University of Alberta

Reclamation Status Of Plains Rough Fescue Grasslands At Rumsey Block In Central Alberta, Canada After Oil And Gas Well Site And Pipeline Disturbances

by

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This morning the two of us, Jennifer and myself, were touring the ranch with Alicia and Tracy when Alicia slammed on the brakes and backed up a bit. We looked at each other in astonishment as Alicia got out and ripped some grass out of the ground at the side of the road. It was a lone tuft of downy brome, an aggressive annual weed that had allegedly arrived after a pipeline was recently constructed. Alicia was going to have none of that on her family's ranch.

As I complete this M.Sc. project, I remember Alicia Hargrave who showed me that, with awareness and diligence of all parties, industrial development can occur where ecological integrity is to be preserved. She is no longer with us, but countless others remain that share that same determination. I am inspired, and dedicate this thesis to them.

ABSTRACT

Rumsey Block is a remnant of plains rough fescue (*Festuca hallii* (Vasey) Piper) prairie in southern Alberta, Canada. Reclamation success of 17 pipelines and 36 well sites was assessed by comparing them to undisturbed prairie and determining the influences of age, construction and revegetation methods and cattle grazing. With few exceptions, these disturbances had different soil and plant community characteristics than undisturbed prairie. Reclamation success was more closely related to methods of construction and revegetation and grazing pressure than to age. Greater similarity between undisturbed prairie and well sites or pipelines were related to construction methods that leave sod and topsoil intact. Revegetation by natural recovery resulted in a more diverse community than seeding either native or non native mixes but progress is slower on open soil disturbance than on minimal disturbance. In most cases increased grazing pressure was associated with lower reclamation success.

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1. Issues and Background

1.1 Overview of Issues

Attention to Rumsey Block has intensified in recent years due to increased proposals for energy development. Impacts of oil and gas activities on plains rough fescue (*Festuca hallii* (Vasey) Piper) prairie are poorly studied and few restoration successes on prairie disturbed by industry have been documented. Several Alberta ministries, industrial corporations and non-government organizations are interested in supporting research to better understand how industrial activity impacts plains rough fescue plant communities, how to best mitigate these disturbances, and how to restore them successfully.

Rumsey Block is Crown Land with activity administered by three provincial government bodies, Alberta Community Development, Alberta Public Lands and Alberta Energy. Public Lands leases the land for grazing to a few ranches and grazing cooperatives. Hiking and hunting are allowed, but vehicle use is tightly restricted. Several oil and gas companies have surface access rights on some parts of Rumsey Block (Alberta Wilderness Association 2006a). Since oil and gas companies in Alberta continually exchange surface rights and responsibilities and use the services of many contractors during various stages of construction and reclamation, it is difficult to have consistency in construction and reclamation because such policies aren't always passed on.

Rumsey Block contains one of the few intact plains rough fescue plant communities in western Canada (Alberta Wilderness Association 2006b). The soil and climatic conditions upon which this plant community depends are very favourable for annual cropping (Padbury et al. 2002, Natural Regions Committee 2006). Thus remnants across western Canada in areas such as Riding Mountain National Park, Prince Albert National Park, the Saskatoon Natural Prairie and the Handhills Ecological Reserve, occur mainly where topographical or administrative constraints have discouraged annual cropping, hay production or heavy grazing (Legris and Cornish 1997, Canadian Parks and Wilderness Society 2006, Parks Canada 2006).

Attempts to restore plains rough fescue have been mostly unsuccessful, although there are undocumented occurrences. Plains rough fescue community dynamics under natural disturbance (including grazing) have been studied; however, there is little research on its reclamation after anthropogenic disturbances. Investigating whether disturbances are being successfully restored is necessary to inform future restoration efforts. This research should include below ground and above ground plant community aspects.

