HABITAT CHARACTERISTICS OF INTERMITTENT STREAMS WITHIN SOUTH DAKOTA'S NORTHERN GLACIATED PLAINS ECOREGION

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ABSTRACT

Headwater streams are linked tightly with terrestrial systems and contribute directly to downstream channel habitat and water quality. They comprise the majority of stream miles in South Dakota but have received little attention. The objective of this effort was to assess differences in physical habitat between intermittent streams of the Prairie Coteau (PC) (n = 6) and those of the Prairie Coteau Escarpment (PCE) (n = 4). Habitat sampling occurred during the summer of 2007 following protocols of EPA (Peck et al. 2006) and Fritz et al. (2006). Results demonstrated no significant differences for bankfull width ($p = 0.25$), bankfull height ($p = 0.55$) and incised height ($p = 0.39$). Large and small tree canopy cover (> 5 m high) and woody understory cover (0.5 to 5.0 m high) were greater at PCE sites than PC sites. Alien plants were more prevalent at PC sites than PCE sites, and riparian human disturbances were more prevalent at PCE sites than PC sites. Results of this effort demonstrate differences among key riparian components from minimally disturbed streams of two level IV ecoregions. Continuing efforts will allow habitat comparisons and between-year comparisons among a larger number of level IV ecoregions.

Keywords

Headwater, intermittent stream, ecoregion, habitat

INTRODUCTION

Since the establishment of the Clean Water Act in 1972 (PL 95-217), state agencies have expanded assessment and monitoring of our nation's streams. With continuing water quality problems, managers have begun to move their focus farther upstream to headwaters. Headwater streams are very important because they comprise the bulk of drainage basin area and directly influence downstream water quality (Dodds 1997, Gomi et al. 2002, Rabeni 1999). South Dakota has approximately 138,148 km of intermittent streams compared to only 14,949 km of perennial streams (SD DENR 2008). Between the years 2002-2007, approxi-

mately 12,720 km of perennial rivers were assessed, but intermittent streams were not assessed.

Ecoregions are homogenous landscape units (Hughes and Larson 1988) that provide a geographical framework for assessing natural resource condition (Omernik 1987). Minimally disturbed streams within an ecoregion provide regional reference sites useful for monitoring and setting regional management goals (Omernik 1995). While many states have adopted a level III ecoregion framework, others have found landscape characteristics to be too variable at this scale (Troelstrup and Perry 1990). The objective of this effort was to assess differences in physical habitat of intermittent headwater streams between level IV Prairie Coteau (PC) and Prairie Coteau Escarpment (PCE) ecoregions.

STUDY AREA

All study streams were located within the Northern Glaciated Plains (NGP) level III ecoregion of South Dakota (Figure 1). This ecoregion is characterized by its glaciated landscape ranging from flat to gently rolling hills (Bryce et al. 1998). The NGP includes many temporary and seasonal wetlands created from receding glaciers. The climate is subhumid with mean annual precipitation ranging from approximately 406 to 559 mm and mean temperatures ranging from -23 C in the winter to 29 C in the summer. The natural vegetation of the region is composed of tall and mixed grass prairie, but much of the landscape has been tilled for agriculture. Small grains, hay, and pastureland are the main land uses. Two

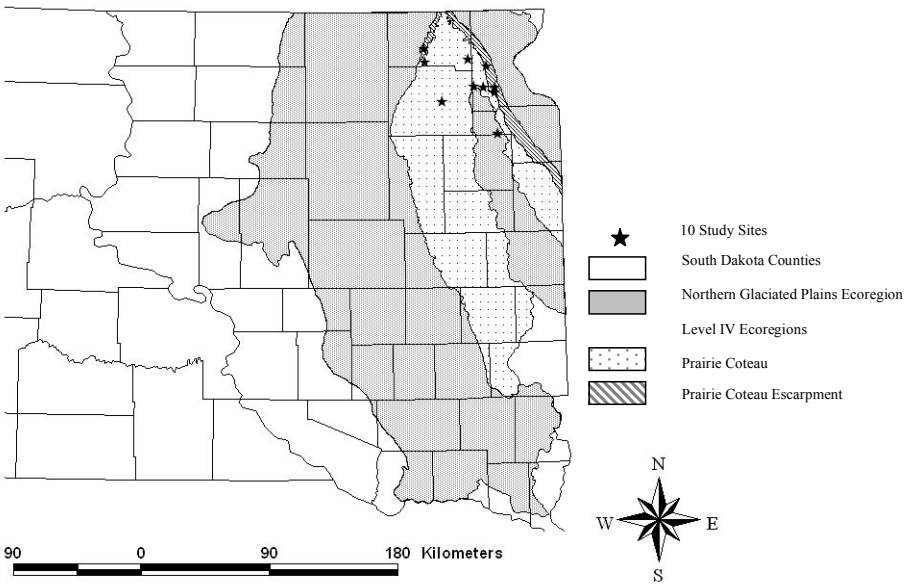

Figure 1. Study area map showing the location of the ten study sites. Level IV Prairie Coteau and Prairie Coteau Escarpment ecoregions are sub-regions of the Northern Glacieated Plains Ecoregion.

