

Vegetation Colonizing River Gravel Bars in the Rocky Mountains of Southeastern British Columbia

Abstract

The vegetation of gravel bars in the Blaeberry River near Golden, B.C. was classified into six community types using six species-groups derived by Braun-Blanquet techniques. The distribution of communities on the bars appeared to be controlled by variation in soil texture and water table depth. Successional development of communities found in xeric and mesic locations led to a community containing species common to the climax floodplain forest of the area. Communities found in wet depressions may not be successional related to other bar communities because of frequent inundation and sediment deposition.

Introduction

Primary successional plant communities form a significant component of the vegetation in mountainous regions because new land surfaces are continually being exposed by erosional forces. As early as 1916, Cooper described successional vegetation on morainal and glacial outwash materials and reports of similar research in glaciated areas are numerous (Crocker and Major 1955, Tisdale *et al.* 1966, Viereck 1966, Lawrence *et al.* 1974). Although most major river valleys in the Canadian Rocky mountains contain areas of alluvial gravel bars, the plant communities colonizing these areas and the factors controlling their establishment have not been studied. This paper describes the vegetation of gravel bars typical of those found in river valleys along the western slope of the Rocky mountains in southeastern British Columbia.

Study Area

The Blaeberry River runs southwest through the western ranges of the Rocky mountains to join the Columbia River 16 km north of Golden, B.C. The western ranges consist of sedimentary and metamorphic rocks, mainly limestone and quartzite, and are deeply dissected through glacial and stream erosion (Holland 1964). Outwash from alpine glaciers has been deposited along several sections of the Blaeberry valley to form networks of channels and bars. Our study site, situated at an elevation of 1900m asl (51° 34'N, 116° 48'W),

is representative of a braided section of river 13 km in length.

The forests of the upper Blaeberry valley adjacent to the study site are dominated by Engelmann spruce (*Picea engelmannii*) and subalpine fir (*Abies lasiocarpa*) on the valley walls, and by white spruce (*Picea glauca*) and black cottonwood (*Populus trichocarpa*) on the flood plain. Bell (1971) placed the valley bottoms in the sub-boreal spruce zone and the upper slopes in the Engelmann spruce-subalpine fir zone of Krajina (1965). Rowe (1972) describes this part of the valley as Interior Subalpine Forest.

The closest meteorological station to the study site, Golden, B.C., averages 50 cm of precipitation annually with 40 percent falling as snow. January is the wettest month while April is the driest. Average monthly temperatures range from -11.6° C in January to 17.2° C in July, with seven months warmer than 0° C and 170 frost free days annually. The study site is higher in elevation and farther into the mountains than Golden and probably has lower temperatures and higher precipitation.

Methods

Fifty releves were located in homogeneous stands of vegetation which appeared, on the basis of initial site reconnaissance, to represent distinct communities on the bar complex. Plot dimensions were dictated by the size and shape of individual stands but were based on minimal area determinations in each of the reconnaissance community types.

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Each releve included a list of all species found in the plot rated for cover and abundance according to the seven point Braun-Blanquet scale. Local habitat conditions were described in terms of size and nature of the stand, surrounding vegetation, slope, microrrelief, moisture regime, drainage, and estimated frequency of flooding. Pits were dug in each plot to examine soil texture, profile characteristics and water table depth. A voucher collection of all plant species recorded is on file in the Herbarium at the University of Victoria (UVIC).

Floristic data were analysed using the Table Method of Ellenberg (1956), facilitated by a computer program which performed the initial sorting (Geska and Roemer 1971). A description of the Table Method is given by Mueller-Dombois and Ellenberg (1974).

Of the species groups generated by the computer program using different sorting rules, those which best reflected conditions on the bars were chosen. The selected groups were reorganized to indicate the dispersal of the community types along the prevailing environmental gradients using the program's rewriting mode. Final sorting of the data table was done by hand to emphasize relationships among community types.

Results and Discussion

Analysis of the floristic data produced four species groups (Table 1). In addition, two single species "groups" were recognized because of their value for differentiating community types. Named after the species dominant in each, they are the *Carex*, *Juncus*, *Parnassia*, *Epilobium*, *Populus*, and *Dryas* groups.

