BLACK COTTONWOOD COMMUNITIES OF SPION KOP RESEARCH NATURAL AREA, COEUR D'ALENE RIVER, IDAHO

by

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January 1994

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PREFACE

During July and September, 1993, we inventoried the flora and sampled cottonwood vegetation in Spion Kop Research Natural Area (RNA), on the Wallace Ranger District, Idaho Panhandle National Forests. This project was a cooperative RNA Challenge Cost Share Project between the Department of Fish and Game's Conservation Data Center and the Panhandle NFs. The rationale and objectives of the study, as well as the results and conclusions, are contained in the following sections, which is a manuscript that will be submitted for publication to *Northwest Science*, a peer-reviewed journal published by the Northwest Scientific Association. In keeping with editorial guidelines of the journal, the tables and figures mentioned in the text appear at the end of the manuscript.

Appendices to this report contain the floristic checklist, stand delineation and plot locations, copies of the field forms for the 24 plots placed in cottonwood communities of the RNA, and the stand table used in classifying cottonwood communities.

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ABSTRACT

Black cottonwood (*Populus trichocarpa*) can occur as extensive forests along major rivers in the Pacific Northwest, however, the physical and ecological processes that maintain diverse, self-perpetuating communities have been disrupted in many areas. An extensive stand of black cottonwood has been established as Spion Kop Research Natural Area (RNA) by the U.S. Forest Service along the upper Coeur d'Alene River, one of the few drainages in Idaho where large-scale landscape processes are still operating relatively undisturbed. Our objective is to provide a baseline characterization of black cottonwood communities in Spion Kop RNA, using floristic composition and structure data to classify and determine the environmental gradients affecting the spatial and temporal dynamics of the vegetation. We found that the age class distribution of cottonwoods is discrete, with regeneration taking place following peak discharge events or wildfire. Three community types (ct) resulted from the TWINSPAN classification, representing a successional sequence along the fluvial disturbance gradient from *Populus trichocarpa*/recent alluvial bar ct occurring on or adjacent to active point bars, through the mid-successional *Populus trichocarpa*/*Rhamnus* spp. ct, to the oldest *Populus trichocarpa*/ *Symphoricarpos albus* ct. The direct gradient ordination corroborates this interpretation. Maintenance of black cottonwood community diversity in Spion Kop RNA is controlled largely by landscape-level processes operating in the upper Coeur d'Alene River drainage, primarily fluvial processes and secondarily, wildfires. The model of black cottonwood community dynamics we developed for the RNA can be used for developing restoration plans in perturbed drainages with similar floodplain characteristics.

INTRODUCTION

Black cottonwood (*Populus trichocarpa*) is the largest broad-leaved tree in the Pacific Northwest (Preston 1976), where it commonly occurs in extensive stands along major rivers. In Idaho, black cottonwood forests are found along rivers at the northern edge of the Snake River Plain, the upper Salmon River basin, and tributaries of the Spokane and Pend Oreille drainages. Flow regimes of many rivers flowing onto the Snake River Plain have been altered by upstream water storage dams. As has been documented elsewhere (Fenner *et al*. 1985; Bradley and Smith 1986; Akashi 1988; Rood and Heinze-Milne 1989; Sedgwick and Knopf 1990; Caicco *et al*. 1993), damming disrupts the fluvial processes responsible for maintaining diverse, self-perpetuating cottonwood communities. Even on undammed rivers, ongoing disturbances such as urbanization, recreational and residential development, livestock grazing, diking, and dewatering can affect ecological processes important in maintaining cottonwood vegetation (Crouch 1979; Stromberg and Patten 1991; Shankman 1993) and associated vertebrates (Sedgwick and Knopf 1987; Saab 1992a). The upper Coeur d'Alene River drainage is one of the few that has remained relatively undeveloped and the fluvial processes are largely intact.

One of the largest black cottonwood stands in the Coeur d'Alene drainage has been designated as Spion Kop Research Natural Area (RNA) by the U.S. Forest Service (Wellner and Moseley 1988). The primary objective of this project is to provide a baseline characterization (Johnson *et al*. 1984) of the relatively undisturbed black cottonwood communities in Spion Kop RNA. Specific objectives include: 1) compile a floristic baseline for floodplain communities, 2) obtain quantitative data on the composition and structure of plant communities dominated by black cottonwood, 3) classify black cottonwood communities of the RNA, and 4) determine the environmental gradients affecting the spatial and temporal dynamics of the cottonwood vegetation.

