoidea var. scirpoidea
scopulorum var. bracteosa
vernacula

Species of Dry Meadows at Low to Moderate Elevations

brainerdii
brevicaulis
eleocharis
filifolia var. filifolia
geyeri
halliana
haydeniana
hoodii
inops ssp. heliophila
inops ssp. inops
microptera
multicostata
obtusata
occidentalis
petasata
preslii
raynoldsii
rossii
siccata
straminiformis
subfusca
tincta
torreyi
tumulicola
vallicola
whitneyi
xerantica

Species of Dry Meadows at Subalpine to Alpine Elevations

albonigra
arapahoensis
atrata var. chalciolepis
atrata var. erecta
bigelowii
breweri var. breweri
breweri var. paddoensis
egglestonii
elynoides
filifolia var. erostrata
filifolia var. filifolia
geyeri
halliana
haydeniana
hoodii
inops ssp. inops
microptera
multicostata
nardina
obtusata
occidentalis
phaeocephala
preslii
proposita
pyrenaica
raynoldsii
rossii
rupestris
scirpoidea var. scirpoidea
siccata
stenoptila.
straminiformis

Species of Forest Riparian Zones

aenea
amplifolia
aquatilis var. aquatilis
aquatilis var. dives
arcta
backii
concinna
conjuncta
deweyana ssp. leptopoda
dioica var. gynocrates
disperma
echinata ssp. echinata
flava
fracta
hendersonii
hystericina
interrupta
laeviculmis
lenticularis var. lipocarpa
leptalea
luzulina var. ablata
mertensli
nebrascensis
norvegica ssp. norvegica
obnupta
pellita
scoputorum var. prionophylla
sheldonii
stipata var. stipata
tribuloides
tumulicola
utriculata

Species of Rocky Streambeds

athrostachya
interrupta
lenticularis var. impressa
lenticularis var. lenticularis
lenticularis var. lipocarpa
nudata
vulpinoidea

Species of Wetland and Riparian Areas in Sage Steppe

aperta.
aquatilis var. aquatilis
atherodes
athrostachya
aurea
backii
bebbii
douglasii
filifolia var. filifolia
hystericina
interior
lenticularis var. impressa
lenticularis var. lipocarpa
microptera
nebrascensis
nudata
parryana var. parryana
pellita
praegracilis
sheldonii
simulata.
stipata, var. stipata,
sychnocephala
utriculata
viridula
vulpinoidea

Species of Dry Sage Steppes

backii
douglasii
eleocharis
filifolia var. erostrata
filifolia var. filifolia
praegracilis
vallicola

Species of Wet Forests

aurea
capillaris
dioica var. gynocrates
disperma
eburnea
echinata ssp. echinata
flava
laeviculmis
livida
mertensii
neurophora
norvegica ssp. norvegica
tenuiflora
tribuloides
utriculata

Species of Mesic Forests

aurea
backii
concinna
concinnoides
deweyana ssp. leptopoda
dioica var. gynocrates
geyeri
hendersonii
hoodii
inops ssp. inops
praegracilis
rossii
sheldonii
whitneyi

Species of Dry Forests

brainerdii
concinnoides
geyeri
halliana
inops ssp. heliophila
inops ssp. inops
multicaulis
occidentalis
proposita
rossii
siccata
stenoptila
whitneyi

Appendix D. Panel forms.

Columbia River Basin Scientific Assessment
Plant Panel Species Information

Date: January 1995 Panelist Name: Brainerd, Kuykendall, Newhouse, Wilson, Zika

Species or Species Group: *Carex lenticularis* var. *dolia*

Province and/or Section: CRB004 subalpine herbaceous Life Form: LF4 (Cryptophytes)

Key Environmental Correlates

1. Soil moisture regime
   Categorical ✓
   Suitable Categories:
   1. At or near surface
   Applies seasonally? Yes ✓ No Which seasons? Growing season
2. Rocky soil
   Categorical ✓
   Suitable Categories:
   1. Rocky streambanks
   2. Stony shores, seeps
   Applies seasonally? Yes __ No ✓ Which seasons?
3. Canopy cover
   Categorical ✓
   Suitable Categories:
   1. No canopy cover
   2. Partial canopy cover
   Applies seasonally? Yes __ No ✓ Which seasons?
4. Short cold growing season
   Categorical ✓
   Suitable Categories:
   1. Typical of alpine/subalpine conditions
   Continuous __
   Unit of Measure: Minimum: Maximum:
   Applies seasonally? Yes ✓ No __ Which seasons? Growing season
5. Elevation
   Categorical __
   Suitable Categories:
   1.
   Continuous ✓
   Unit of Measure: feet Minimum: 6700′ Maximum: 8000′
   Applies seasonally? Yes __ No ✓ Which seasons?

Key Ecological Functions

1. Primary productivity
2. Soil stability, erosion control
3. Wildlife food and cover, including invertebrates and aquatics

Threats

(Indicate L - M - H)

Change in fire regime: L Grazing: H Mining: H
Exotics: L Development: L Timber harvest: M
Roads (explain): L
Others: Beaver flooding?
Flow regulation = H
Water withdrawal = H

Key Assumptions

A rare variety of a common and widespread species, var. *dolia* is C2 federal candidate.
Familiarity is with other subspp., from Cascades, Rockies and from boreal Atlantic, in North America & Europe, not within EEMP study area. These data supplemented with Montana NHP reports.

Comments

All American populations (in EEMP study area) appear to be in Glacier National Park.

Dispersal

Pollinators: wind
Dispersal mode: gravity, water, wind, perhaps some animal transport?
Requirements for dispersal: unknown

Key Unknowns and Monitoring or Research Needs

Unknown:

- Hydrological needs and tolerances.
- Effects of previous livestock grazing impacts.
- Number and ecology of endemic or disjunct invertebrates, fungi, and microbial species associated with this taxon.
- Population trends. Demographic structure. Basic population biology.
- How the population disperses between widely disjunct habitats in US and Canada, or if it does.

Monitoring needs:

- Monitor clonal cover and recruitment over 5+ years in undisturbed sites to determine baseline.
- Monitor achene production.
- Monitor effects of air pollution on system chemistry.

Research needs:

- Establish undisturbed genetic preserves to protect pristine populations from management and other activities (recreation, regulated water flows, etc.) and facilitate baseline monitoring.
- Study interactions between this taxon and other biota in this specialized habitat, emphasizing non-vascular plants, invertebrate animals, and microbial spp.
- Determine contribution of sexual and asexual propagules to recruitment.

Degree of confidence in knowledge of species: high __ med-hi __ medium __ med-lo ✓ low __

Trend: increasing __ stable __ decreasing __ unknown ✓

Columbia River Basin Scientific Assessment
Plant Panel Species Information

Date: January 1995 Panelist Name: Brainerd, Kuykendall, Newhouse, Wilson, Zika

Species or Species Group: *CAREX* OF CALCAREOUS PEATLANDS

Province and/or Section: Life Form: LF4 (Cryptophytes)

Key Environmental Correlates

1. Calcareous groundwater
   Categorical ✓
   Suitable Categories:
   1. Present
   Continuous __
   Unit of Measure: Minimum: Maximum:
   Applies seasonally? Yes __ No Which seasons?

2. Saturated peaty soil
   Categorical ✓
   Suitable Categories:
   1. Present
   Continuous __
   Unit of Measure: Minimum: Maximum:
   Applies seasonally? Yes ✓ No __ Which seasons? Growing season

3. Canopy cover
   Categorical ✓
   Suitable Categories:
   1. No canopy cover
   2. Partial canopy cover
   Continuous __
   Unit of Measure: Minimum: Maximum:
   Applies seasonally? Yes __ No ✓ Which seasons?