level IV ecoregions sharing boundaries within the NGP are the Prairie Coteau (PC) and the Prairie Coteau Escarpment (PCE). The PC is 13,543 km^2 with rolling terrain dotted by many semi-permanent and seasonal wetlands (Bryce et al. 1998). Natural vegetation is dominated by mixed grass prairie species with land use comprised of small grains in flatter areas and pasture. The PCE is a 91-183 m escarpment, 1,075 km^2 in area, containing many perennial streams. Natural vegetation is dominated by woodland species with openings for short grass prairie and grazing with some small grains in flatter areas. Both ecoregions have similar climates, soil types, and geology.

METHODS

Ten flowing streams were sampled during the summer of 2007. Sites were selected as reference using EPA's Analytical Tools Interface for Landscape Assessments (ATtILA). ATtILA is an extension of ArcView that uses landscape metrics to assess the environmental condition of streams (U.S. EPA 2001). Sampling protocols followed the habitat characterization sections provided by EPA's Field Operations Manual for Assessing the Hydrologic Permanence and Ecological Condition of Headwater Streams (Fritz et al. 2006) and the Western Pilot Study: Field Operations Manual for Wadeable Streams (Peck et al. 2006) (Table 1). All measurements were taken within a 40X wetted width reach, and protocols were modified to better accommodate the shorter reach lengths of these small channels. Channel dimensions and riparian measurements were taken at the downstream, middle, and upstream transects only. Bankfull area was visually estimated using various clues: change in vegetation from temporary to permanent, upper elevation of fine debris deposition, rocks and/or roots exposed in banks, change in size distribution of deposits, topographic break from vertical bank to floodplain (Fritz et al. 2006). Width was measured by stretching a meter tape across the channel at the point of bankfull for both banks. Height was measured from the deepest point of the channel to the top of the bankfull area. Bank channel incision points were visually estimated and incision width was measured from the deepest point in the channel to the top of the incision point on each bank. Flood prone area width was measured by stretching a meter tape across the channel at 2X bankfull height. Riparian structure was measured in a visually estimated 10 m X 10 m plot on both banks. Vegetation was divided into three layers--canopy (> 5 m high), understory (0.5 to 5 m high), and ground cover (< 0.5 m high). In each layer, the vegetation type was classified into aerial cover classes--absent, sparse (<10%), moderate (10 to 40%), heavy (40 to 75%), and very heavy (>75%). Invasive alien plant occurrence was tallied from the same 10 m X 10 m plots. The occurrence of human activity influence was observed from upper, middle and lower transects and segregated into distance classes (absent, on bank, within 10 m of bank but not on, and >10 m from bank). Sinuosity (number of bends) was measured throughout the reach by counting the number of stream bends and dividing by total reach length. Slope was measured by back sighting with a landscaping pole and clinometer. Analysis of variance was used to draw comparisons between headwater streams of PC and PCE ecoregions.

Table 1. Channel and riparian measurements collected from minimally disturbed intermittent streams of the PC and PCE ecoregions, SD.

Physical Attribute	Metric
Channel Dimensions	Bankfull width
	Bankfull height
	Incised height
	Flood prone area width
	Channel sinuosity
Channel Gradient	Slope and bearing
Riparian Vegetation, Cover, and Structure	Invasive alien plants
	Riparian Vegetation Structure
Anthropogenic Alterations	Human influence

RESULTS

Channel slope in the PC was significantly less ($p = 0.04$) than that observed in the PCE (Table 2). Sinuosity in the PC had a greater range of values (0.00 – 75.00 bends/100 m) than the PCE (15 – 19 bends / 100 m), but was not significantly different ($p = 0.19$). No significant difference was observed between the PC and PCE ecoregions for bankfull width ($p = 0.25$), bankfull height ($p = 0.55$), and incised height ($p = 0.39$). Flood prone area width in the PC had a greater range of values (4.40 m – 30.99 m) than the PCE (3.40 m – 13.10 m), and was significantly greater from the PC than PCE ecoregion ($p = 0.04$).

Table 2. Summary of physical habitat characteristics for the PC and PCE ecoregions.