STUDY AREA

Spion Kop RNA lies in the Coeur d'Alene Mountains at the confluence of Tepee Creek and the Coeur d'Alene River, 37 km north of Kellogg, Shoshone County, Idaho (47º 52' 31" N, 116º 07' 21" W). The RNA is 188 ha in size, of which 44% (83 ha) encompasses 4 km of the river floodplain (Appendix 2). Elevation of the floodplain in the RNA is 840 m. Bedrock underlying the area is Precambrian Belt Supergroup metasediments, composed predominantly of quartzite, argillite, and siltite (Savage 1967). Quaternary alluvium, deposited by the Coeur d'Alene River and Tepee Creek, comprises the floodplain substrate. Downcutting through these deposits, coincidental with river channel migration, has left a mosaic of habitats, varying from relatively well-drained terraces to perennially inundated oxbows. Floodplain vegetation in the RNA consists of stands of black cottonwood of varying size classes, interspersed with wetland communities occupying old river channels and grass/forb communities occupying dry river terraces. Under Rosgen's (1993) classification, Tepee Creek and the Coeur d'Alene River in Spion Kop RNA are Type C, a class that includes low-gradient, meandering streams with point bars and riffle/pool channels flowing through a broad, well defined floodplains. Adjacent mountain slopes in the RNA are dominated by a mixed coniferous forest that originated after the 7,260 ha, 1931 McPherson Fire. Large portions of the upper Coeur d'Alene drainage around the RNA also burned in 1910 and 1919. Forest associations adjacent to the floodplain are largely *Tsuga heterophylla* habitat types (Cooper *et al*. 1991).

Spion Kop RNA lies within the inland maritime climatic regime, which is influenced primarily by prevailing westerlies that carry moist air masses from the Pacific Ocean across the Northern Rockies during winter and spring. Gentle rains, deep snow accumulations at higher elevations, and abundant fog, cloudiness, and high humidity characterize conditions during this part of the year. Summers are relatively dry due to the influence of subtropical high pressure systems (Cooper *et al*. 1991). Climate of the RNA is expressed well by records for Deception Creek HQ, Idaho, 30.5 km southwest of the RNA and at a similar elevation. The mean annual temperature at Deception Creek HQ is 5.5ºC and the mean annual precipitation is 1418 mm, of which 86% (1217 mm) falls between October and May (Finklin and Fischer 1987).

METHODS

Data Collection

Voucher specimens of most vascular species occurring in floodplain communities were collected, processed and deposited at the University of Idaho Herbarium (ID). We used Hitchcock and Cronquist (1973) as the nomenclatural authority.

We obtained sets of aerial photographs of the RNA taken in 1937, 1959, 1972, 1983, and 1991. From the 1991 photos, we delineated 15 contiguous cottonwood stands in the RNA (Appendix 2), and, using historical photographs, were able to determine the condition of these stands over the past 56 years. In the 14 largest stands, we subjectively placed 24 10 x 10 m plots in each homogeneous patch of vegetation. To ascertain the age class structure of the stands we cored two black cottonwood trees at each plot. We soon found, however, that trees greater than 76 cm dbh were rotten in the center and useless for determining age. Coring trees of this size tree was discontinued and we ended up with ages for 13 plots.

We collected ocular plant species and environmental data in the plots using the methods of Bourgeron *et al*. (1992), which is a streamlined version of the ECODATA methods (Jensen *et al*. 1993) used by the U.S. Forest Service's Northern Region. We estimated percent cover by plant lifeform classes, *i.e*., trees, shrubs, graminoids, forbs, ferns, and bryophytes/lichens, using the midpoint of 12 cover classes. To characterize the structure of the vegetation, we estimated the total cover of up to four height classes for each lifeform. We collected data on 25 environmental variables at each plot. Because many variables were virtually identical in every plot, such as aspect and elevation, only the following four were used in the data analysis: 1) ground cover by class, including bare soil, gravel, rock, litter, wood, moss, and basal vegetation, 2) distance from bank-full channel, 3) floodplain width, and 4) depth of silt and sand over river-deposited gravel and rock.

Data Analysis

Data editing and formatting was accomplished using COMPOSE (Mohler 1987). We standardized the sample totals to 100 to reduce the potential distortion effects of dominant species, equalize the contribution of each stand, and improve normality. Plots were classified using TWINSPAN, a polythetic divisive classification method, which divides samples into groups based on the entire species composition of the samples (Hill 1979). Species cover data were used to ordinate the 24 plots along environmental gradients with canonical correspondence analysis (CCA), a multivariate direct gradient analysis technique (Ter Braak 1991). The axes extracted by CCA represent those directions of variation in species composition that are related to supplied external variables (Ter Braak 1987).

RESULTS

Flora

The floodplain flora of Spion Kop RNA is comprised of 145 species occurring in 118 genera and 46 families (Moseley and Bursik 1994). Twenty-four species (16.5%) are alien. While several of the alien taxa are abundant in the RNA, their distributions appear to be stabile under current conditions. No rare plants are known from the RNA. See Appendix 1.

