

## **ANNUAL PROGRESS REPORT**

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**Funding Number:**

**CA 83307101-0**

**Agreement Date:**

August 17, 2006

**Reporting Period:**

September 1, 2006 to September 30, 2007

# Reference Site Selection for Monitoring and Assessment of Intermittent Streams in South Dakota

## Project Description

Intermittent streams are defined as those stream channels which flow for only a portion of the year. These streams have well defined bed and bank features and typically display seasonal flow during spring and early summer before drying toward the middle and end of the growing season. Recent emphasis has been placed on monitoring and assessment of intermittent streams. Ephemeral and intermittent channels contribute the bulk of the nation's stream network and contribute greatly to downstream water quality, habitat conditions and biotic integrity. Clearer understanding of the importance of these small catchments to downstream water quality, habitat and biotic integrity has fueled demands to expand protection and monitoring up into these headwater catchments.

This project will define intermittent, headwater stream reference sites and provide supporting field data for the Northern Glaciated Plains (NGP) ecoregion (LIII Ecoregion 46) of South Dakota (Figure 1). The objectives of this proposed effort are to (1) define candidate intermittent stream reference sites within the NGP, (2) conduct field sampling to characterize natural, intermittent reference stream water quality, physical habitat and biological conditions, (3) define optimal macroinvertebrate metrics for monitoring headwater intermittent prairie streams, (4) define the appropriate index period for macroinvertebrate sampling within headwater intermittent prairie streams and (5) validate selection of intermittent stream reference sites against random and targeted intermittent drainages within the NGP.

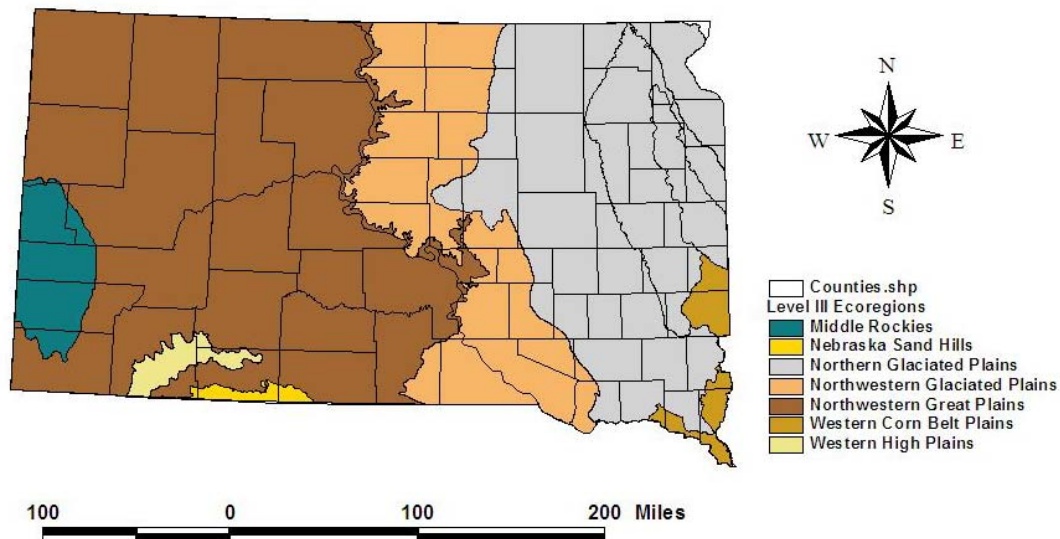


Figure 1. The Northern Glaciated Plains (gray) target area for selection of intermittent stream reference sites in eastern South Dakota.

## Year I Accomplishments

Major accomplishments in 2007 by South Dakota State University and the South Dakota Department of Environment and Natural Resources included: (1) development and approval of the project Quality Assurance Project Plan (QAPP); (2) delineation of the intermittent stream target population within the NGP; (3) optimal selection of ATtILA landscape metrics for generation of watershed condition scores; (4) calculation of ATtILA watershed condition scores for all streams within the target population; (5) random selection of 10 validation sites from the entire target population; (6) selection of 10 targeted sites based upon SD DENR, NRCS and SD GF&P recommendations; (7) random selection of candidate reference sites from within the upper 15<sup>th</sup> percentile of watershed condition scores in each level IV ecoregion of the NGP; and (9) field validation of intermittency using the North Carolina *Identification Method for the Origins of Intermittent and Perennial Streams* and site condition using the Petersen *Riparian, Channel and Environmental (RCE) Inventory* for each validation, targeted and candidate reference site.

### 1. Quality Assurance Project Plan (QAPP)

A QAPP was completed for this project in July of 2005. The QAPP included detailed descriptions of project management, data measurement, data acquisition, data management, assessment of project, project reporting, and data validation components. The QAPP was signed by representatives of the South Dakota Department of Environment and Natural Resources on February 26, 2007.