4. Short cold growing season
   Categorical ✓
   Suitable Categories:
   1. Usually frost pockets present
   Continuous __
   Unit of Measure: Minimum: Maximum:
   Applies seasonally? Yes ✓ No __ Which seasons? Growing season

Key Ecological Functions

1. Primary productivity
2. Habitat for rare flora and rare fauna

Threats

(Indicate L - M - H)

Change in fire regime: L;
Grazing: H
Mining: H
Exotics: L
Development: L
Timber harvest: M
Roads (explain): L
Others: Beaver flooding can be local threat to individual peatlands.
Recreational use (trails) and botanical collecting are possible threats.

Key Assumptions

Rare habitat type, with many widely disjunct and rare spp. of *Carex* and other vascular and non-vascular plants.
Familiarity with most spp. is from boreal Atlantic, in North America & Europe, not within EEMP study area. These data supplemented with NHP reports on rare spp. in area.

Comments

Several of the species are not in the regional manuals; these were discovered in our EEMP area only recently (refs: NHP r/t/e pubs).
Total number of species in group = 28. Federal status species = 0. Rare species (any NHP status) = 16.

Dispersal

Pollinators: wind
Dispersal mode: gravity, water, wind? perhaps some animal transport?
Requirements for dispersal: unknown

Key Unknowns and Monitoring or Research Needs

Unknown:

- Hydrological needs of calcareous peatlands & relation to logging in watershed
- Number of endemic or disjunct invertebrates and fungi in these peatlands, and their relation to the ecological requirements of *Carex* spp. in the habitat
- Population trends of rare *Carex* in these habitats
- How the species disperse between widely disjunct habitats, or if they do.

Monitoring needs:

- Monitor clonal cover and recruitment over 5+ years in undisturbed sites to determine baseline
- Monitor achene production.
- Monitor effects of air-borne contaminants on system chemistry in closed basins.

Research needs:

- Establish genetic preserves, undisturbed, to protect pristine populations from management and allow baseline monitoring.
- Study interactions between these *Carex* and other flora and fauna in such specialized habitats, emphasizing non-vascular and invertebrate spp.

Degree of confidence in knowledge of species: high __ med-hi __ medium ✓ med-lo __ low
Trend: increasing __ stable __ decreasing __ unknown ✓

Columbia River Basin Scientific Assessment
Plant Panel Species Information

Date: January 1995 Panelist Name: Brainerd, Kuykendall, Newhouse, Wilson, Zika

Species or Species Group: *CAREX* OF NON-CALCAREOUS PEATLANDS

Province and/or Section: Life Form: LF4 (Cryptophytes)

Key Environmental Correlates

1. Soil moisture regime
   Categorical ✓
   Suitable Categories:
   1. Saturation at or near soil surface
   Continuous __
   Unit of Measure: Minimum: Maximum:
   Applies seasonally? Yes ✓ No Which seasons? Most of growing season

2. Peaty soil
   Categorical ✓
   Suitable Categories:
   1. High content of undecomposed organics
   Continuous __
   Unit of Measure: Minimum: Maximum:
   Applies seasonally? Yes No ✓ Which seasons?

3. Canopy cover
   Categorical ✓
   Suitable Categories:
   1. No canopy cover
   2. Partial canopy cover at edge of meadows, or in open woods
   Continuous __
   Unit of Measure: Minimum: Maximum:
   Applies seasonally? Yes __ No ✓ Which seasons?

4. Short cold growing season
   Categorical ✓
   Suitable Categories:
   1. Frost pockets usually present
   2. Often in cold air drainages
   Continuous __
   Unit of Measure: Minimum: Maximum:
   Applies seasonally? Yes ✓ No __ Which seasons? growing season

Key Ecological Functions

1. Primary productivity, soil stabilization

2. Wildlife food and cover
3. Habitat for rare fauna and flora

Threats

(Indicate L - M - H)

Change in fire regime: L
Grazing: H
Mining: H
Exotics: L
Development: L
Timber harvest: M
Roads (explain): L
Others: Beaver flooding can be local threat to individual peatlands

Key Assumptions

Rare habitat type, with many widely disjunct spp. of *Carex* and other vascular and non-vascular plants. Familiarity with most spp. is from boreal Atlantic, in North America & Europe, not within EEMP study area. These data supplemented with NHP reports on rare spp. in area.

Comments

Several of the species are not in the regional manuals; these were discovered in our EEMP area only recently (refs: NHP r/t/e pubs).
Total number of species in group = 37. Federal status species = 0. Rare species (any NHP status) = 19.

Dispersal

Pollinators: wind
Dispersal mode: gravity, water, wind? perhaps some animal transport?
Requirements for dispersal: unknown

Key Unknowns and Monitoring or Research Needs

Unknown:

- Hydrological needs of closed basin peatlands or mires & relation to logging in watershed
- Number of endemic or disjunct invertebrates and fungi in these peatlands, and their relation to the ecological requirements of *Carex* spp. in the habitat
- Population trends of rare *Carex* in these habitats
- How the species disperse between widely disjunct habitats, or if they do.

Monitoring needs:

- Monitor clonal cover and recruitment over 10+ years in undisturbed sites to determine baseline
- Monitor achene production.
- Monitor effects of air pollution on system chemistry in closed basins.

Research needs:

- Establish genetic preserves, undisturbed, to protect pristine populations from management and allow baseline monitoring.
- Study interactions between these *Carex* and other flora and fauna in such specialized habitats, emphasizing non-vascular and invertebrate spp.

Degree of confidence in knowledge of species: high __ med-hi __ medium ✓ med-lo __ low

Trend: increasing __ stable __ decreasing __ unknown ✓

Columbia River Basin Scientific Assessment
Plant Panel Species Information

Date: January 1995 Panelist Name: Brainerd, Kuykendall, Newhouse, Wilson, Zika

Species or Species Group: *CAREX* OF WET MEADOWS -- LOW TO MODERATE ELEVATION

Province and/or Section: Life Form: LF4 (Cryptophytes)

Key Environmental Correlates

1. Exposure
   Categorical ✓
   Suitable Categories:
   1. Open -- full sun
   2. Part shade
   Continuous __
   Unit of Measure: Minimum: Maximum:
   Applies seasonally? Yes __ No ✓ Which seasons?

2. Soil moisture regime
   Categorical ✓
   Suitable Categories:
   1. Anoxic/hypoxic: inundated to saturated for most of the growing season
   Continuous __
   Unit of Measure: Minimum: Maximum:
   Applies seasonally? Yes ✓ No __ Which seasons? Spring/summer growing season

3. Disturbance to maintain opening
   Categorical ✓
   Suitable Categories:
   1. Fire
   2. Animals
   Continuous __
   Unit of Measure: Minimum: Maximum:
   Applies seasonally? Yes __ No ✓ Which seasons?

Key Ecological Functions

1. Primary productivity
2. Wildlife food and habitat
3. Soil stabilization

Threats

(Indicate L - M - H)

Change in fire regime: H Grazing: H Mining: M
Exotics: H Development: H (residential, agricultural, recreation)

Timber harvest: H (in meadows adjacent to harvest areas, esp. if used as landings or for skidding)
Roads (explain): H
Others: Recreation (trampling) = H

Key Assumptions

Wetness (high water table) may be a factor in maintaining open character by inhibiting seedling establishment.
Scattered and/or clustered trees or shrubs may be present within this habitat type.
This habitat type often occurs as small areas within forest or other meadow habitat types.

Comments

All or nearly all of this habitat type meets definition of jurisdictional wetlands.

Total number of species in group = 82. Federal status species = 1. Rare species (any NHP status) = 38.

Representative (common or dominant) species: *Carex angustata, C. aquatilis* (2 var.), *C. lenticularis* var. *lipocarpa, C. pellita, C. utriculata,* and *C. vesicaria* var. *vesicaria.*

Dispersal

Pollinators: wind; other?
Dispersal mode: gravity; wind; animals; water (seasonal flooding in some areas)
Requirements for dispersal: wind; animal contact?; seasonal flooding?; other?