1.2 Plains Rough Fescue Prairie

The Northern Fescue Natural Subregion borders the Mixedgrass and Dry Mixedgrass Natural Subregions to the south and the Central Parkland Natural Subregion to the north. In western Alberta it evolves into higher elevations of the Foothills Fescue Natural Subregion (Natural Regions Committee 2006). Plains rough fescue and foothills rough fescue (*Festuca campestris* Rydb.) are distinct species occupying the Northern Fescue and Foothills Fescue Natural Subregions, respectively. Altai fescue (*Festuca altaica* Trin.) exists at subalpine and alpine elevations and in northern British Columbia. Foothills rough fescue communities occupy higher elevations of the Cypress Hills in southeastern Alberta and southwestern Saskatchewan. Plains rough fescue has been found across the Prairie Provinces, Ontario and northern United States (Pavlick and Looman 1984), but the region characterized by communities dominated by this grass is only a narrow band across central Alberta, Saskatchewan, Manitoba and the Dakotas.

Several gradients exist on grasslands which determine particular plant communities. Most of these gradients influence soil water dynamics. As the gradient moves from wetter to drier conditions, the community shifts from dominance by woody species to moisture loving grasses to grasses tolerant of drier conditions. For example, western porcupine grass (*Hesperostipa curtiseta* (A.S. Hitchc.) Barkworth) dominated communities are more frequent in the drier climate of the southern prairies. Further north, available moisture increases and *Festuca hallii* dominated communities become more frequent until there is sufficient moisture for trembling aspen (*Populus tremuloides* Michx.) communities (Weerstra and Holcroft Weerstra 1998). Similar effects occur across toposequences from south facing slopes to crests to north facing slopes to depressions, and along grazing gradients from heavily grazed to ungrazed. Fire acts in a similar manner to grazing by removing biomass thereby affecting available soil water.

1.3 Attributes of Rumsey Block

Rumsey Block (a.k.a. Wildland or Parkland) is located east of Rumsey in Central Alberta, approximately 80 km east-southeast of Red Deer. It includes the 34 km^2 Rumsey Ecological Reserve in the north, and the 149 km^2 Rumsey Natural Area in the south. The Ecological Reserve includes a quarter section of land protected from grazing since 1973. The Rumsey Block lies between the Northern Fescue and Central Parkland Natural Subregions (Natural Regions Committee 2006). Its hummocky topography has helped prevent it from being annually cultivated, like much of the grassland around it.

Rumsey Block falls within the Endiang Upland Ecodistrict (McNeil 2004) of the Northern Fescue Natural Subregion of Alberta (Natural Regions Committee 2006). The Northern Fescue Natural Subregion is a narrow arc beginning southwest of Drumheller, running north of Hanna and east through Provost into Saskatchewan. It continues southeast through Saskatchewan, western Manitoba and into North Dakota, although the national classification includes it as part of the Aspen Parkland Ecoregion (Ecological Stratification Working Group 1995). It is transitional between two Mixedgrass Subregions to the south and the Central Parkland Subregion to the north, and evolves into the Foothills Fescue Subregion in western Alberta. Historically this ecoregion has been placed in the Aspen Parkland (Achuff and Wallace 1977, Fehr 1982, Strong and Leggat 1992, Ecological Stratification Working Group 1995), but is now a separate subregion. Defining boundaries of the region characterized by plains rough fescue grassland is difficult because cultivation altered most of its suitable habitat, and it grades easily from regions where mixedgrass communities or aspen communities cover the landscape (Weerstra and Holcroft Weerstra 1998). The Endiang Upland Ecodistrict includes 17 townships to the north and west of Hanna (McNeil 2004). The Rumsey Natural Area accounts for over two of these townships in the western part of the Ecodistrict.

The Northern Fescue Natural Subregion falls within the Grassland Ecoclimatic Province (Natural Regions Committee 2006). The continental climate is characterized by cold winters and short hot summers, with a mean annual temperature of 3 °C (Strong and Leggat 1992). The growing season lasts from May until September with over 100 frost free days per year (Natural Regions Committee 2006). Climate normals for the nearest weather stations at Scollard and Craigmyle show a mean annual precipitation of 390.3 mm and 407.0 mm, respectively. Most precipitation occurs as rainfall in June, July and

August (Environment Canada 2004). Moisture is limiting for plant growth due to high insolation and drying winds (Strong and Leggat 1992).