	PC (n = 6)			PCE (n = 4)		
Parameter	**Median**	**Minimum**	**Maximum**	**Median**	**Minimum**	**Maximum**
Slope (%)	-1.5	-1	-3	-3	-2.5	-4
Sinuosity (# of bends/100m)	46	0	75	17	15	19
Bankful Width (m)	1.95	0.3	3.60	2.55	0.50	5.50
Bankfull Height (m)	0.40	0.16	0.72	0.36	0.11	0.84
Incised Height (m)	0.47	0.16	0.81	0.36	0.11	1.06
Flood Prone Area Width (m)	9.75	4.40	30.99	8.10	3.40	13.10

PC streams had no canopy coverage > 5.0 m high while PCE streams had a high frequency of very heavy canopy cover among sites. Canopy cover of PCE streams was dominated equally by big (≥0.3 m DBH) and small (<0.3 DBH) trees (Figure 2).

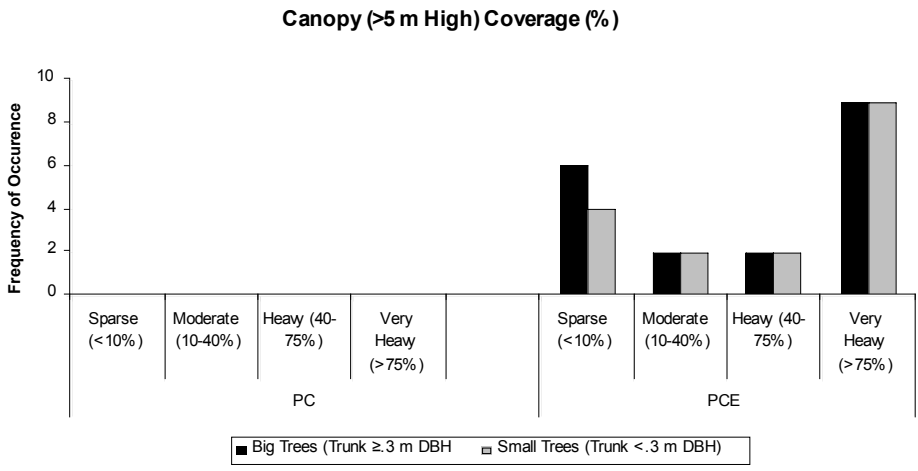

Figure 2. Riparian canopy coverage classes of trees greater than 5 m high. Trees were divided into two size classes: big trees (trunks ≥ .3 m DBH) and small trees (trunks < 0.3 m DBH). Frequency of occurrence equals the number of cover class occurrences divided by the total number of sample plots per ecoregion (PC = 36 plots; PCE = 24 plots).

The PC understory (0.5 – 5.0 m high) was dominated by herbs, grasses, and forbs while the PCE understory demonstrated a greater variation in structure and was dominated by woody shrubs and saplings (Figure 3).

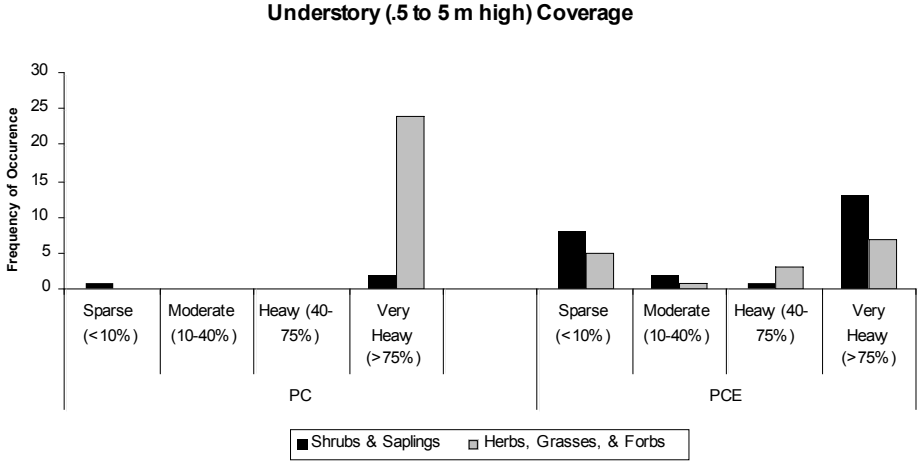

Figure 3. Riparian understory coverage classes of vegetation between 0.5 to 5.0 m high. Vegetation classes were divided into shrubs and saplings and herbs, grasses, and forbs. Frequency of occurrence equals the number of cover class occurrences divided by the number of total sample plots per ecoregion (PC = 36 plots; PCE = 24 plots).