Key Unknowns and Monitoring or Research Needs

Unknown: If grazing excesses in last 150 yrs have affected spp. diversity in this habitat type.
Population biology, trends, genetics and demography.
Nature of relations with microbial, fungal & vascular plant associates, native & introduced fauna.
Monitoring needs:
Monitor populations (and recruitment) in natural disturbances (fire, landslide, snow avalanche, flood, frost heaving)
Monitor populations (and recruitment) in unnatural disturbances (mowed roadsides, grazed pastures, campgrounds, livestock staging areas, heavy elk management areas, etc.)
Research needs:
Determine contribution of sexual vs. asexual reproduction to recruitment.
More inventory to locate new populations and habitats of rare spp.
Establish undisturbed genetic reserves at type localities and exceptionally diverse communities for baseline research.
Improve identification skills of field workers.

Degree of confidence in knowledge of species: high __ med-hi ✓ medium __ med-lo __ low __
Trend: increasing __ stable __ decreasing __ unknown ✓

Columbia River Basin Scientific Assessment
Plant Panel Species Information

Date: January 1995 Panelist Name: Brainerd, Kuykendall, Newhouse, Wilson, Zika

Species or Species Group: *CAREX* OF WET MEADOWS -- SUBALPINE TO ALPINE

Province and/or Section: Life Form: LF4 (Cryptophytes)

Key Environmental Correlates

1. Exposure
   Categorical ✓
   Suitable Categories:
   1. Open -- full sun
   2. Part shade
   Continuous __
   Unit of Measure: Minimum: Maximum:
   Applies seasonally? Yes __ No ✓ Which seasons?

2. Soil moisture regime
   Categorical ✓
   Suitable Categories:
   1. Anoxic/hypoxic: inundated to saturated for most of the growing season
   Continuous __
   Unit of Measure: Minimum: Maximum:
   Applies seasonally? Yes ✓ No __ Which seasons? Spring/summer growing season

3. Disturbance to maintain opening
   Categorical ✓
   Suitable Categories:
   1. Landslides
   2. Animals
   3. Avalanche
   Continuous __
   Unit of Measure: Minimum: Maximum:
   Applies seasonally? Yes __ No ✓ Which seasons?

4. Elevation
   Categorical ✓
   Suitable Categories:
   1. Subalpine to alpine
   Continuous __
   Unit of Measure: -- Minimum: Maximum:
   Applies seasonally? Yes __ No ✓ Which seasons?

Key Ecological Functions

1. Primary productivity
2. Wildlife food and habitat

3. Soil stabilization

Threats

(Indicate L - M - H)

Change in fire regime: L (unlikely at higher elevations)
Grazing: H Mining: H Exotics: M Development: H (recreation)
Timber harvest: H (unlikely because of small size of trees in higher elevations)
Roads (explain): H Others: Recreation (trampling) = H

Key Assumptions

Wetness (high water table) may be a factor in maintaining open character by inhibiting seedling establishment.
Scattered and/or clustered trees or shrubs may be present within this habitat type.
This habitat type often occurs as small areas within forest or other meadow habitat types.

Comments

All or nearly all of this habitat type meets definition of jurisdictional wetlands.
Total number of species in group = 49. Federal status species = 1. Rare species (any NHP status) = 23.
Representative (common and/or dominant) species: *Carex angustata*, *C. lenticularis* var. *lipocarpa*, *C. nardina*, *C. nigricans*, *C. utriculata*, *C. vesicaria* var. *vesicaria*.

Dispersal

Pollinators: wind; other?
Dispersal mode: gravity; wind; animals; water (seasonal flooding in some areas)
Requirements for dispersal: wind; animal contact; seasonal flooding?; other?

Key Unknowns and Monitoring or Research Needs

Unknown: If grazing excesses in last 150 yrs have affected spp. diversity in this habitat type.
Population biology, trends, genetics and demography.
Nature of relations with microbial, fungal & vascular plant associates, native & introduced fauna.
Monitoring needs:
Monitor populations (and recruitment) in natural disturbances (fire, landslide, snow avalanche, flood, frost heaving)
Monitor populations (and recruitment) in unnatural disturbances (mowed roadsides, grazed pastures, campgrounds, livestock staging areas, heavy elk management areas, etc.)
Research needs:
Determine contribution of sexual vs. asexual reproduction to recruitment.
More inventory to locate new populations and habitats of rare spp.
Establish undisturbed genetic reserves at type localities and exceptionally diverse genus communities, for baseline research.
Improve taxonomy. Improve identification skills of field workers.

Degree of confidence in knowledge of species: high __ med-hi ✓ medium __ med-lo __ low __
Trend: increasing __ stable __ decreasing __ unknown ✓

Columbia River Basin Scientific Assessment
Plant Panel Species Information

Date: January 1995 Panelist Name: Brainerd, Kuykendall, Newhouse, Wilson, Zika

Species or Species Group: *CAREX* OF MESIC MEADOWS -- LOW TO MODERATE ELEVATION

Province and/or Section: Life Form: LF4 (Cryptophytes)

Key Environmental Correlates

1. Exposure
   - Categorical ✓
     - Suitable Categories:
       1. Open -- full sun
       2. Part shade
   - Continuous __
     - Unit of Measure: Minimum: Maximum:
   - Applies seasonally? Yes __ No ✓ Which seasons?

2. Soil moisture regime
   - Categorical ✓
     - Suitable Categories:
       1. Seasonally anoxic/hypoxic: inundated to saturated for early part of the growing season only
   - Continuous __
     - Unit of Measure: Minimum: Maximum:
   - Applies seasonally? Yes ✓ No __ Which seasons? Spring/summer growing season

3. Disturbance to maintain opening
   - Categorical ✓
     - Suitable Categories:
       1. Fire
       2. Animals
   - Continuous __
     - Unit of Measure: Minimum: Maximum:
   - Applies seasonally? Yes __ No ✓ Which seasons?

4. Elevation
   - Categorical __
     - Suitable Categories:
   - Continuous ✓
     - Unit of Measure: -- Minimum: low Maximum: moderate
   - Applies seasonally? Yes __ No ✓ Which seasons?

Key Ecological Functions

1. Primary productivity
2. Wildlife food and habitat
3. Soil stabilization

Threats

(Indicate L - M - H)

Change in fire regime: H Grazing: H (highest during wetter periods)
Mining: H Exotics: H Development: H (residential, agriculture, recreation)
Timber harvest: H (in meadows adjacent to harvest areas, esp. if used as landings or for skidding)
Roads (explain): H
Others: Recreation (hiking; horse packing; mountain biking) = H

Key Assumptions

Scattered and/or clustered trees or shrubs may be present within this habitat type.
This habitat type often occurs as small areas within forest or other meadow habitat types.

Comments

Some of this habitat type may meet the definition of jurisdictional wetlands.

Total number of species in group = 31. Federal status species = 0. Rare species (any NHP status) = 14.

Dispersal

Pollinators: wind; other?
Dispersal mode: gravity; wind; animals; other?
Requirements for dispersal: wind; animals; other?

Key Unknowns and Monitoring or Research Needs

Unknown: If grazing excesses in last 150 yrs have affected spp. diversity in this habitat type.
Population biology, trends, genetics and demography.
Nature of relations with microbial, fungal & vascular plant associates, native & introduced fauna.

Monitoring needs:
Monitor populations (and recruitment) in natural disturbances (fire, landslide, flood, frost heaving)
Monitor populations (and recruitment) in unnatural disturbances (mowed roadsides, grazed pastures, campgrounds, livestock staging areas, heavy elk management areas, etc.)

Research needs:
Determine contribution of sexual vs. asexual reproduction to recruitment.
More inventory to locate new populations and habitats of rare spp.
Establish undisturbed genetic reserves at type localities and exceptionally diverse communities, for baseline research.
Improve identification skills of field workers.