The landscape of Rumsey Block mostly originated from deposition of medium textured glacial till derived from the Edmonton formation, with the Paskapoo and Bearpaw formations exerting some influence. The Edmonton and Paskapoo formations are brackish or freshwater sediments that developed into Orthic Dark Brown Chernozems dominating well drained uplands. The Bearpaw formation is marine shale that developed into Dark Brown Solodized Solonetzes comprising approximately 20 % of Rumsey Block soils (Bowser et al. 1951). A small proportion of Gleysolic soils are found in depressions throughout Rumsey Block (Bowser et al. 1951). A small amount of sandy and gravelly outwash exists along the western boundary of the Ecological Reserve and a series of eskers occurs immediately to the east of that outwash area (Fehr 1982).

Terrain of the Northern Fescue Subregion is mostly hilly with annual cropping as the primary land use (Natural Regions Committee 2006), however, the Rumsey Block is atypical, with rolling to strongly hummocky topography. This terrain is not well suited to cultivation and land use is mainly pastures and oil and gas operations, although a few private quarters of gently rolling land in eastern Rumsey Block are in annual crops.

Surface drainage on Rumsey Block is internal, with depressions catching most water where it then evaporates or is recharged into ground water. The small glacial outwash area along the Ecological Reserve western boundary has some drainage westward into the Snake Lake Drainage which eventually runs into the Red Deer River (Fehr 1982).

Due to the complex topography, there is much variation in soil depth and development. Deeper soils occur near toe slopes and on north facing slopes where there is more available moisture. All upland soils developed under grassland vegetation and thus have very fertile topsoil (Bowser et al. 1951). Hummocky topography results in a complex pattern of soil water dynamics because of variable exposures of sun on the soil surface, the variety of positions on slopes and differences in accumulation of rain and snow among hilltops, depressions, lee slopes and windward slopes. This results in differential soil development leading to establishment of a mosaic of vegetation communities.

Upland grasslands dominate the Northern Fescue Natural Subregion (Natural Regions Committee 2006). North facing slopes often have woody vegetation due to less water loss from insolation. Wetlands are frequent in this morainal landscape, especially in the depressional pockets of the knob and kettle terrain of Rumsey Block, and comprise up to 6 % of the land area in this subregion (Natural Regions Committee 2006).

Plains rough fescue dominates under mesic soil conditions (Natural Regions Committee 2006). It forms dense stands with low diversity where undisturbed. Grazing and dry soil conditions favour western porcupine grass, Hooker's oatgrass (*Helictotrichon hookerii* (Scribn.) Henr.), bearded wheatgrass (*Elymus subsecundus* (Link) A.Love & D.Love), June grass (*Koeleria macrantha* (Ledeb.) J.A. Schultes), pasture sage (*Artemisia frigida* Willd.), fleabanes (*Erigeron* spp. L.) and other perennial forbs. Moister sites, like north facing slopes, contain western snowberry (*Symphoricarpos occidentalis* Hook.), silverberry (*Elaeagnus commutata* Bernh. ex Rydb.), Wood's rose (*Rosa woodsii* Lindl.) and saskatoon berry (*Amelanchier alnifolia* (Nutt.) Nutt. ex M. Roemer). On northerly slopes and adjacent to moist depressions, more trembling aspen is encountered.

Various wetland communities occur in the kettles. Species include rushes (*Scirpus* spp. L.), sedges (*Carex* spp. L.), hydrophytic grasses such as northern reedgrass (*Calamagrostis* spp. Adans.), sloughgrass (*Beckmannia syzigachne* (Steud.) Fern.) and *Glyceria* spp. R. Br.), cattails (*Typha latifolia* L.) and willows (*Salix* spp. L.). Saline wet meadows occur in the glacial outwash along the western boundary of the Ecological Reserve and contain cosmopolitan bulrush (*Schoenoplectus maritimus* (L.) Lye), Nuttall's alkali grass (*Puccinellia nuttalliana* (J.A. Schultes) A.S. Hitchc.), saltgrass (*Distichlis spicata* (L.) Greene) and foxtail barley (*Hordeum jubatum* L.) (Fehr 1982).