The species of the *Carex* group are most prevalent in wet areas but occur widely on the bar complex in locations with wet to mesic moisture regimes. The *Juncus* group is restricted in distribution to the wettest sites on the bars, often growing in silt deposits adjacent to standing water. The species of the *Parnassia* group are most often observed growing in moist sandy deposits along the sides of depressions and old river channels. The *Epilobium* group is widely distributed in sandy to gravelly areas with moist to mesic moisture regimes. The *Populus* group is restricted to stable areas in the center of bars where mesic conditions prevail. The *Dryas* group

consists of a single species, *Dryas drummondii*, which forms extensive mats in xeric, gravelly locations.

Six community types were differentiated on the basis of presence or absence of the species groups. The community types were named according to the dominant species group and edaphic characteristics as follows: the *Carex* Wet Depression, *Parnassia* Silt Channel, *Parnassia/Epilobium* Deep Sand, *Epilobium* Shallow Sand, *Populus* Stable Bar, and *Dryas* Dry Gravel community types.

1. *Carex* Wet Depression Community Type

The *Carex* community type is characterized by the presence of the *Carex* and *Juncus* species groups and is dominated by *Carex oederi*, *Equisetum variegatum* and *Juncus alpinus*. Other commonly occurring species include *Deschampsia cespitosa*, *Salix farriera* and *Aster hesperius*. This type is found in depressions and old channels where fine sand and silt have accumulated. The depth to water table at the time of sampling averaged 27 cm (range 15-40 cm) ensuring that hygric conditions prevail throughout the year. Flooding of this community probably occurs annually when the water table rises in spring flood.

2. *Parnassia* Silt Channel Community Type

The *Parnassia* community type is characterized by the presence of the *Parnassia* and *Carex* species groups and partial occurrence of the *Epilobium* group. The dominant species are *Parnassia palustris*, *Carex oederi* and *Equisetum variegatum*. In addition to members of the species groups mentioned, *Salix farriera*, *S. wolfii*, *Aster hesperius*, *Prunella vulgaris*, *Calamagrostis inexpansa*, and *Juncus alpinus* may occur.

Communities of this type are commonly found along lower slopes and bottoms of old river channels which have become filled with silt and fine sand to depths of 20-25 cm. Water table depths average 46 cm (range 30-55 cm). This type often occurs around wet depressions occupied by the *Carex* type. Flooding probably occurs every 2-4 years, either as seepage from rising ground water or low velocity flow over the surface of the bar.

3. Parnassia/Epilobium Deep Sand Community Type

The Parnassia/Epilobium community type is characterized by the Parnassia, Epilobium, and Carex species groups and is strongly dominated by *Parnassia palustris* and *Epilobium latifolium*. Other species which may occur include *Salix farriera*, *S. wolfii*, *Aster hesperius*, *Prunella vulgaris*, *Solidago canadensis*, and *Dryas drummondii*. This type occupies old channel positions similar to the Parnassia type but the soil consists of 15-30 cm of coarse sand over gravel. Parnassia/Epilobium communities are often found in upper slope positions around depressions that support the Parnassia type.

4. Epilobium Shallow Sand Community Type

The Epilobium community type is characterized by the Epilobium and Carex species groups. *Epilobium latifolium* is strongly dominant. *Salix farriera* and *Aster hesperius* occur commonly while *Dryas drummondii*, *S. wolfii*, and members of the Parnassia species group may also be present. Communities of this type are found in shallow depressions and upper slope positions with an average water table depth of 45 cm (range 30-60 cm). The soil consists of a 2-8 cm layer of coarse sand over gravel. They often occupy positions between Parnassia/Epilobium communities on depression slopes and Dryas communities on the top of the bar.

5. Populus Stable Bar Community Type

The Populus community type is characterized by the presence of the Populus and Epilobium species groups. Two phases are distinguished by the presence of either the Carex or the Dryas species group. This community type is dominated by long lived woody perennials including *Populus tremuloides*, *Salix farriera* and *S. wolfii*, *Epilobium latifolium* is the dominant herbaceous species. Other commonly occurring species include *Aster hesperius*, *A. ciliolatus*, *Castilleja miniata*, *Habenaria hyperborea*, *Picea glauca*, and *Prunella vulgaris*.