Degree of confidence in knowledge of species: high __ med-hi ✓ medium __ med-lo __ low __
Trend: increasing __ stable __ decreasing __ unknown ✓

Columbia River Basin Scientific Assessment
Plant Panel Species Information

Date: January 1995 Panelist Name: Brainerd, Kuykendall, Newhouse, Wilson, Zika

Species or Species Group: *CAREX* OF MESIC MEADOWS -- SUBALPINE TO ALPINE

Province and/or Section: Life Form: LF4 (Cryptophytes)

Key Environmental Correlates

1. Exposure
   Categorical ✓
   Suitable Categories:
   1. Open -- full sun
   2. Part shade
   Continuous __
   Unit of Measure: Minimum: Maximum:
   Applies seasonally? Yes __ No ✓ Which seasons?

2. Soil moisture regime
   Categorical ✓
   Suitable Categories:
   1. Seasonally anoxic/hypoxic: inundated to saturated for early part of the growing season only
   Continuous __
   Unit of Measure: Minimum: Maximum:
   Applies seasonally? Yes ✓ No __ Which seasons? Spring/summer growing season

3. Disturbance to maintain opening
   Categorical ✓
   Suitable Categories:
   1. Fire
   2. Animals
   3. Avalanche
   Continuous __
   Unit of Measure: Minimum: Maximum:
   Applies seasonally? Yes __ No ✓ Which seasons?

4. Elevation
   Categorical ✓
   Suitable Categories:
   1. Subalpine to alpine
   Continuous __
   Unit of Measure: -- Minimum: Maximum:
   Applies seasonally? Yes __ No ✓ Which seasons?

Key Ecological Functions

1. Primary productivity

2. Wildlife food and habitat
3. Soil stabilization

Threats

(Indicate L - M - H)

Change in fire regime: M Grazing: H (highest during wetter periods)
Mining: H Exotics: H Development: H (recreation: ski resorts and runs)
Timber harvest: H (unlikely because of small size of trees in adj. habitats)
Roads (explain): H Others: Recreation (hiking; horse packing; mountain biking; ski lifts) = H

Key Assumptions

Scattered and/or clustered trees or shrubs may be present within this habitat type.
This habitat type often occurs as small areas within forest or other meadow habitat types.
Threats become increasingly serious as climate warms and dries.

Comments

Some of this habitat type may meet the definition of jurisdictional wetlands.

Total number of species in group = 35. Federal status species = 0. Rare species (any NHP status) = 15.
Representative (common and/or dominant) species: *Carex nigricans*, *C. phaeocephala*

Dispersal

Pollinators: wind
Dispersal mode: gravity; wind; animals; other?
Requirements for dispersal: wind; animals

Key Unknowns and Monitoring or Research Needs

Unknown: If grazing excesses in last 150 yrs have affected spp. diversity in this habitat type.
Population biology, trends, genetics and demography.
Nature of relations with microbial, fungal & vascular plant associates, native & introduced fauna.

Monitoring needs:
Monitor populations (and recruitment) in natural disturbances (fire, landslide, snow avalanche, frost heaving)
Monitor populations (and recruitment) in unnatural disturbances (mowed roadsides, grazed pastures, campgrounds, livestock staging areas, heavy elk management areas, etc.)

Research needs:
Determine contribution of sexual vs. asexual reproduction to recruitment.
More inventory to locate new populations and habitats of rare spp.
Establish undisturbed genetic reserves at type localities and exceptionally diverse communities, for baseline research.
Improve identification skills of field workers.

Degree of confidence in knowledge of species: high __ med-hi ✓ medium __ med-lo __ low __
Trend: increasing __ stable __ decreasing __ unknown ✓

Columbia River Basin Scientific Assessment
Plant Panel Species Information

Date: January 1995 Panelist Name: Brainerd, Kuykendall, Newhouse, Wilson, Zika

Species or Species Group: *CAREX* OF EPHEMERAL MEADOWS – LOW TO MODERATE ELEVATION

Province and/or Section: Life Form: LF4 (Cryptophytes)

Key Environmental Correlates

1. Soil moisture regime
   Categorical ✓
   Suitable Categories:
   1. Seasonally saturated to standing water on soil surface
   Continuous __
   Unit of Measure: Minimum: Maximum:
   Applies seasonally? Yes ✓ No __ Which seasons? Parts of winter and spring

2. Soil moisture regime
   Categorical ✓
   Suitable Categories:
   1. seasonally dry to parched soils
   Continuous __
   Unit of Measure: Minimum: Maximum:
   Applies seasonally? Yes ✓ No __ Which seasons? mid-summer to late fall

3. Solar exposure
   Categorical ✓
   Suitable Categories:
   1. open to partial shade
   Continuous __
   Unit of Measure: Minimum: Maximum:
   Applies seasonally? Yes __ No ✓ Which seasons?

4. Disturbance to maintain open meadow conditions
   Categorical ✓
   Suitable Categories:
   1. Periodic fires
   Continuous __
   Unit of Measure: Minimum: Maximum:
   Applies seasonally? Yes __ No ✓ Which seasons?

5. Subsurface soil conditions
   Categorical ✓
   Suitable Categories:
   1. Slow draining clays or impermeable layer
   Continuous __
   Unit of Measure: Minimum: Maximum:

Applies seasonally? Yes __ No ✓ Which seasons?

Key Ecological Functions

1. Primary productivity
2. Wildlife food and habitat
3. Soil stability, relating to detention and storage of floodwaters
4. Nutrient retention
5. Increased water quality

Threats

(Indicate L - M - H)

Change in fire regime: H Grazing: H in wet season, M in dry season
Mining: H Exotics: H Development: H Timber harvest: H in wet season, L in dry season
Roads (explain): H Soil disturbance: H in wet season, H in dry season
Interruption of upland water flow: H Climatic warming: M

Key Assumptions

The low to moderate elevation ephemeral meadow habitat may receive water from perennial streams and lakes, and/or may be precipitation-fed. This habitat, therefore, includes floodplains and lakeshore margins as well as low lying vernal meadows.

Comments

Total number of species in group = 33. Federal status species = 1. Rare species (any NHP status) = 11.
Representative (common/dominant) species: *Carex aperta, C. aurea, C. feta,* and *C. scoparia.*

Dispersal

Pollinators: wind; unknown
Dispersal mode: gravity; wind; animals?; unknown
Requirements for dispersal: unknown

Key Unknowns and Monitoring or Research Needs

Unknown: If grazing excesses in last 150 yrs have affected spp. diversity in this habitat type.
Population biology, trends, genetics and demography.
Nature of relations with microbial, fungal & vascular plant associates, native & introduced fauna.

Monitoring needs:
Monitor populations (and recruitment) in natural disturbances (fire, landslide, flood, frost heaving)
Monitor populations (and recruitment) in unnatural disturbances (mowed roadsides, grazed pastures, campgrounds, livestock staging areas, heavy elk management areas, etc.)

Research needs:
Determine contribution of sexual vs. asexual reproduction to recruitment.
More inventory to locate new populations & habitats.
Establish undisturbed genetic reserves at type localities and exceptionally diverse communities for baseline research.
Improve identification skills of field workers.