Age Structure of Black Cottonwood Stands

The homogeneous vegetation patches sampled in each stand represent discrete cohorts of even-aged black cottonwood. Both trees cored at each plot were similar in age, as well as diameter. Plots fell in one of four age classes (Table 1), with the old age class probably representing several cohorts greater than 60 yrs old. For the most part, the youngest cohorts occur adjacent to active point bars, and older cohorts occur progressively farther away. Old stands do occur adjacent to channels, but they are always on banks where active erosion is taking place, not deposition, as is taking place on point bars. There are exceptions to this establishment pattern. Three medium-aged stands on the periphery of the floodplain were well away from active point bars at the time of their establishment. From the 1937 aerial photographs, it appears that these three stands, each comprised of only one cohort, originated after the 1931 McPherson Fire. Therefore, the distance from and active or historical channels is not always a good indicator of stand age.

Classification

Interpretation of the dendrogram produced by TWINSPAN (Figure 1) suggests that the 24 samples could be grouped into three community types: *Populus trichocarpa*/*Symphoricarpos albus*, *Populus trichocarpa*/*Rhamnus* spp. and *Populus trichocarpa*/recent alluvial bar. Three divisions proved to be adequate for interpretation of the dendrogram, placing clusters of samples into relatively homogenous groups.

The 18 samples occurring in groups 1, 2, and 3 comprise the *Populus trichocarpa*/*Symphoricarpos albus* community type (ct). This type is characterized by medium and old black cottonwood cohorts with a structurally diverse understory comprised of a rich assortment of shrubs, grasses, and forbs. *Symphoricarpos albus* has high cover in all these samples and, in places, reaches 4 m in height (Appendix 4). Some stratification of samples within this ct took place in the TWINSPAN analysis at divisions 2 and 3. Group 1 samples have few exotics and a high cover of *Elymus glaucus* and *Festuca occidentalis*. Group 2, which contains only the old age class, has a nearly complete cover of *S. albus*, while group 3 is characterized by a high cover of *Phalaris arundinacea*. The *Populus trichocarpa*/*Symphoricarpos albus* ct has not been described elsewhere in the literature. It is probably related to the *Populus trichocarpa*/*Cornus stolonifera* ct that Boggs *et al*. (1990) describe from nearby Montana. Their type lacks *S. albus*, while the congeneric, *S. occidentalis*, reaches high cover only under prolonged anthropogenic disturbance.

Samples in groups 4 and 5 are related in that they include the youngest age classes, contain most of the alien species (although in low cover), and have high amounts of rock and gravel cover. The *Populus trichocarpa*/*Rhamnus* spp., is represented by the four samples in group 4. These samples are of young and medium age. Three plots in this group have the highest cover of *Poa pratensis* of any of our plots, and in this respect is similar to the *Populus trichocarpa*/*Poa pratensis* ct of Boggs *et al*. (1990). Their type is grazing-induced, however, with a two-layer structure of widely-spaced (presumably older) cottonwoods and a grass-forb sward in the understory. Livestock grazing is not an influence at Spion Kop RNA. Several shrubs, a stratum missing from their type, have a high constancy in ours, including *Rhamnus alnifolia*, *R. purshiana*, *Symphoricarpos albus*, and *Rosa gymnocarpa*. The two *Rhamnus* species also occur in high cover. Group 5 comprises the *Populus trichocarpa*/recent alluvial bar ct, which includes two samples from the juvenile and young age classes. Floristically, this group contains a high proportion of alien taxa, as well as early successional natives, such as *Achillea millefolium* and *Salix exigua*. This ct has been previously described by Boggs *et al*. (1990) from Montana.

Gradient Analysis

Direct gradient analysis of the samples with CCA corroborates our interpretation of the TWINSPAN classification. Figure 2 displays the ordination diagram of black cottonwood plots and external variables along the first two axes extracted by CCA. Plots are arranged in the ordination space based on species composition. The main direction of change for each of the external variables is illustrated by an arrow (actually a line in Figure 3), with the length of the arrow corresponding to the relative importance of that variable in explaining floristic change. The first two axes account for 40% of the variance in species ordination scores with respect to environmental variables. The eigenvalue and species-environment correlation for axis 1 are lambda = 0.24, R = 0.96, respectively, while lambda = 0.15 and R = 0.94 for axis 2.