### 2. Delineation of Stream Target Population

Intermittent stream watersheds within the NGP ecoregion were defined using the National Hydrographic Dataset (NHDPlus). Each watershed (=reporting unit) was screened using the following criteria:

- 1) The stream and its watershed must fall within the NGP ecoregion
- 2) The stream must be an NHDPlus Strahler Order =1 stream channel
- 3) Watershed size must fall between 1.0 and 6.0 km<sup>2</sup>
- 4) The stream must not be a lake outlet

A total of 2,849 intermittent, headwater streams met all of our initial site criteria. An additional site criterion was that all streams must have well defined bed and bank features. This criterion was evaluated during field validation (see below).

### 3. Optimal Selection of ATtILA Landscape Metrics

Candidate reference sites were screened from the target population using U.S. EPA's Analytical Tools Interface for Landscape Assessments (ATtILA). This ArcView extension tool supports generation of landscape condition scores using attributed GIS coverages. ATtILA provided the capability to calculate 85 different metrics of landscape condition. While all of these metrics were calculated for all 2,849 watersheds (=reporting units) of the target population, many did not

vary significantly throughout the ecoregion. Thus, an optimization process was employed to identify those metrics explaining the most variation in condition within the ecoregion. Steps in the optimization process included:

- a) metrics calculated for all reporting units
- b) summary statistics generated for each metric
- c) metrics with unvarying values were eliminated from the metric set
- d) principle components analysis performed on remaining metrics
- e) correlation analysis performed on remaining metrics versus first two principle components
- f) most highly correlated metrics of each class selected for inclusion in a final set of 10 metrics

The final watershed condition metric set included landscape metrics (% watershed in natural grassland, % watershed in natural use, % watershed in all human use, % watershed in all agricultural use), riparian metrics (% 120m buffer in all natural use, % 120m buffer in all human use and % 120m buffer in all agricultural use) and human stressor metrics (annual phosphorus load, annual nitrogen load).

#### 4. Calculation of Watershed Condition Scores

Optimal metrics (above) were used within ATtILA to generate condition scores for individual reporting units (= watersheds in this study). Separate class scores were generated from within ATtILA (landscape, riparian, human stressor) using the metrics from each class. These class scores were summed for each reporting unit and the sum rescaled to 100 to provide watershed condition scores that ranged in value from 5.4 to 100 for the total target population. Scores generated for all 2,849 reporting units within the NGP are shown in Table 1.

Table 1. Summary statistics for watershed condition scores generated for all reporting units within the NGP ecoregion.

<b>Statistic`</b>	<b>Value</b>
n	2849
Minimum Score	5
25 <sup>th</sup> Percentile	29.2
50 <sup>th</sup> Percentile	54.2
75 <sup>th</sup> Percentile	75.4
Maximum Score	100

#### 5. Selection of Random Validation Sites

Ten validation sites were selected at random from within the entire NGP target population. Detailed water quality, habitat and invertebrate data collected from these sites will be used to help validate candidate reference sites following year #2 sampling.