Degree of confidence in knowledge of species: high __ med-hi ✓ medium __ med-lo __ low __
Trend: increasing __ stable __ decreasing __ unknown ✓

Columbia River Basin Scientific Assessment
Plant Panel Species Information

Date: January 1995 Panelist Name: Brainerd, Kuykendall, Newhouse, Wilson, Zika

Species or Species Group: **CAREX OF EPHEMERAL MEADOWS -- SUBALPINE TO ALPINE**

Province and/or Section: Life Form: LF4 (Cryptophytes)

Key Environmental Correlates

1. Soil moisture regime
   Categorical ✓
   Suitable Categories:
   1. Seasonally saturated soil to standing water on soil surface
   Continuous __
   Unit of Measure: Minimum: Maximum:
   Applies seasonally? Yes ✓ Which seasons? Parts of winter and spring

2. Soil moisture regime
   Categorical ✓
   Suitable Categories:
   1. Seasonally dry to parched soils
   Continuous __
   Unit of Measure: Minimum: Maximum:
   Applies seasonally? Yes ✓ No __ Which seasons? mid-summer to late fall

3. Elevation
   Categorical ✓
   Suitable Categories:
   1. Subalpine to alpine
   Continuous __
   Unit of Measure: Minimum: Maximum:
   Applies seasonally? Yes __ No ✓ Which seasons?

4. Solar exposure
   Categorical ✓
   Suitable Categories:
   1. Open to partial shade
   Continuous __
   Unit of Measure: Minimum: Maximum:
   Applies seasonally? Yes __ No ✓ Which seasons?

Key Ecological Functions

1. Primary productivity
2. Wildlife food and habitat
3. Soil stability, relating to detention and storage of floodwaters; increased water quality
4. Nutrient retention

Threats

(Indicate L - M - H)

Change in fire regime: L Grazing: H in wet season, L in dry season
Mining: H Exotics: M
Development: H in wet season, M in dry season
Timber harvest: H in wet season, H in dry season if used as yarding or log deck
Roads (explain): L
Other: Soil disturbance: H; Climatic warming: M

Key Assumptions

The subalpine to alpine elevation ephemeral meadow habitat may receive water from either perennial streams and lakes, and/or be precipitation-fed. This habitat, therefore, includes floodplains, tarns, and lakeshore margins as well as low vernal meadows and snow-melt fields.
Climatic change to warmer and drier increases stress on system and makes threats more serious.

Comments

Total number of species in group = 17. Federal status species = 0. Rare species (any NHP status) = 6.
Representative (common and/or dominant) species: *Carex lenticularis* var. *lipocarpa.*

Dispersal

Pollinators: wind; unknown
Dispersal mode: gravity; wind; animals?; unknown
Requirements for dispersal: unknown

Key Unknowns and Monitoring or Research Needs

Unknown: If grazing excesses in last 150 yrs have affected spp. diversity in this habitat type.
Population biology, trends, genetics and demography.
Nature of relations with microbial, fungal & vascular plant associates, native & introduced fauna.
Monitoring needs:
Monitor populations (and recruitment) in natural disturbances (landslide, snow avalanche, flood, frost heaving)
Monitor populations (and recruitment) in unnatural disturbances (mowed roadsides, grazed pastures, campgrounds, livestock staging areas, heavy elk management areas, mining areas, etc.)
Research needs:
Determine contribution of sexual vs. asexual reproduction to recruitment.
More inventory to locate new populations and habitats of rare spp.
Establish undisturbed genetic reserves at type localities and exceptionally diverse communities, for baseline research.
Improve identification skills of field workers.

Degree of confidence in knowledge of species: high __ med-hi ✓ medium __ med-lo __ low__
Trend: increasing __ stable __ decreasing __ unknown ✓

Columbia River Basin Scientific Assessment
Plant Panel Species Information

Date: January 1995 Panelist Name: Brainerd, Kuykendall, Newhouse, Wilson, Zika

Species or Species Group: *CAREX* OF DRY MEADOWS -- LOW TO MODERATE ELEVATION

Province and/or Section: Life Form: LF4 (Cryptophytes)

Key Environmental Correlates

1. Exposure
   - Categorical ✓
     - Suitable Categories:
       1. Open -- full sun
       2.
       3.
       4.
   - Continuous __
     - Unit of Measure:
     - Minimum:
     - Maximum:
   - Applies seasonally? Yes __ No ✓ Which seasons?

2. Moisture regime
   - Categorical ✓
     - Suitable Categories:
       1. Xeric
       2.
       3.
       4.
   - Continuous __
     - Unit of Measure:
     - Minimum:
     - Maximum:
   - Applies seasonally? Yes ✓ No __ Which seasons? Summer - fall

3. Disturbance to maintain opening
   - Categorical ✓
     - Suitable Categories:
       1. Fire
       2. Animals
   - Continuous __
     - Unit of Measure:
     - Minimum:
     - Maximum:
   - Applies seasonally? Yes __ No ✓ Which seasons?

4. Elevation
   - Categorical __
     - Suitable Categories:
       1.
       2.
       3.
       4.
   - Continuous ✓
     - Unit of Measure: -
     - Minimum: low
     - Maximum: moderate
   - Applies seasonally? Yes __ No ✓ Which seasons?

Key Ecological Functions

1. Primary producer
2. Wildlife food and habitat
3. Soil stabilization

Threats

(Indicate L - M - H)

Change in fire regime: H Grazing: H Mining: M
Exotics: H Development: H (agriculture, residential, recreation)
Timber harvest: L (unlikely because of few trees; yarding or log deck could = H)
Roads (explain): H Others: Recreation (trampling) = M

Key Assumptions

Scattered and/or clustered trees or shrubs may be present within this habitat type.
This habitat type often occurs as small areas within forest or other meadow habitat types.

Comments

Total number of species in group = 27. Federal status species = 1. Rare species (any NHP status) = 14.
Representative (common and/or dominant) species: *Carex filifolia* var. *filifolia, C. geyeri, C. hoodii.*
Some of these spp. have widely declined because of livestock grazing.

Dispersal

Pollinators: wind
Dispersal mode: gravity; wind, water, animals?
Requirements for dispersal: unknown

Key Unknowns and Monitoring or Research Needs

Unknown: If grazing excesses in last 150 yrs have affected spp. diversity in this habitat type.
Population biology, trends, genetics and demography.
Nature of relations with microbial, fungal & vascular plant associates, native & introduced fauna.

Monitoring needs:
Monitor populations (and recruitment) in natural disturbances (fire, landslide, flood, frost heaving)
Monitor populations (and recruitment) in unnatural disturbances (mowed roadsides, grazed pastures, campgrounds, livestock staging areas, heavy elk management areas, etc.)

Research needs:
Determine contribution of sexual vs. asexual reproduction to recruitment.
More inventory to locate new populations & habitats.
Establish undisturbed genetic reserves at type localities and exceptionally diverse communities, for baseline research.
Improve identification skills of field workers.

Degree of confidence in knowledge of species: high __ med-hi ✓ medium __ med-lo __ low__
Trend: increasing __ stable __ decreasing __ unknown ✓

Columbia River Basin Scientific Assessment
Plant Panel Species Information

Date: January 1995 Panelist Name: Brainerd, Kuykendall, Newhouse, Wilson, Zika

Species or Species Group: **CAREX OF DRY MEADOWS -- SUBALPINE TO ALPINE**

Province and/or Section: Life Form: LF4 (Cryptophytes)

Key Environmental Correlates

1. Exposure
   - Categorical ✓
     - Suitable Categories:
       1. Open -- full sun
   - Continuous __
     - Unit of Measure: Minimum: Maximum:
   - Applies seasonally? Yes __ No ✓ Which seasons?

2. Moisture regime
   - Categorical ✓
     - Suitable Categories:
       1. Xeric
   - Continuous __
     - Unit of Measure: Minimum: Maximum:
   - Applies seasonally? Yes ✓ No __ Which seasons? Summer - fall

3. Disturbance to maintain opening
   - Categorical ✓
     - Suitable Categories:
       1. Cold climate
       2. Animals
       3. Avalanche
       4.
   - Continuous __
     - Unit of Measure: Minimum: Maximum:
   - Applies seasonally? Yes __ No ✓ Which seasons?