The external variables, cohort age, ground cover of rock and gravel, and depth of silt and sand explain most of the floristic variation along axis 1, along which the three ct's are separated. Young age and high ground cover of rock and gravel characterize the *Populus trichocarpa*/*Rhamnus* spp. and *Populus trichocarpa*/recent alluvial bar ct's. A greater depth of silt and sand deposited over river gravels, along with greater basal area of the vegetation, distance from bank-full channel, and ground cover of wood and litter, characterize the *Populus trichocarpa*/*Symphoricarpos albus* ct. The 18 *Populus trichocarpa*/*Symphoricarpos albus* samples are clumped into a short distance along axis 1, but are widely dispersed along axis 2. In each ct, samples at the extreme ends of the axis 2 gradient represent extremes in floodplain width, which increases from top to bottom. The remaining samples of *Populus trichocarpa*/*Symphoricarpos albus* ct, however, do not follow this pattern and are somewhat better explained by the related gradients of high ground cover of bare soil to high bryophyte cover (top to bottom).

All but three structural classes are correlated with samples of the *Populus trichocarpa*/*Symphoricarpos albus* ct (Figure 3). Only cover of the two shortest shrub height classes and cover of medium-height trees are strongly correlated with samples of the *Populus trichocarpa*/*Rhamnus* spp. and *Populus trichocarpa*/recent alluvial bar ct's.

DISCUSSION

Flora

The relatively small, 83 ha floodplain of Spion Kop RNA is relatively rich in vascular plant species. A considerable portion, however, is comprised of introduced taxa. Although not well documented in the literature, our observations suggest that the relatively weedy nature of the Spion Kop floodplain flora is typical of even undisturbed riverine vegetation in Idaho (*cf*. Miller 1976).

Although not often thought of as useful for monitoring long-term ecological changes, a basic inventory of the biota can provide important monitoring benchmarks. Persistence or extirpation of plants, animals, and fungi can be used as an indicator of stability or change in an ecosystem. Using checklists prepared 20 and 40 years earlier, Bursik and Moseley (1994) determined that several peatland plant species, including several rare elements, have been extirpated from two fens in the Selkirk Mountains of Idaho and Washington. We recommend that future monitoring efforts in RNA's establish baselines for at least some taxonomic groups.

Age Structure of Black Cottonwood Stands

Discrete pulses of regeneration related to peak river discharges has been well documented for other cottonwood species throughout western North America (Everitt 1968; Fenner *et al*. 1985; Bradley and Smith 1986; Baker 1989; 1990). Flood conditions transport and then deposit large amounts of sediment on active point bars. Formation of these moist, bare seedbed conditions are ideal for seed germination and generally coincide seasonally with cottonwood seed dispersal. If these newly established stands survive mortality from flooding and desiccation, the chances of survival are probably good (Bradley and Smith 1986). Subsequent vertical and lateral aggredation of the point bar further removes saplings from extreme floods. In the RNA, it appears that the juvenile age class became established following floods in 1981 or 1984, and the young class after a large rain-on-snow event in 1974 (Rabe and Flaherty 1974; Logsdon pers. comm.; unpublished USGS discharge data from the Enaville gague). Although flow data are lacking, the medium age class probably became established after the Christmas flood of 1933 (Logsdon pers. comm.).

We could not determine whether the black cottonwood stands that originated following the McPherson Fire were from basal sprouts or seeds. Boggs *et al*. (1990) observed that black cottonwood has sprouting ability intermediate to *Populus angustifolia* (higher) and *Populus deltoides* (lower), and that sprouting potential decreases as trees mature. We have no information regarding the existence or age of precursor stands, but it is evident from the 1937 photos that all are well away from active point bar formation. They are, however, in areas where mineral seedbeds may have been previously deposited. One stand is at the mouth of a small creek, while the other two are in shallow concavities that could have been overflow channels during peak floods.

Classification and Gradient Analysis

The three ct's described from Spion Kop RNA represent a successional gradient from the *Populus trichocarpa*/recent alluvial bar ct occurring on or adjacent to active point bars, through the mid-successional *Populus trichocarpa*/*Rhamnus* spp. ct, to the oldest stands in the RNA of the *Populus trichocarpa*/*Symphoricarpos albus* ct. Alien species decrease over time (Appendix 4), while vegetation basal area, and the ground cover of litter and woody debris, as well as structural diversity increases. Understory structure develops rapidly, reaching advanced stages within 50 to 60 yrs of cohort establishment, although some species, such as *Symphoricarpos albus*, may increase in cover from medium to old stands as well. The rock and gravel substrates of the early successional ct's are ideal for black cottonwood seed germination, while the greater depth of fine textured substrates, occurring in the older stages, support a greater number of species in the community and greater structural diversity.

As the river continues to experience episodic floods, the active channels will proceed to migrate across the floodplain, destroying the old stands along the way and starting the successional sequence over again. If the river aggrades deep enough into the floodplain, lowering the water table and decreasing the likelihood of flooding, coniferous species may eventually dominate floodplain stands. No stands in the RNA have reached this stage, but observations of downstream stands indicate that *Thuja plicata* may eventually be the climax species, even though *Tsuga heterophylla* fills that role on adjacent slopes.