Detailed plant community descriptions of Rumsey Ecological Reserve or adjacent areas were developed by Wroe (1971) and Fehr (1982). In the 1970s and 1980s, grasslands covered approximately 73 % of the landscape mosaic in Rumsey Ecological Reserve. Of the total area, 50 % or less was composed of *Festuca* grassland and about 11 % was composed of *Hesperostipa-Festuca* grassland. The remainder of the grassland was dominated by *Hesperostipa-Artemisia* and *Symphoricarpos* communities, with a small contribution from the *Koeleria-Agropyron* community. Fehr (1982) recognized small contributions from *Bouteloua-Artemisia* and *Agrostis-Achillea-Antennaria* communities.

The landscape permanency and the complex mosaic of habitat types in Rumsey Block provides for many wildlife species. Whitetail deer (*Odocoileus virginianus* Zimmerman, 1970), mule deer (*Odocoileus hemionus* Rafinesque, 1817) and moose (*Alces alces* Linnaeus, 1758) are common ungulates. Pronghorn antelope (*Antilocapra americana* Ord, 1815) also occur (Fehr 1982). Numerous birds are found, including those requiring a moderately to heavily grazed prairie habitat. Richardson's ground squirrel (*Spermophilus richardsonii* Sabine, 1822) is a key species (Natural Regions Committee 2006), providing burrows for snakes, amphibians, insects, birds and other small animals, and food for raptors, badgers, coyotes, carrion feeders and other predators. The frequent patches of tree cover host forest specific animals, including cavity or tree nesting birds, bats and small mammals. A different suite of species is found in wetland pockets, such as amphibians, muskrats (*Ondatra zibethicus* Linnaeus, 1766), waterfowl and other water birds (Natural Regions Committee 2006). Fehr (1982) has a longer list of wildlife observed during a biophysical inventory of the Rumsey Ecological Reserve.

The ranges for seven species at risk intersect Rumsey Block, but only five have potential to occur in the type of wildlife habitats available. These are loggerhead shrike (*Lanius ludovicianus excubitorides* Linnaeus, 1766), long billed curlew (*Numenius americanus* Bechstein, 1812), yellow rail (*Coturnicops noveboracensis* Gmelin, 1789), Sprague's pipit (*Anthus spragueii* Audubon, 1844) and monarch (*Danaus plexippus* Linnaeus). All are listed as Threatened by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC), except monarch and yellow rail, which are listed as Special Concern (Environment Canada 2005).

1.4 History of Rumsey Block

The following history is adapted from Bradley (2004) and the AWA (2006c). Prior to 1900, Rumsey Block was primarily occupied by nomadic Indian groups who hunted the abundant wildlife. Settlers did not arrive to homestead until just before the turn of the century. Grazing leases were established after the Dominion Land Survey was completed in 1907. Since then, grazing privileges have stayed in very few hands.

The Usher lease in the Rumsey Ecological Reserve endured from 1917 until 1999 when it was transferred to the Stewarts. This resulted in a change from winter grazing, considered beneficial to sustaining plains rough fescue communities, to summer grazing. Grazing rates on the property had been conservative at 26 to 36 acres/head/year. The ranchers wanted to reduce the rate to 20 acres/head/year, but Public Lands determined after assessment in 1968 that the minimum stocking rate needed to sustain forage production was 24 to 25 acres/head/year and only under superior grazing management.

In 1968 a quarter section in Rumsey Block was fenced as a reference area against which to measure grazing practices. In 1973 this quarter was removed from the Usher grazing lease and designated as a Grasslands Research Reserve for conservation and research by the Department of Lands and Forestry and the University of Alberta.