Key Ecological Functions

1. Primary productivity
2. Soil stabilization
3. Wildlife food and habitat

Threats

(Indicate L - M - H)

Change in fire regime: M (fires uncommon at this elevation)

Grazing: H (soils often shallow and susceptible to trampling)
Mining: H
Exotics: M
Development: L (resorts, ski areas)
Timber harvest: H (if landings, skidding occurs in meadow; timber harvest unlikely because of small tree size)
Roads (explain): H
Others: Recreation trails = H

Key Assumptions

Subalpine to alpine talus, pumice flats, and fell-fields included.
Climatic change to warmer and drier increases stress, raising impact of threats.

Comments

Some species germinate in subnival conditions.

Total number of species in group = 33. Federal status species = 1. Rare species (any NHP status) = 15.

Representative (common and/or dominant) species: *Carex albonigra, C. egglestonii, C. filifolia* var. *filifolia, C. geyeri, C. hoodii, C. phaeocephala.*

Dispersal

Pollinators: wind
Dispersal mode: gravity, wind, water, animals?
Requirements for dispersal: unknown

Key Unknowns and Monitoring or Research Needs

Unknown: If grazing by native ungulates is increasing, and if it is affecting spp. diversity in this habitat type.
Population biology, trends, genetics and demography.
Nature of relations with microbial, fungal & vascular plant associates, fauna.

Monitoring needs:
Monitor populations (and recruitment) in natural disturbances (fire, landslide, snow avalanche, frost heaving, summer elk browsing)

Research needs:
Determine contribution of sexual vs. asexual reproduction to recruitment.
More inventory to locate new populations and habitats of rare spp.
Establish undisturbed genetic reserves at type localities and exceptionally diverse communities, for baseline research.
Improve identification skills of field workers.

Degree of confidence in knowledge of species: high __ med-hi ✓ medium __ med-lo __ low __
Trend: increasing __ stable __ decreasing __ unknown ✓

Columbia River Basin Scientific Assessment
Plant Panel Species Information

Date: January 1995 Panelist Name: Brainerd, Kuykendall, Newhouse, Wilson, Zika

Species or Species Group: *CAREX* OF RIPARIAN FORESTS

Province and/or Section: Life Form: LF4 (Cryptophytes)

Key Environmental Correlates

1. Near perennial stream, river, pond, or lake; influenced by presence of water
   Categorical ✓
   Suitable Categories:
   1. Present
   2.
   Continuous __
   Unit of Measure: Minimum: Maximum:
   Applies seasonally? Yes __ No ✓ Which seasons?

2. Organic inputs from surrounding habitat
   Categorical ✓
   Suitable Categories:
   1. Present
   Continuous __
   Unit of Measure: Minimum: Maximum:
   Applies seasonally? Yes __ No ✓ Which seasons?

3. Seasonally wet to moist soils
   Categorical ✓
   Suitable Categories:
   1. Present
   Continuous __
   Unit of Measure: Minimum: Maximum:
   Applies seasonally? Yes ✓ No __ Which seasons? Spring to mid-summer

4. Exposure
   Categorical ✓
   Suitable Categories:
   1. Partial to full shade
   Continuous __
   Unit of Measure: Minimum: Maximum:
   Applies seasonally? Yes __ No ✓ Which seasons?

Key Ecological Functions

1. Primary productivity

2. Wildlife food and habitat
3. Detention storage of floodwater
4. Soil stabilization; increased water quality

Threats

(Indicate L - M - H)

Change in fire regime: L Grazing: M Mining: M
Exotics: H Development: H (e.g., dams) Timber harvest: M
Roads (explain): M
Others: Lowered water levels resulting from diversions = H. Flow regulation (may flood or dry out habitats) = H.

Key Assumptions

Nearby perennial water feature influences the vegetation in this habitat type. Many areas in this habitat type may be subject to periodic flooding and/or high water table. Located on floodplains or lower slopes adjacent to water bodies. Riparian areas with perennially saturated soils are included in wet forest habitat type.

Comments

Total number of species in group = 32. Federal status species = 0. Rare species (any NHP status) = 15. Representative (common and/or dominant) species: *Carex deweyana, C. disperma, C. hendersonii, C. pellita,* and *C. sheldonii*.

Dispersal

Pollinators: wind; animals
Dispersal mode: wind, water?, or animals? (unknown)
Requirements for dispersal: unknown

Key Unknowns and Monitoring or Research Needs

Unknown: If grazing is affecting spp. diversity in this habitat type.
Population biology, trends, genetics and demography.
Nature of relations with microbial, fungal & vascular plant associates, fauna.

Monitoring needs:
Monitor populations (and recruitment) in natural disturbances (fire, landslide, snow avalanche, frost heaving, summer elk browsing)

Research needs:
Determine contribution of sexual vs. asexual reproduction to recruitment.
More inventory to locate new populations and habitats of rare spp.
Establish undisturbed genetic reserves at type localities and exceptionally diverse communities, for baseline research.
Improve identification skills of field workers.

Degree of confidence in knowledge of species: high __ med-hi ✓ medium __ med-lo __ low __
Trend: increasing __ stable __ decreasing ✓ unknown __

Columbia River Basin Scientific Assessment
Plant Panel Species Information

Date: January 1995 Panelist Name: Brainerd, Kuykendall, Newhouse, Wilson, Zika

Species or Species Group: *CAREX* OF ROCKY STREAMBEDS

Province and/or Section: Life Form: LF4 (Cryptophytes)

Key Environmental Correlates

1. Hydraulic scouring by fast-flowing streams (water and/or ice)
   - Categorical ✓
     - Suitable Categories:
     - 1.Present
   - Continuous __
     - Unit of Measure: Minimum: Maximum:
   - Applies seasonally? Yes ✓ No __ Which seasons? Winter, spring
2. Rocky streambed or bank
   - Categorical ✓
     - Suitable Categories:
     - 1. Cobbles 3. Gravel
     - 2. Boulders
   - Continuous __
     - Unit of Measure: Minimum: Maximum:
   - Applies seasonally? Yes __ No ✓ Which seasons?
3. Seasonally inundated growing site
   - Categorical ✓
     - Suitable Categories:
     - 1. Present
   - Continuous __
     - Unit of Measure: Minimum: Maximum:
   - Applies seasonally? Yes ✓ No __ Which seasons? Late fall, winter, spring
4. Seasonally exposed growing site (at/just above water line)
   - Categorical ✓
     - Suitable Categories:
     - 1. Present
   - Continuous __
     - Unit of Measure: Minimum: Maximum:
   - Applies seasonally? Yes ✓ No __ Which seasons? Summer growing season
5. Sun to part shade
   - Categorical ✓
     - Suitable Categories:
     - 1. Present 3.
     - 2. 4.
   - Continuous __
     - Unit of Measure: Minimum: Maximum:
   - Applies seasonally? Yes __ No ✓ Which seasons?

Key Ecological Functions

1. Habitat for fish and other aquatic life
2. Water cooling (shade)
3. Streambank/bed stabilization

Threats

(Indicate L - M - H)

Change in fire regime: L
Grazing: H
Mining: H (esp. placer mining)
Exotics: L
Development: H (e.g., dams)
Timber harvest: M
Roads (explain): M
Others: Lowered water levels resulting from diversions = H. Flow regulation (may flood or dry out habitats) = H.

Key Assumptions

Requires habitat that experiences hydraulic scouring from rapidly-flowing water, and inundation alternating with exposure.

Comments

Total number of species in group = 7. Federal status species = 0. Rare species (any NHP status) = 0.
Representative (common and/or dominant) species: *C. interrupta, C. nudata*.
Carex nudata declines rapidly in eastern OR if grazed/trampled (B. Youtie, pers. comm.)

Dispersal

Pollinators: wind
Dispersal mode: gravity, wind, water, animals?
Requirements for dispersal: unknown

Key Unknowns and Monitoring or Research Needs

Unknown: Habitat suitability of rivers with near-constant water levels (e.g., spring-fed).
If grazing is affecting spp. diversity in this habitat type.
Population biology, trends, genetics and demography.
Nature of relations with microbial, fungal & vascular plant associates, fauna.