CONCLUSIONS

The maintenance of black cottonwood community diversity in Spion Kop RNA is controlled largely by landscape-level processes operating in the upper Coeur d'Alene River drainage. The dynamic nature of the fluvial processes of erosion, sediment deposition, and channel migration, especially related to episodic peak discharge events, is the primary one affecting the floodplain bioenvironments in the RNA. Secondarily, large, stand-replacing wildfires also contribute to maintaining diverse black cottonwood communities.

The model of black cottonwood community dynamics we developed for Spion Kop RNA can be used as comparison to other drainages with the similar Type C (Rosgen 1993) fluvial characteristics of relatively low sediment load and moderate gradient. This model will provide a useful baseline for rehabilitation of cottonwood forests elsewhere in Idaho, such as in the St. Joe drainage following a large wildfire (Harrington pers. comm.) and the Boise River (Tiedemann *et al*. 1994) and South Fork Snake River (Saab 1992b; Merigliano 1992) in southern Idaho, where models for the restoration of cottonwood community diversity under altered flow regimes and other disturbances are being developed.

ACKNOWLEDGEMENTS

The U.S. Forest Service provided a majority of the funding for this project, through their challenge cost-share grants for Research Natural Areas. The Idaho Department of Fish and Game provided the remaining funds. We would like to thank Angela Evenden, USFS Intermountain Research Station, and Jill Blake, Rick Barth, Henry Logsdon, and Art Zack, Idaho Panhandle National Forests, for their help and encouragement during all phases of this project. Thanks also to Charles Wellner for sharing his knowledge of the Coeur d'Alene drainage, Chip Corsi for summarizing USGS discharge data, and Mike Merigliano for stimulating discussions on cottonwood ecology and fluvial geomorphology. The manuscript benefitted greatly from a review by Michael Mancuso.

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Table 1. Characteristics of black cottonwood age classes in 24 plots in Spion Kop Research Natural Area.

Class	Number Plots	Age (years)	Diameter (cm)	Height (m)	Crown Form
Juvenile	1	<10	<2	up to 5	spindly
Young	3	15-20	20-50	up to 20	conical
Medium	9	50-60	50-76	up to 34	conical
Old	11	>60	>76	up to 45	flat-topped

Figure 1. Hierarchical classification produced by TWINSPAN of 24 black cottonwood samples from Spion Kop RNA. Pop tri/Sym alb = *Populus trichocarpa*/*Symphoricarpos albus*; Pop tri/Rha = *Populus trichocarpa*/*Rhamnus* spp.; Pop tri/Rec all = *Populus trichocarpa*/recent alluvial bar.

Figure 2. CCA ordination of the 24 black cottonwood plots (numbered) with 11 external variables (labeled). Lines associated with the external variables denote main direction of change and relative importance of each variable. Community types determined using TWINSPAN have been circled and are discussed in the text. See Methods for definitions of external variables.

Figure 3. CCA ordination of the three black cottonwood community types (samples not shown) with coverage of 23 structural classes. Lines associated with each class denote main direction of change and relative importance of each variable. Abbreviations have two parts: First part is the lifeform, as follows: Tree = tree; Shrb = Shrub; Forb = forb; Gram = graminoid. Second part refers to height class, as follows: Totl = total cover of lifeform; Tall = tall class, >5 m; Medi = medium class, 0.5 - 5 m; Low = low class, 0.05 - 0.5 m; Grnd = ground class, <0.05 m.

APPENDIX 1

List of vascular plants occurring in floodplain communities of Spion Kop RNA.

The checklist is arranged by division and class (in Anthophyta), then alphabetically by family, genus, and species within these major groups. Species nomenclature follows Hitchcock and Cronquist (1973). Rob Bursik's collection numbers follow most of the species. These specimens are deposited at the University of Idaho Herbarium (ID). Species without a number were only observed. Alien species are indicated with an "*****."