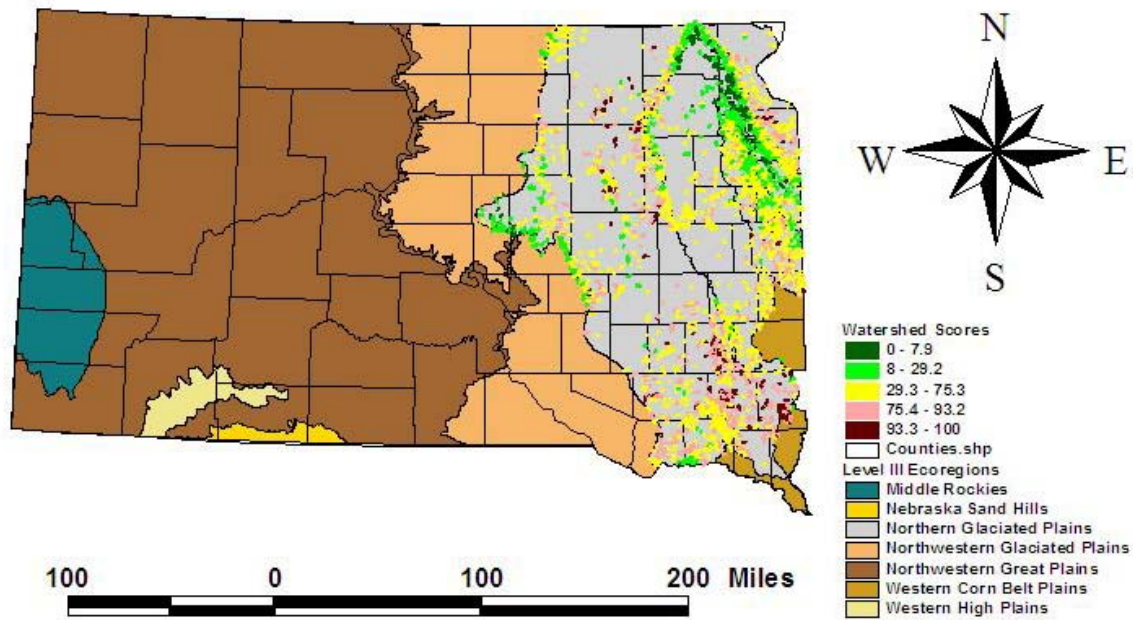


Figure 2. Target population of intermittent, headwater stream sites within the NGP ecoregion. Streams within the upper 25<sup>th</sup> percentile of watershed condition green in color. Streams in lower 25<sup>th</sup> percentile of watershed condition pink and dark red in color.

## 6. Selection of Targeted Sites

One targeted site was selected on the basis of historical monitoring data. It was the only site within the target population with existing historical data. The remaining targeted sites were selected based upon recommendations from South Dakota DENR, South Dakota Game, Fish and Parks, East Dakota Water Development District and district conservationists of counties within the target area. Nine additional targeted sites could be defined from input from these local water resource professionals. Paired good and bad targeted sites were identified for each of five LIV ecoregions within the NGP.

## 7. Selection of Candidate Reference Sites

Examination of ATtILA watershed condition scores revealed spatial patterns consistent with LIV ecoregion delineations of the NGP. In addition, total stream miles varied significantly by LIV ecoregion within the NGP. Following discussion with SD DENR, it was determined that candidate reference sites should be selected randomly from the upper 15<sup>th</sup> percentile of watershed condition scores of LIV ecoregion strata. Forty candidate reference sites were allocated to LIV ecoregions within the NGP in proportion to total intermittent, headwater stream miles within each LIV. At least three reference sites were allocated to each of the LIV ecoregions.

## 8. Field Validation of Intermittency and Condition

Random, targeted and candidate reference sites were field validated to verify intermittency, site condition and compliance with site selection criteria using the North Carolina *Identification Method for the Origins of Intermittent and Perennial Streams* and site condition using the Petersen *Riparian, Channel and Environmental (RCE) Inventory*. Ninety stream sites were visited during the validation process. Thirty sites were eliminated from consideration (lack of defined bed/bank-15, denied permission for access-8, stream was a lake/wetland outlet-5, candidate reference site of poor condition-2). Prior to site visits, permissions were acquired from 60 stream sites. Eliminated sites were replaced at random from their respective LIV ecoregion target pool. Thus, the final set of 60 sampling sites included 10 random validation sites, 10 targeted sites identified from natural resource personnel and 40 candidate reference sites with watershed condition scores falling in the upper 15<sup>th</sup> percentile of their respective LIV ecoregions.

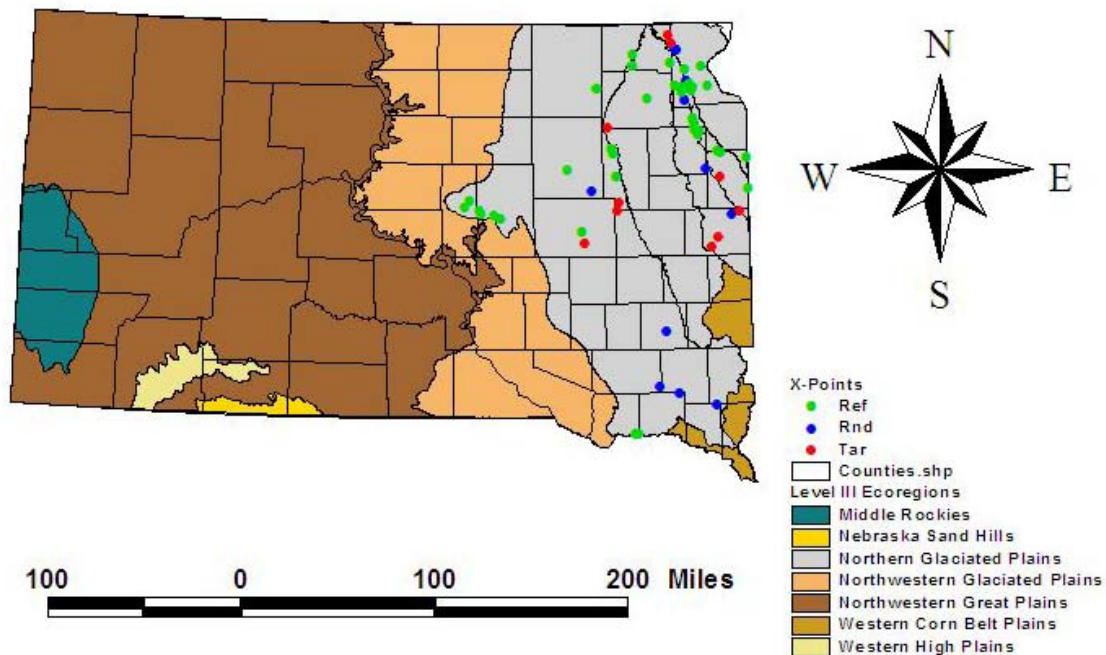


Figure 3. Final distribution of random, targeted and candidate reference stream sites within the NGP ecoregion.