Monitoring needs:
Monitor populations (and recruitment).

Research needs:
Determine contribution of sexual vs. asexual reproduction to recruitment.
Establish undisturbed genetic reserves at type localities and extensive intact communities.
Improve identification skills of field workers.

Degree of confidence in knowledge of species: high __ med-hi ✓ medium __ med-lo __ low __
Trend: increasing __ stable __ decreasing ✓ unknown __

Columbia River Basin Scientific Assessment
Plant Panel Species Information

Date: January 1995 Panelist Name: Brainerd, Kuykendall, Newhouse, Wilson, Zika

Species or Species Group: *CAREX* OF SAGEBRUSH STEPPE WETLAND AND RIPARIAN

Province and/or Section: Life Form: LF4 (Cryptophytes)

Key Environmental Correlates

1. Annually wet to moist soils
   - Categorical ✓
     - Suitable Categories:
     - 1. Present
   - Continuous __
     - Unit of Measure: Minimum: Maximum:
   - Applies seasonally? Yes ✓ No __ Which seasons? All (possibly dry for short periods in late summer/early fall

2. Low annual precipitation
   - Categorical __
     - Suitable Categories:
   - Continuous ✓
     - Unit of Measure: mm/yr Minimum: 100mm Maximum: 500mm (Franklin and Dyrness 1974)
   - Applies seasonally? Yes __ No ✓ Which seasons?

3. Hot, dry summers
   - Categorical ✓
     - Suitable Categories:
     - 1. Present
   - Continuous __
     - Unit of Measure: Minimum: Maximum:
   - Applies seasonally? Yes ✓ No __ Which seasons? Summer

4. Grassland-shrub community
   - Categorical ✓
     - Suitable Categories:
     - 1. Present
   - Continuous __
     - Unit of Measure: Minimum: Maximum:
   - Applies seasonally? Yes __ No ✓ Which seasons?

5. Presently or historically ungrazed or moderately grazed
   - Categorical ✓
     - Suitable Categories:
     - 1. Present
   - Continuous __
     - Unit of Measure: Minimum: Maximum:

Applies seasonally? Yes __ No ✓ Which seasons?

Key Ecological Functions

1. Primary productivity
2. Wildlife food and habitat
3. Detention/storage of floodwater
4. Soil stabilization; increased water quality

Threats

(Indicate L - M - H)

Change in fire regime: M Grazing: H Mining: M
Exotics: H Development: H (e.g., dams, rural residential, agriculture, stock watering holes, etc.)
Timber harvest: L Roads (explain): L
Others: Lowered water levels and drying resulting from diversions or ditching = H. Flow regulation (may flood or dry out riparian habitats) = H.

Key Assumptions

Periodic flooding and/or high water table influence this habitat.

Comments

These plants generally decline with grazing. Many of these species are alkaline-tolerant. Most or all examples of this habitat probably qualify as jurisdictional wetlands.

Total number of species in group = 26. Federal status species = 0. Rare species (any NHP status) = 8. Representative (common and/or dominant) species: *Carex athrostachya, C. douglasii, C. nebrascensis, C. praegracilis, and C. viridula.*

Dispersal

Pollinators: wind; ants?; other animals?
Dispersal mode: gravity, wind, water?, animals? (unknown)
Requirements for dispersal: Plants must not be grazed until fruit matures and dehisces

Key Unknowns and Monitoring or Research Needs

Unknown: Population biology, trends, genetics and demography.
Nature of relations with microbial, fungal & vascular plant associates, fauna.
Monitoring needs:
Monitor populations (and recruitment) in natural disturbance areas (fire, etc.).
Research needs:
Determine contribution of sexual vs. asexual reproduction to recruitment.
More inventory to locate new populations and habitats of rare spp. and intact communities.
Establish undisturbed genetic reserves at type localities and exceptionally diverse communities, for baseline research.
Improve identification skills of field workers.

Degree of confidence in knowledge of species: high __ med-hi ✓ medium __ med-lo __ low __
Trend: increasing __ stable __ decreasing ✓ unknown __

Columbia River Basin Scientific Assessment
Plant Panel Species Information

Date: January 1995 Panelist Name: Brainerd, Kuykendall, Newhouse, Wilson, Zika

Species or Species Group: *CAREX* OF DRY SAGEBRUSH STEPPE

Province and/or Section: Life Form: LF4 (Cryptophytes)

Key Environmental Correlates

1. Low annual precipitation
   Categorical __
   Suitable Categories:
   1.
   Continuous ✓
   Unit of Measure: mm/yr Minimum: 100mm Maximum: 500mm
   (Franklin and Dyrness 1974)
   Applies seasonally? Yes __ No ✓ Which seasons?

2. Hot, dry summers
   Categorical ✓
   Suitable Categories:
   1. Present
   Continuous __
   Unit of Measure: Minimum: Maximum:
   Applies seasonally? Yes ✓ No __ Which seasons? Summer

3. Grassland-shrub community
   Categorical ✓
   Suitable Categories:
   1. Present
   Continuous __
   Unit of Measure: Minimum: Maximum:
   Applies seasonally? Yes __ No ✓ Which seasons?

4. Presently or historically ungrazed or moderately grazed
   Categorical ✓
   Suitable Categories:
   1. Present
   Continuous __
   Unit of Measure: Minimum: Maximum:
   Applies seasonally? Yes __ No ✓ Which seasons?

Key Ecological Functions

1. Primary productivity
2. Wildlife food and cover, including invertebrates

3. Soil stabilization

Threats

(Indicate L - M - H)

Change in fire regime: M
Grazing: H
Mining: H
Exotics: H
Development: M
Timber harvest: L
Roads: L
Others: Recreation (trampling by vehicles, foot) = M

Key Assumptions

Some spp. eventually sensitive to grazing and have declined, e.g. *c. filifolia.*

Comments

Most of these plants probably decline with grazing.
Total number of species in group = 7. Federal status species = 0. Rare species (any NHP status) = 3.
Representative (common) species include: *Carex douglasii, C. filifolia var. filifolia*, and *C. vallicola.*

Dispersal

Pollinators: wind, possibly ants?
Dispersal mode: gravity, water, wind? animals?
Requirements for dispersal: Plants must not be grazed until fruit matures and dehisces

Key Unknowns and Monitoring or Research Needs

Unknown: Population biology, trends, genetics and demography.
Nature of relations with microbial, fungal & vascular plant associates, fauna.
Monitoring needs:
Monitor populations (and recruitment) in natural disturbances (fire, etc.).
Research needs:
Determine contribution of sexual vs. asexual reproduction to recruitment.
Establish undisturbed genetic reserves at type localities and intact communities for baseline research.
Improve identification skills of field workers.

Degree of confidence in knowledge of species: high ✓ med-hi __ medium __ med-lo __ low

Trend: increasing __ stable __ decreasing ✓ unknown __

Columbia River Basin Scientific Assessment
Plant Panel Species Information

Date: January 1995 Panelist Name: Brainerd, Kuykendall, Newhouse, Wilson, Zika

Species or Species Group: *CAREX* OF WET FORESTS

Province and/or Section: Life Form: LF4 (Cryptophytes)

Key Environmental Correlates

1. Soil moisture regime
   Categorical ✓
   Suitable Categories:
   1. Saturation at or near soil surface
   Continuous __
   Unit of Measure: Minimum: Maximum:
   Applies seasonally? Yes ✓ No __ Which seasons? Most or all of growing season

2. Canopy cover
   Categorical ✓
   Suitable Categories:
   1. Deep shade
   2. Partial shade at edge of meadows, or in open woods
   Continuous __
   Unit of Measure: Minimum: Maximum:
   Applies seasonally? Yes __ No ✓ Which seasons?