DIVISION SPHENOPHYTA

Equisetaceae

Equisetum arvense 2862
Equisetum laevigatum 3164

DIVISION PTEROPHYTA

Dennstaedtiaceae

Pteridium aquilinum

Dryopteridaceae

Athyrium felix-femina 2924
Dryopteris austriaca 2925
Dryopteris felix-mas 2917
Gymnocarpium dryopteris

DIVISION CONIFEROPHYTA

Cupressaceae

Thuja plicata

Pinaceae

Abies grandis
Picea engelmannii
Pinus monticola

DIVISION ANTHOPHYTA

CLASS DICOTYLEDONES

Aceraceae

Acer glabrum 2914

Apiaceae

Cicuta douglasii 2887
Heracleum lanatum 2920
Ligusticum canbyi 2923
Osmorhiza chilensis 2895

Aristolochiaceae

Asarum caudatum 2931

Asteraceae

Achillea millefolium 2886
Anaphalis margaritacea 2815
Antennaria microphylla 2871
Aster foliaceus var. *lyallii* 3165
Aster modestus 3119
*****Centaurea maculosa*
*****Chrysanthemum leucanthemum* 2848
*****Cirsium arvense*
*****Cirsium vulgare* 2919
Erigeron speciosus var. *speciosus* 2812, 2855
*****Hieracium pretense* 2821
*****Lactuca biennis* 3117
Rudbeckia occidentalis 2891
Senecio triangularis 2885
Solidago canadensis var. *salebrosa* 3122
*****Tanacetum vulgare*
*****Taraxacum officinale*
*****Tragopogon dubius* 2832

Berberidaceae

Berberis repens

Betulaceae

Alnus incana 2811

Brassicaceae

Cardamine oligosperma
Rorripa curvisiliqua 2877

Boraginaceae

Mertensia paniculata 2896
Myosotis laxa 2817, 3123

Callitrichaceae

Callitriche heterophylla 2933

Campanulaceae

Campanula rotundifolia 2853

Caprifoliaceae

Lonicera involucrata 2912
Sambucus cerulea 2824
Symphoricarpos albus 2905

Caryophyllaceae

*****Cerastium vulgatum* 2844
*****Dianthus armeria* 2820
Stellaria crassifolia 2830

Cornaceae

Cornus stolonifera 2911

Crassulaceae

Sedum lanceolatum 2839

Ericaceae

Arctostaphylos uva-ursi 2828
Pyrola asarifolia

Fabaceae

Lathyrus nevadensis ssp. *lanceolatus* var. *parkeri* 2930
*****Trifolium agrarium* 2860
*****Trifolium pratense* 2827
*****Trifolium repens* 2843
Vicia americana

Haloragaceae

Myriophyllum spicatum 2937

Hydrophyllaceae

Phacelia heterophylla var. *heterophylla*

Hypericaceae

*****Hypericum perforatum*

Lamiaceae

Agastache urticifolia 2850
Lycopus uniflorus 2825
Mentha arvense 2845
Prunella vulgaris var. *lanceolatus* 2890

Onagraceae

Circaea alpina 2927
Epilobium minutum 2881A
Epilobium watsonii var. *occidentalis* 2858, 2881B

Plantaginaceae

*****Plantago lanceolatus* 2835
*****Plantago major* var. *major* 2842

Polemoniaceae

Collomia linearis 2874
Polemonium occidentale
Polemonium pulcherrimum var. *calycinum*

Polygonaceae

Polygonum hydropiperoides var. *hydropiperoides* 3121
*****Rumex acetosella* 2856
*****Rumex crispus* 2857

Portulaceae

Montia sibirica var. *sibirica* 2913

Ranunculaceae

Aconitum columbianum 2841
Actea rubra 2915
Ranunculus aquatilis 2934
Ranunculus uncinatus 2867
Thalictrum occidentale 2816
Trautvetteria carolinensis 2901

Rhamnaceae

Rhamnus alnifolia 2926
Rhamnus purshiana 2916

Rosaceae

Amelanchier alnifolia 2909
Crataegus douglasii 2907
Crataegus suksdorfii 2906
Fragaria vesca
Geum macrophyllum 2859
Potentilla gracilis 2831
Prunus virginiana
Rosa gymnocarpa
Rosa nutkana 2910
Rubus leucodermis
Rubus parviflorus
Spiraea douglasii 2908

Rubiaceae

Galium trifidum var. *pacificum* 2897

Salicaceae

Populus trichocarpa
Salix bebbiana 2819
Salix exigua 2822
Salix drummondiana 2818, 2851

Saxifragaceae

Mitella caulescens 3116
Tiarella trifoliata 3124

Scrophulariaceae

Castilleja miniata 2846
Collinsia parviflora 2878
Mimulus moschatus 2929
Penstemon attenuatus 2837
Scrophularia lanceolata
******Verbascum thapsus* 2826, 3118
Veronica americana 2838

Urticaceae

Urtica dioica 2904

Violaceae

Viola glabella 2928

CLASS MONOCOTYLEDONES

Cyperaceae

Carex sp. 2983
Carex bebbii 2868, 2894, 2982
Carex disperma 2864
Carex lenticularis 2888
Carex rostrata 2847
Carex stipata 2869
Scirpus microcarpus 2849

Juncaceae

Juncus ensifolius 2866, 2875
Juncus longistylis 2870
Juncus tenuis var. *tenuis* 289