In the mid to late 1970s Alberta Recreation, Parks and Wildlife and the Alberta Wilderness Association (AWA) recognized the significance of the area and attempted to have all public lands within Rumsey Block designated as a reserve for conservation purposes. In 1979, 34 km^2 in the north end of Rumsey Block was nominated to be reserved because of its significance as one of the few large areas of aspen parkland undisturbed by cultivation, with good rangeland condition, unique landscapes and rare or uncommon animal species. Public discussion and biophysical inventories were conducted through the 1980s to achieve ecological reserve status for that area. In 1990 the Rumsey Ecological Reserve was designated on the 34 km^2 conservation area.

Under the Wilderness Areas, Ecological Reserves and Natural Areas Act, grazing could continue, but new energy leases were to be excluded and old energy leases phased out. A formal management plan was not developed for the Reserve until 1998. In 1996 the southern part of Rumsey Block consisting of 149 km^2 was designated as Rumsey Natural Area. This lowest protective tier under the Natural Heritage Policy, Special Places 2000 allows for continued economic development. Recent efforts to obtain further protection for the Rumsey Natural Area have attempted to have it designated as a Heritage Rangeland which would prohibit surface disturbance.

By the mid 1970s energy leaseholders began to extract oil and gas on Rumsey Block. In the early 1980s, after the conservation reserve was established, discussions and field tours among stakeholders occurred to determine what restrictions on development of the land should be implemented. All stakeholders agreed to conserve the natural character of the land. In 1984, guidelines developed by conservation groups and industry and government stakeholders for oil and gas activities were implemented specifically for 30 wells to be developed between 1984 and 1987. These guidelines included temporary roads only, recontouring of well sites and revegetation with native species.

A permanent road built across Rumsey Block in 1987 by a petroleum company with government endorsement came as a surprise to the AWA. It fuelled discussions about oil and gas development, and a push for protected area status. In late 1993 a Regional Integrated Decision (RID) to govern oil and gas activity was released after four years of discussion and public consultation. Its primary goal was to preserve and protect Rumsey Parkland South while allowing responsible resource use. AWA remained skeptical of the ability of the RID to prevent environmental degradation of Rumsey Block. The RID was reviewed internally in 2001 and deemed relevant and effective, with measures in place to mitigate environmental degradation as oil and gas development proceeds. The AWA argues that not all RID recommendations were being pursued, including monitoring, inventories, cumulative effects assessments and annual and five year reports.

1.5 Disturbance and Reclamation Requirements in Rumsey Block

Rumsey Block has received increased attention in the last few years partly because of the continued exchange and purchase of surface access rights to oil and gas companies and partly because of the increased feasibility and occurrence of coal bed methane extraction (Collison 2006), which is believed to have a larger footprint than traditional energy extraction methods (Alberta Wilderness Association 2006a). The AWA believes that the RID now needs updating (Alberta Wilderness Association 2006d). The phase out of existing oil and gas production they had hoped for appears to be unlikely.

Disturbances that keep the soil intact have been most successful in conserving the plains rough fescue community. The approach recommended to oil and gas companies to conserve native prairie is to practice minimal disturbance techniques and/or minimize the footprint of their activities (Sinton 2001, Alberta Energy and Utilities Board 2002).

While agricultural settlement has had the largest impact in the region, the oil and gas industry is having a significant impact on remaining intact areas of native prairie (Sinton 2001). Although most single disturbances by oil and gas are small (1 ha right-of-way for a well site or 15 m strip for a pipeline) their collective impacts on the landscape can be large. Oil and gas activity impacts prairie landscapes by fragmenting habitat; introducing exotic species in plantings or by opening niches for invasion; disturbing vegetation, soils, heritage resources and wildlife; and contaminating soil (Sinton 2001).