Canada thistle *(Cirsium arvense)* and common burdock *(Arctium minus)* were the only two non-native riparian species out of eight possible EPA target

invasives observed from our sites. Canada thistle was observed in 13 of 18 plots in the PC and 1 of 18 plots in the PCE. Common burdock was not observed in the PC but was observed in 2 of 12 plots in the PCE.

Five of eleven categories of human disturbance were observed at varying distances from the channel on either bank of our study reaches (Figure 4). PC riparian disturbances were dominated by livestock grazing (on the bank) with low frequencies of cultivation (>10 m from the banks) and trash (within 10 m of the bank). The PCE had a larger variety of human influences with livestock grazing (on the bank) representing the dominant influence. Low frequencies of buildings (>10 m from the bank), roads (>10 m from the bank), and trash (both within 10 m of the bank and > 10 m from the bank) were observed.

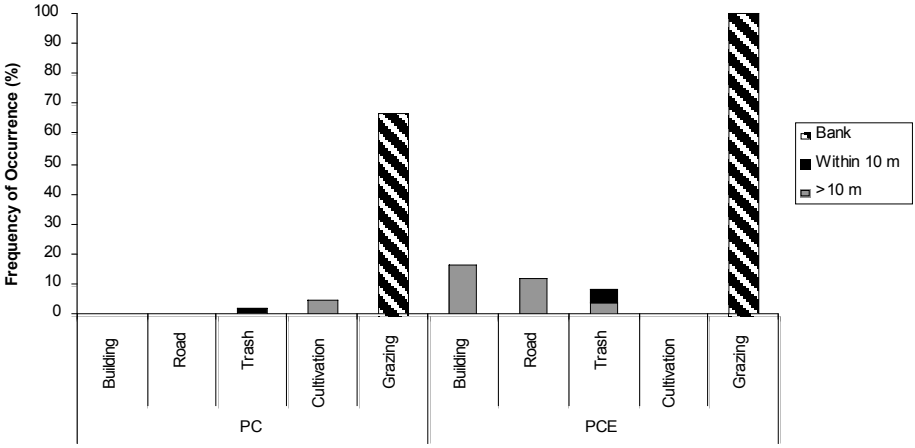

Figure 4. Frequency of human disturbance observed between PC and the PCE sites at varying distances from the stream bank. Human disturbances included: (1) walls, dikes, revetments, riprap, and dams; (2) buildings; (3) pavement/cleared lot; (4) roads or railroads; (5) inlet or outlet pipes; (6) trash; (7) parks or maintained lawns; (8) cultivation; (9) grazing; (10) logging; and (11) mining. Frequency of occurrence equals the number of human disturbance distant class occurrences divided by the number of total sample plots per ecoregion (PC = 36 plots; PCE = 24 plots).

DISCUSSION

PC streams displayed greater sinuosity than PCE streams due to differences in stream gradient. The PC is flat with rolling hills allowing for greater lateral movement of the channel (Rosgen 1994). The PCE with its 91-183 m escarpment (Bryce et al. 1998) and banks stabilized by boulders and tree roots tended to show greater velocity. This created greater vertical incision, decreased lateral movement and reduced sinuosity. Flood prone area widths were also greater in the PC due to landscape characteristics. The PC with its wider valleys allowed streams to overflow banks and spread out, whereas streams in the PCE were constrained within narrow valleys.

Riparian vegetation structure differed greatly depending upon level IV ecoregion. PC riparia contained no trees, and were dominated by grasses, herbs and

forbs. This is similar to other descriptions of prairie stream riparia (Dodds et al. 2004, Matthews 1988, Wiley et al. 1990). PCE riparia had a high frequency of heavy tree and shrub coverage with some grasses, herbs, and forbs. Impracticality for land development due to the steeper slopes of the PCE may enable these deciduous stands to remain intact.

Many of the physical differences between the PC and PCE streams can be explained by the NGP's defining landscape characteristics (Omernik 1987, Bryce et al. 1998). Slope and vegetation, in particular, varied greatly within the riparia. These observations tend to support suggestions that some ecoregions are relatively homogeneous while others display considerable within-region heterogeneity (Omernik 1987, Troelstrup and Perry 1990).

Physical measurements are key components used by agencies to set stream management goals (Rheinhardt et al. 1999). Depending on ecoregion size and variability among its defining characteristics, agencies may find it necessary to develop baseline data and management goals at the level IV ecoregion scale. Continuing sampling efforts on intermittent drainages in eastern South Dakota will allow habitat comparisons and between-year comparisons among a larger number of level IV ecoregions.

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