### Summary

ATtILA analysis using optimized landscape metrics was a useful tool for screening candidate stream reference sites. All 60 intermittent, headwater stream sampling sites were identified and field validated. Validation data confirm that sites were intermittent and generally agree with watershed condition scores generated through ATtILA analysis. Intensive sampling for water quality, habitat and biotic integrity will commence in spring 2008. Data collected from that

effort will be used to address remaining project objectives.

**Budget Overview**

This project was supported by funds totaling \$291,756. Allocation of this amount by expenditure category and amount spent by category over the period September 1, 2006 to September 30, 2007 are shown below in Table 2.

Table 2. Budget summary for South Dakota intermittent stream project as of September 30, 2007.

<b>Budget Category</b>	<b>Allocated Amount</b>	<b>Amount Spent Year #1</b>
Salaries	\$122,399.00	\$24,933.89
Fringe Benefits	4,153	542.12
Travel	30,000.00	4,096.71
Contractual	28,500.00	113.61
Supplies	20,500.00	7,803.04
Tuition Remission	6,000	1,871.74
Equipment	20,000.00	11,115.00
Indirect Costs	60,204.00	13,123.80
Total Costs	\$291,756.00	\$63,599.91

The Department of Biology & Microbiology has awarded graduate teaching assistantships to both graduate students working on this project for the fall 2007 term in order to conserve grant salary dollars. This will facilitate extension of student effort through the second year of this project. Undergraduate field technicians will not be hired until spring 2008 to provide support for detailed sampling during the second growing season.

**Deviations from the QAPP**

The QAPP for this effort proposed allocation of candidate reference sites using a probability-based, GRTS approach across the entire NGP ecoregion. However, following ATtILA analysis, it was determined that the spatial distribution of stream condition scores was not random across the NGP. Rather, there appeared to be good correspondence between watershed condition and LIV ecoregion boundaries, suggesting the need for stratification. Following discussions with the SD DENR, it was determined that candidate reference site allocation should be stratified by LIV ecoregion to account for this spatial correspondence. Furthermore, it was determined that allocation of the 40 candidate reference sites should be made in proportion to the total stream miles to be monitored (in the future) within each LIV ecoregion. The GRTS approach to sample allocation provides the advantage of more even spatial allocation of sites within a sampling frame while still providing a known probability of allocation (Stevens and Olsen 2004). However, the GRTS site allocation is more time consuming and technically demanding to produce than a stratified-random site allocation (McDonald 2004). Because we had anticipated working through EPA to generate the GRTS design and were concerned about our ability to

generate reiterations of sampling sites (30% of our sites had to be re-sampled on the fly, see above), SD DENR and SDSU altered the probability-based approach from a GRTS allocation to a stratified-random site allocation. This allowed rapid generation of random replacement sites within each LIV ecoregion while still following a probability-based allocation scheme.

The QAPP for this effort called for 20 targeted sites and 30 candidate reference sites. However, we were only able to identify 10 targeted sites within the population. Thus, the remaining 10 sites were added to the candidate reference site pool, bringing that total to 40 sites. Oak Lake Field Station (SDSU) provided the only targeted site based upon historical data. SD DENR had no existing data from which to base a selection of targeted sites. Thus, the remaining nine targeted sites were selected from personal recommendations of water resource agencies and local district conservationists (based upon familiarity with local landscape conditions). Only nine additional targeted sites could be identified from these sources. Five targeted sites considered to be in good-excellent condition and five considered to be in poor condition were defined.

### **Appended Support Materials**

Attached to this report is a presentation summarizing project activities and data collected through the 2007 sampling season. These materials are included to clarify and support statements made above in our annual progress report. Questions regarding these materials should be directed to Dr. Nels H. Troelstrup, Jr., Principle Investigator.

### **Literature Cited**

McDonald, T. 2004. GRTS for the average Joe: A GRTS sampler for Windows. Biometrics/Statistics Project Report, West Inc., Cheyenne, WY. 10p.

Stevens, D.L. and A.R. Olsen. Spatially balanced samples of natural resources. Journal of the American Statistical Association 99: 262-278.