Reclamation did not occur in the early days of oil and gas production. In the 1950s sites were starting to be reclaimed, but construction was not designed to make reclamation easier and more successful (Sinton 2001). The idea of what a reclaimed site should look like was different from what it is today. Today, reclamation expectations and practices are regulated and successful examples have been reported for many landscapes.

A key disturbance mitigative measure is to practice minimal disturbance. Measures to create a lighter footprint from oil and gas activity include minimizing disturbance area, avoiding sensitive areas such as habitat for key plants and wildlife, avoiding work during sensitive periods such as wet seasons and nesting or rearing of wildlife, preventing accelerated loss of exposed soil, preventing non native plant introduction and controlling equipment use on site and traffic to the site (Sinton 2001). An Energy and Utilities Board information letter emphasizes development on native prairie should be avoided and existing access to non native areas should be exploited first (Alberta Energy and Utilities Board 2002). It suggests that where necessary to develop oil and gas on native prairie, minimal disturbance should be used, as outlined in the Native Prairie Guidelines Working Group (2002) for minimizing surface disturbance. Site planning should be used to locate leases along existing access routes, and to avoid development within an intact prairie, which would lead to habitat fragmentation. Necessary development should consider disturbance timing and avoid environmentally sensitive areas such as erosive soils, steep slopes or areas with sensitive wildlife, rare plants or plant communities.

For years, topsoil was salvaged to protect the seed bank during operations. By using smaller rigs, placing rigs on muskeg pads and working during dormant and dry conditions in fall and winter, topsoil can be left in place. Where topsoil must be removed, it should be handled when the ground is dry or frozen (Native Prairie Guidelines Working Group 2002). A number of minimal soil disturbance practices are listed specifically for pipeline construction such as matching technique and equipment to pipe diameter, and if soil stripping is needed salvaging the sod layer. The advantage of constructing pipelines over well sites is that topsoil and sod needs only to be salvaged a short time before the pipeline is placed and soil replaced (Native Prairie Guidelines Working Group 2002).

During reclamation, seed mixes used on native prairie should only contain native species, and preferably a diverse range of species local to the area (Native Prairie

Guidelines Working Group 2002). Seed used should be weed free, which can be determined by checking seed analysis certificates on purchased seed or sending harvested seed to a laboratory to be analyzed (Sinton 2001).

Revegetation strategies for oil and gas disturbances at Rumsey Block have evolved since the early 1980s to help reestablish native vegetation comparable to undisturbed sites. There have been three strategies: natural recovery following topsoil replacement, spreading native mulch following topsoil replacement, or seeding a mix of quickly establishing species allowing for egress of native grasses and forbs from undisturbed areas. The current recommended seed mixes for Rumsey Block are all native grasses; some are costly, limited in availability and difficult to seed without special equipment. The most recent documented strategy (as of 1992) includes applying 45.5 kg of nitrogen per hectare, which conflicts with the understanding that native plants respond poorly to nitrogen relative to agronomic and weed species (Wedin and Tilman 1996). In recent years Public Lands has been consultative in prescribing construction and reclamation measures, rather than providing blanket prescriptions (Cole Personal Communication).

2. Literature Review

2.1 Natural Disturbance

Two natural disturbances mainly affecting vegetation dynamics of plains rough fescue grasslands are grazing and fire. Altered grazing and fire regimes on these grasslands since settlement have changed plant community dynamics. Fire is now an infrequent disturbance at Rumsey Block. Due to risks associated with oil and gas activity, fire is not used for brush control and wildfires are suppressed as soon as possible. Summer grazing is practiced except on the excluded quarter section in the Ecological Reserve.

Plains rough fescue stands produce a thick layer of persistent litter. Without disturbance, most other native and non native species are excluded through shading. Fire and grazing remove this biomass, increasing invasibility by native and non native plants. Plains rough fescue persists under high moisture conditions only if disturbance is absent or at low levels; however, when its shading advantage is removed by disturbance, other plants take advantage of the moisture and establish within the fescue stand (Vujnovic et al. 2000). Although species diversity of grasslands can be increased this way, they