This community type is generally found in the center of bars often where there is a slight rise or knoll. Water table depth averages 50 cm (range 40-60 cm). The soil consists of a layer of

fine sand and silt 8-15 cm deep over gravel. The upper 1-3 cm of the silt layer is enriched with organic matter. In some locations the finer surface horizon appeared to have been deposited in the standing vegetation.

6. Dryas Dry Gravel Community Type

The Dryas community type is dominated entirely by *Dryas drummondii*. *Salix farriera*, *S. wolfii*, and *Anaphalis margaritacea* occur occasionally. This community type is found on the tops of bars, mainly on the upstream end, where floodwaters have removed sand and silt leaving only coarse gravels. The water table depth of 60 cm and the coarse texture of the soil make these sites extremely dry. During flooding, this community type is exposed to the full force of the river current which can cause severe disturbance or destruction of the vegetation cover. The prostrate habit and woody stems and roots of *Dryas* make it well suited to such severe conditions. In addition *Dryas* has a symbiotic association with nitrogen-fixing organisms which undoubtedly increases its ability to colonize these infertile soils (Lawrence *et al.* 1974).

In addition to the six community types described, the data analysis generated two type fragments, one having affinities with the Carex and Parnassia communities and the other having affinities with the Dryas communities. These fragments could not be considered as separate community types because they were represented by only two relevés each. It is not known whether these fragments are mere anomalies or if they represent infrequently occurring communities which would have been apparent in a more extensive survey of bars in the Blaeberry valley.

Distribution of Community Types

The Blaeberry River gravel bar communities appear to be distributed in relation to edaphic site conditions, particularly soil texture. Textural differences between locations on a bar arise through differential suspension and deposition of sediment during periods of flooding. Water flowing rapidly over the top of a bar will pick up fine textured materials, leaving behind coarse sands and gravels. When water enters an old channel, cut off from the main river, the flow rate

decreases, giving the finer particles time to settle. This process produces the typical textural gradient observed along a transect from the top of a bar into a depression (Figure 1). Water table depth also changes along this transect and together these parameters determine the moisture regime at a given location.

water table to the ground surface makes it more likely that plants can access capillary water, particularly since the silty material would not restrict root growth. The nutrient status of these sites would probably be better than the bar top locations because of the higher nutrient exchange capacity of fine textured soils. The main restric-