Liliaceae

Disporum hookeri var. *oreganum* 2814
Smilacina stellata 2899
Veratrum viride 2835

Orchidaceae

Habenaria saccata 2829

Poaceae

***Agrostis alba* 2854
Bromus inermis ssp. *pumpellianus* var. *pumpellianus* 2900
Bromus vulgaris var. *vulgaris* 2852
Calamagrostis canadensis
***Dactylis glomerata*
Danthonia intermedia 2872
Elymus glaucus 2893
Festuca occidentalis 2884
Festuca subulata 2892
Glyceria grandis 2932
Glyceria striata 2813, 2865
Phalaris arundinacea 2889
***Phleum pratense* 2903
***Poa palustris* 2840, 2903
Stipa occidentalis var. *minor* 2834

Potamogetonaceae

Potamogeton berchtoldii 2936
Potamogeton gramineus 2935

Sparganiaceae

Sparganium minimum 2880

Appendix 2

Cottonwood stand delineation and approximate location of plots in Spion Kop RNA.

STAND 1 **-** between Tepee Cr. and C d'A River, upstream from their confluence

PLOT 1 **-** **old**, adjacent to river in middle of east side stand
PLOT 2 **-** **medium**, between old stand (plot 1) and young stand adjacent to old Tepee Cr channel; on west side of stand
PLOT 3 **-** **medium**, at southern end of stand adjacent to gravels

STAND 2 **-** across river from stand 1, between river and road

PLOT 4 **-** **old**, in middle of stand

STAND 3 **-** on west side of C d'A River, downstream from Tepee Cr. confluence

PLOT 5 **-** **young**, on point bar on east side of stand
PLOT 6 **-** **old**, in center of stand

STAND 4 **-** northwest corner of RNA; old Tepee Cr. channels run through and around stand

PLOT 7 **-** **old**, near east corner of stand

STAND 5 **-** south of stand 4, west of present Tepee Cr. channel, surrounded on north and west by old Tepee Cr. channel

PLOT 8 **-** **old**, near center of stand
PLOT 9 **-** **medium**, adjacent to channel on west side of stand
PLOT 10 **-** **medium**, on west side of stand; channel separates this plot from rest of stand 5

STAND 6 **-** mouth of Senator Cr.

PLOT 11 **-** **medium**, located in center of stand

STAND 7 **-** NOT SAMPLED; scattered clumps of trees along oldest Tepee Cr. channel

STAND 8 **-** mouth of Davey Cr.

PLOT 12 **-** **medium**, located near southeastern edge of stand

STAND 9 **-** between C d'A River and mouth of oldest Tepee Cr. channel, upstream from their confluence

PLOT 13 **-** **old**, located near center of stand

STAND 10 **-** east side of C d'A River, next to large pull-out along river road

PLOT 14 **-** **young**, between very young stand on east and older part of stand on west
PLOT 15 **-** **juvenile**, in channel that is still scoured on east side of stand, next to road
PLOT 16 **-** **old**, west side of stand

STAND 11 **-** east side of C d'A River, across old channel (south) from stand 10

PLOT 17 - **old**, near center of stand

STAND 12 - west side of C d'A River, downstream from stand 11

PLOT 18 - **medium**, north edge of stand
PLOT 19 - **old**, near south end of stand

STAND 13 - scattered clumps on east side of C d'A River, downstream from stand 12

PLOT 20 - **medium**, near southern end of stand

STAND 14 - largest continuous stand in RNA; on west side of C d'A River opposite mouth of Cinnamon Cr.

PLOT 21 - **young**, on point bar on east edge of stand
PLOT 22 - **old**, along northeastern edge of stand
PLOT 23 - **old**, near northern point stand

STAND 15 - small, linear stand on west side of C d'A River, downstream from stand 14

PLOT 24 - **medium**, near northern (upstream) end of stand

Appendix 3

Field forms for the 24 cottonwood plots in Spion Kop RNA.

Appendix 4

Stand table produced by TWINSPAN of the 24 black cottonwood plots and 79 species in Spion Kop RNA.

KEY FOR STAND TABLE: Groups 1, 2, and 3 comprise the *Populus trichocarpa/Symphoricarpos albus* ct; Group 4 comprises the *Populus trichocarpa/Rhamnus* spp. ct; Group 5 comprises *Populus trichocarpa*/recent alluvial bar ct. Values are the relative cover of a species in a plot. Appendix 1 has a list of all species occurring in the Spion Kop RNA floodplain. This table contains only those occurring in the plots.