Key Ecological Functions

1. Primary productivity
2. Wildlife food and cover, including invertebrates
3. Soil stabilization

Threats

(Indicate L - M - H)

Change in fire regime: M
Grazing: H
Mining: H
Exotics: M
Development: L
Timber harvest: H
Roads: M
Others: Beaver flooding can be a local threat = M

Key Assumptions

May be near perennial water features, but wetter than riparian.

Comments

At one extreme may border on peatland.

Much or all of this habitat qualifies as jurisdictional wetlands.

Total number of species in group = 15. Federal status species = 0. Rare species (any NHP status) = 9.

Representative (common and/or dominant) species: *Carex laeviculmis, C. mertensii, C. utriculata.*

Dispersal

Pollinators: wind
Dispersal mode: gravity, water, wind? perhaps some animal transport?
Requirements for dispersal: unknown

Key Unknowns and Monitoring or Research Needs

Unknown:

- Effects of logging and mining on near-surface hydrology during critical times in the growing season.
- Number of endemic or disjunct invertebrates and fungi in wet soils, and their relation to the ecological requirements of *Carex* spp. in the habitat
- Population trends of rare *Carex* in these habitats
- How the species disperse between widely disjunct habitats, or if they do.

Monitoring needs (for rare spp.):

- Monitor clonal cover and recruitment over 5+ years in undisturbed sites to determine baseline
- Monitor achene production.
- Monitor effects of air pollution on system chemistry.

Research needs:

- Establish undisturbed genetic preserves to protect pristine populations from management and allow baseline monitoring.
- Study interactions between these *Carex* and other flora and fauna in such specialized habitats, emphasizing non-vascular and invertebrate spp.

Degree of confidence in knowledge of species: high ✓ med-hi __ medium __ med-lo __ low

Trend: increasing __ stable __ decreasing __ unknown ✓

Columbia River Basin Scientific Assessment
Plant Panel Species Information

Date: January 1995 Panelist Name: Brainerd, Kuykendall, Newhouse, Wilson, Zika

Species or Species Group: *CAREX* OF MESIC FORESTS

Province and/or Section: Life Form: LF4 (Cryptophytes)

Key Environmental Correlates

1. Canopy cover
   - Categorical ✓
     - Suitable Categories:
       1. Deep shade
       2. Partial shade, meadow margins and open woods
   - Continuous __
     - Unit of Measure: Minimum: Maximum:
   - Applies seasonally? Yes __ No ✓ Which seasons?

2. Soil moisture
   - Categorical ✓
     - Suitable Categories:
       1. Mesic
   - Continuous __
     - Unit of Measure: Minimum: Maximum:
   - Applies seasonally? Yes ✓ No __ Which seasons? Summer growing season

Key Ecological Functions

1. Primary productivity
2. Wildlife food and cover, including invertebrates
3. Prevention of soil erosion

Threats

(Indicate L - M - H)

Change in fire regime: Fire suppression: M
Grazing: H
Mining: H
Exotics: H
Development: H
Timber harvest: M
Roads (explain): roads through meadows = M; subsequent improved access and development = H.
Others: Recreation impacts: trampling, camping, compaction, fire-building, associated backcountry livestock trampling-grazing-exotic introduction = M to H, depending on size of site
Others: Succession: M

Key Assumptions

No sharp boundary between wet and mesic forest habitats and spp. pools, but mesic habitats would generally not meet jurisdictional wetland criteria of most wet forests.

Comments

Most or all areas in this habitat type would not meet the definition of jurisdictional wetlands; drier than wet forest habitat type; not influenced by proximity to permanent water body.

Total number of species in group = 14. Federal status species = 1. Rare species (any NHP status) = 6.
Representative (common) species: *Carex geyeri, C. rossii.*

Dispersal

Pollinators: wind
Dispersal mode: gravity, wind?, animals?
Requirements for dispersal: unknown

Key Unknowns and Monitoring or Research Needs

Unknown: If grazing excesses have affected spp. diversity in this habitat type.
Population biology, genetics and reproduction.
Nature of relations with fungal & vascular associates, native & introduced fauna.
Demography and population trends.

Monitoring needs:
Follow life history of rare & common spp for 10+ years in undisturbed "control" situations, to provide baseline for management decisions.
Monitor populations (and recruitment) in natural disturbances (fire, landslide, snow avalanche, flood, frost heaving)
Monitor populations (and recruitment) in unnatural disturbances (mowed roadsides, grazed pastures, campgrounds, livestock staging areas,)

Research needs:
Determine contribution of sexual vs. asexual reproduction to recruitment.
More inventory to locate new populations and habitats of rare spp.
Establish undisturbed genetic reserves at type localities and exceptionally diverse communities for baseline research.
Improve identification skills of field workers.

Degree of confidence in knowledge of species: high __ med-hi ✓ medium __ med-lo __ low

Trend: increasing __ stable __ habitat decreasing ✓ unknown _

Columbia River Basin Scientific Assessment
Plant Panel Species Information

Date: January 1995 Panelist Name: Brainerd, Kuykendall, Newhouse, Wilson, Zika

Species or Species Group: **CAREX OF DRY FORESTS**

Province and/or Section: Life Form: LF4 (Cryptophytes)

Key Environmental Correlates

1. Canopy cover
   - Categorical ✓
     - Suitable Categories:
       1. Deep shade
       2. Partial shade, meadow margins and open woods
   - Continuous __
     - Unit of Measure: Minimum: Maximum:
   - Applies seasonally? Yes __ No ✓ Which seasons?

2. Soil moisture regime
   - Categorical ✓
     - Suitable Categories:
       1. Xeric
   - Continuous __
     - Unit of Measure: Minimum: Maximum:
   - Applies seasonally? Yes ✓ No __ Which seasons? Summer growing season

Key Ecological Functions

1. Primary productivity
2. Wildlife food and cover, including invertebrates and microbial spp.
3. Soil stabilization

Threats

(Indicate L - M - H)

Change in fire regime: M
Grazing: H
Mining: H
Exotics: M
Development: H
Timber harvest: H
Roads (explain): M
Others: Recreation impacts: trampling, camping, compaction, fire-building, associated backcountry livestock trampling-grazing-exotic introduction = M to H, depending on size of site

Key Assumptions

No sharp boundary between mesic and xeric forest habitats and spp. pools, but mesic habitats would generally have more moderate conditions, and hence be more susceptible to weed invasion and easier to

reforest if logged.

Comments

Total number of species in group = 13. Federal status species = 1. Rare species (any NHP status) = 3.

Representative (common) species: *Carex inops*.

Dispersal

Pollinators: Wind
Dispersal mode: gravity, wind?, animals? (possibly ants for prostrate culm spp., e.g., C. concinnoides)
Requirements for dispersal: unknown

Key Unknowns and Monitoring or Research Needs

Unknown: If grazing excesses in last 150 yrs have affected spp. diversity in this habitat type.
Population biology, trends, genetics and demography.
Nature of relations with microbial, fungal & vascular plant associates, native & introduced fauna.

Monitoring needs:
Follow life history of rare & common spp for 10+ years in undisturbed "control" situations, to provide baseline for management decisions.
Monitor populations (and recruitment) in natural disturbances (fire, landslide, snow avalanche, flood, frost heaving)
Monitor populations (and recruitment) in unnatural disturbances (mowed roadsides, grazed pastures, campgrounds, livestock staging areas, etc.)

Research needs:
Determine contribution of sexual vs. asexual reproduction to recruitment.
More inventory to locate new populations and habitats of rare spp.
Establish undisturbed genetic reserves at type localities and exceptionally diverse communities for baseline research.
Improve taxonomy. Improve identification skills and documentation of field workers.

Degree of confidence in knowledge of species: high __ med-hi ✓ medium __ med-lo __ low

Trend: increasing __ stable __ decreasing _ unknown ✓