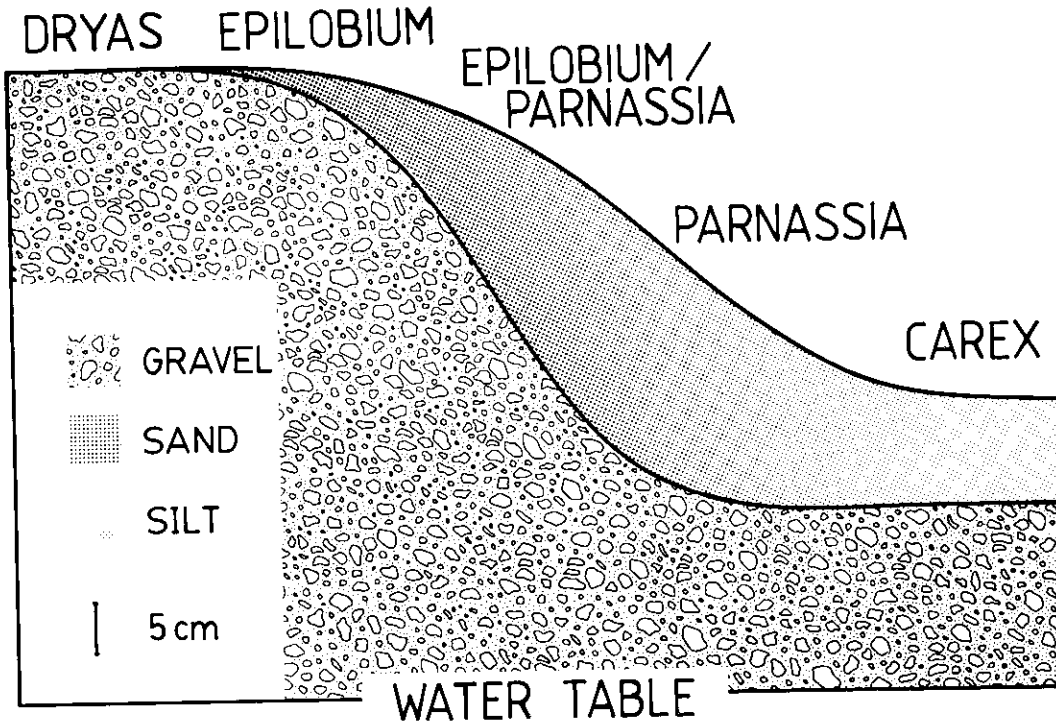


Figure 1. A schematic cross-section of the gravel bar showing the distribution of community types in relation to soil texture and water table depth.

Low moisture holding capacity and rapid drainage of the coarse gravel of the bar tops and the maximum observed water table depth in these locations makes them extremely dry during the growing season. Coarse textured soils have a low nutrient exchange capacity and, consequently are infertile (Black 1968). In addition, the compact nature of the gravel and preponderance of pebbles and stones make it difficult for establishing seedlings to develop a root system, reducing their ability to access what little moisture and nutrients are available.

In contrast, the silty soils of the depressional areas have a high moisture holding capacity and, while potentially well drained, are less permeable than the gravelly soils. The close proximity of the

tion to plant growth in silty depressions may be the frequency of flooding which causes the rooting zone to be saturated at regular intervals, particularly early in the growing season. This condition may lead to root oxygen deficiency with a concomitant reduction in root growth and nutrient uptake. In addition, wet soils warm up slowly in the spring so that onset of the growing season may be delayed (Brady 1974). Seedlings colonizing these sites would be completely submerged and subject to drowning during spring high water.

Depressional slope positions, while not as moist as the lower sites during the summer, would not be subject to prolonged submergence. Slope positions would have a more favorable

moisture regime than the gravel areas of the bar tops and therefore probably represent the most favorable environment for initial colonization of the bars.

Successional relationships among the community types may be inferred from patterns of floristic development (Mueller-Dombois and Ellenberg 1974). In the Blaeberry valley, plant succession on river terraces is directed toward a vegetation type dominated by *Populus trichocarpa* and *Picea glauca*. These two species are consistently found only in the Populus Stable Bar community type, suggesting that this community is successional more advanced than others defined in this study.

The two phases observed within the Populus community indicate that this successional stage develops from both the Dryas Dry Gravel and Epilobium Shallow Sand community types. A well established *Dryas* mat will ameliorate the xeric, infertile conditions of the bar top by adding organic matter and nitrogen to the soil. During periods of flooding, the mat will reduce water velocity and act as a filter, increasing the deposition of silt which further increases moisture availability. With improved fertility and moisture conditions, less tolerant species can invade. Lawrence (1974) found that shrubs growing in old *Dryas* mats had higher growth rates than shrubs growing on bare glacial outwash. Citing the work of Cooper (1931), he suggested that *Dryas* was

very shade intolerant and would quickly die out once other species had become established. Similar processes acting in the Epilobium community type would allow later successional species to invade in these areas.

Three relevés of the Parnassia/Epilobium Deep Sand community type (22, 25, 26), may be successional predecessors of the Epilobium community type. In these relevés the species of the Parnassia group are not abundant and are strongly dominated by *Epilobium latifolia*. The surficial sand layer in these sites is within the depth range of the Epilobium community. Local extinction of the Parnassia group species through competition with later successional species probably will occur in the future, producing stands that would be classified in the Epilobium community type.

Stands of the Populus community type were not found in depressions or in areas of deep sand or silt typical of the remaining relevés of the Parnassia/Epilobium Deep Sand, Parnassia Silt Channel, and Carex Wet Depression types. These communities may be located in areas which remain too wet in the spring to permit the establishment of later successional species. They would be expected to become drier as river bed cutting lowered the water table but, since this is a slow process, it is likely that reactivation of the old channels by changes in river flow patterns would cause the destruction of these communities before succession could occur.

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