Group		1	2	3	4	5
Plots		111	122	1111 22	12	1
		6123	84723	790689104	2341	55
Pic	eng	3--3	-----	---2-----	1---	--
Fes	occ	3422	1-111	-------1-	----	--
Gly	str	--2-	-----	------1--	----	--
Pol	occ	-21-	-----	---------	----	--
Pyr	asa	---2	-----	---------	----	--
Ely	gla	4334	21--3	2222223-4	2---	--
Mit	cau	--3-	21--1	11----1--	----	--
Mon	sib	11-2	--111	------2--	----	--
Cra	dou	-133	-222-	1133-3--3	----	--
Rub	leu	-1--	-1---	--1----11	----	--
Pru	vir	----	-----	-1--2----	----	--
Cal	can	----	-----	2--------	----	--
Car	oli	----	-----	---1-----	----	--
Men	arv	----	-----	-----1---	----	--
Gyn	dry	----	-----	------1--	----	--
Pte	aqu	----	-----	--------2	----	--
Ros	nut	----	---11	-------2-	----	--
Ath	fel	---1	4-112	2-112-13-	-1--	--
Cor	sto	--3-	2-344	--1324433	-111	-1
Lig	can	---2	1--21	22-1-1--1	--1-	--
Sen	tri	----	211-1	--1--12--	---1	--
Tha	occ	----	-1111	----111--	----	1-
Sym	alb	5444	55455	424442432	343-	1-
Dis	hoo	2111	-2121	---1112--	1---	--
Osm	chi	---1	1--11	-----1--1	---1	--
Urt	dio	--2-	-11--	2-1--1---	--1-	--
Ace	gla	1---	-13--	-----212-	3--1	--
Vio	gla	---1	1-1-1	--------1	1--1	--
Pop	tri	3454	45544	455555455	5435	45
Aln	inc	---3	-2--2	----2313-	-3--	--
Ros	gym	-11-	-1-1-	1--11-1-3	-111	--
Pha	aru	4--2	3-442	455455434	1143	55
Gal	tri	-212	11211	2111-1311	1111	11
Geu	mac	-1--	-1---	-----1---	----	1-
Her	lan	3-33	322-1	33221232-	-23-	2-
Mer	pan	-111	11211	2-121-121	-111	1-
Rud	occ	--21	--111	-11--1-11	1-1-	1-
Bro	vul	22--	----1	1--------	--2-	--

Stand table continued.

Group		1	2	3	4	5
Plots		111	122	1111 22	12	1
		6123	84723	790689104	2341	55
Asa	cau	3-2-	-2--2	3-1------	3-1-	--
Ran	unc	122-	4----	--2------	11--	--
Rub	par	1---	-----	----1-222	-1--	11
Smi	ste	----	--11-	--11--111	11--	--
Tra	car	-1-1	1--1-	2-1111122	-111	--
Vic	ame	----	-----	1-------1	----	1-
Rha	pur	2---	11-33	2---3--22	3424	--
Car	dis	----	--1--	--------1	--1-	--
Pru	vul	----	---1-	--11--2--	-1-1	1-
Rha	aln	-52-	---3-	3-22-222-	4345	--
Agr	alb	2---	-----	11----1-1	21--	2-
Eqi	arv	----	-----	-----1-1-	-1-1	--
Ast	fol	--11	-----	11---311-	1121	1-
Cic	dou	-211	----2	222111-1-	1331	--
Pin	mon	3--3	12--1	---------	11-1	2-
Ame	aln	-122	2-21-	-11-1----	3-3-	1-
Eri	spe	-1--	---1-	--------1	---1	1-
Fra	ves	1-2-	-----	------1-1	1-1-	-1
Phl	pra	----	-----	--------1	-1--	1-
Cir	arv	----	-----	--1------	----	-1
Lac	bie	----	-----	-1-----1-	--1-	2-
Tri	agr	----	-----	------1--	1---	1-
Abi	gra	1---	-----	-1----1--	1111	--
Poa	pra	-3--	-----	-2----111	443-	-2
Ane	pip	----	-1---	---1-----	11--	--
Cen	mac	----	2----	---------	1--1	11
Arc	uva	----	-----	---------	---1	--
Ber	rep	----	-----	---------	1---	--
Dac	glo	----	-----	---------	-1--	--
Ana	mar	----	-----	---------	1--1	--
Sol	can	----	-----	---------	11-1	--
Tar	off	----	-----	---------	--11	1-
Tri	rep	----	-----	---------	2111	11
Sal	exi	----	-----	---------	--2-	-2
Ach	mil	----	-----	-1-------	1--1	1-
Cas	min	----	-----	---------	1---	11
Chr	leu	----	-----	----1---1	-122	11
Hyp	per	----	--1--	------1--	--11	21
Tan	vul	----	-----	-1---1---	---1	22
Tri	pra	----	-----	---------	----	11
Ver	tha	----	-----	---------	----	-1