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"An assessment of Stream Bed and Stream Bank Characteristics" is the first in a series of Pictured Rocks Resource Reports. The Reports are intended to communicate the results of specific investigations and to educate the reader on the values of the natural, cultural, and human resources of Pictured Rocks National Lakeshore. Management alternatives and implications are offered based on the scientific studies. Readers comments on the results and recommendations of the Reports are invited.

Grant A. Petersen, Superintendent
Pictured Rocks National Lakeshore

Pictured Rocks RESOURCE Report

PIR091-1

AN ASSESSMENT OF STREAM BED AND STREAM BANK CHARACTERISTICS WITHIN PICTURED ROCKS NATIONAL LAKESHORE

by Walter L. Loope and Michael P. Holman

INTRODUCTION AND BACKGROUND

Overview

General accounts of land use history in the northern Great Lake states suggest that exhaustive clear-cutting, slash fires and log drives along stream courses effected a dramatic degradation of forest, soil and water resources between about 1880 and 1910 (Martin, 1944; Pyne, 1982; Ahlgren and Ahlgren, 1983; Karamanski, 1989). While the large-scale picture is clear, documentation of site-specific extent and persistence of impacts is not widely available.

Clear-cutting of pine and the practice of log driving near the turn of the twentieth century are documented within Pictured Rocks National Lakeshore (PRNL, Figure 1) and in many localities in central Upper Michigan (Hall, 1912; Reimann, 1953; Carter, 1967). At that time, water courses provided the only feasible means of log transport. During a "drive", small streams were dammed and pine logs were felled into the reservoirs created behind the dams; dams were then dynamited and the resulting flood of water carried the logs downstream to a larger stream or lake and on to market (Karamanski, 1989). During this process riparian corridors were stripped of soil-binding vegetation and the destabilized banks yielded tons of sand onto stream beds. Since overland flow is generally low in sandy substrates after logging (Patric, 1976; Patric, 1977), stream banks likely yielded most of the sediment that covered stream bottoms.

Legislative and administrative mandate for watershed protection

The concept of the watershed as a tangible ecosystem unit has not had much bearing upon configuration of most National Park boundaries (Runte, 1979). The goal of watershed integrity was, however, part of the rationale for boundary location at PRNL (U.S. Senate Report 1681, 89th Congress, 2nd Session, 1966). The park's enabling legislation (P.L. 89-668, signed October 15, 1966) instituted a core "shoreline zone" (to be acquired in fee by the U.S.) backed by an "inland buffer zone" ("IBZ," not necessarily to be acquired in fee by the U.S.). The purpose of the IBZ is, in part, "to stabilize and protect the existing character and uses of the lands, waters, and other properties within such zone for the purpose of preserving the setting of the shoreline and lakes, protecting the watersheds and streams ..." within the "shoreline zone."

Watershed problems: real and perceived

Recent studies which simulated elevated sand bed load in northern Michigan cold water streams provide insight into the impacts of log drives. Increase in sand bed load causes a decrease in stream depth, an increase in width, smoothing of stream profile, an increase in stream bed sand cover, and an overall deterioration of trout habitat (Hansen, 1971; Hansen et. al., 1983; Alexander and Hansen, 1983).

The west unit of the Hiawatha National Forest, southeast of PRNL (Figure 1), contains similar ecosystems and has a similar land use history. Watershed investigations on the Hiawatha suggest that most major streams still bear the imprint of turn-of-the-century land use (USDA-FS,

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1986). Corings of stream beds reveal 6 to 8 inches of sand covering gravel. Analysis of tag alder (Alnus rugosa) stem cross-sections indicate a large scale invasion of the riparian zone by this small native tree during the 1930s. Alder invasion is interpreted as a response to logging era abuse of stream banks. The movement of sand from destabilized banks into stream beds caused a decrease in channel depth, an increase in channel width, filling of holes, and the burial of rock and natural wood falls by sand (Alexander and Hansen, 1986). The Hiawatha NF is now attempting to restore a semblance of earlier stream characteristics through stabilization of existing raw banks, construction of sand traps, cutting/chemically treating alder and planting white cedar along stream channels (Hansen, 1973; Hansen et al. 1983). A study to document logging era impacts on the Indian River within the Forest is underway.

Michigan Department of Natural Resources (MDNR) and PRNL personnel have expressed concern about stream bed condition on several PRNL waterways, most notably, Chapel Creek (Schrouder, 1983; F. Young, personal communication). The situation on Chapel Creek led to the recommendation that a sand trap be installed there.

Given this historical outline of past land use and recent legislation, the NPS has found itself confronting several questions: 1) within PRNL, do streams possess the same "logging era legacy" of sand bed load that apparently exists in the west unit of the Hiawatha National Forest? 2) what is the distribution of "excessive" sand bed load? 3) is a program of stream bed rehabilitation desirable within PRNL?

PURPOSE OF THIS STUDY

The primary purpose of this project was to conduct an assessment of physical condition, vegetation characteristics and local land use history along PRNL streams to help determine the need for rehabilitation. In addition, we wished to collect base line information and to perform a general test of the hypothesis that significant impacts of the logging era remain evident today within the park.

METHODS

Based on the general literature (e.g. Platts et al., 1983), stream surveys from other agencies and our own judgment, we selected 15 parameters to characterize streams. These were: stream width, stream depth, evidence of bank erosion, development of natural barriers (e.g., deadfall into streams), per cent shade, evidence of beaver activity, general surface topography, pool development, bottom type, bank stability, streamside vegetation, aquatic vegetation, evidence of change and other comments.

Each park stream within the PRNL shoreline zone was walked from the shoreline zone boundary to stream mouth during the summer of 1986. The 15 parameters were recorded approximately every 100 meters along each of the streams; aluminum tags were placed on trees to permanently mark each observation point. Some observations are estimates of physical distances (e.g., stream width), while others involved the subjective placement of characteristics into classes (e.g., bank stability: 0 = unstable, 3 = very stable). A total of 253 stations were established on 10 streams.

Notes from original land surveys ("GLO" or General Land Office notes) in the 1850s (Bourdo, 1956) were examined to check general reference to streamside vegetation by the surveyors.

RESULTS

Average values of parameters for each stream are shown in Table 1. The two key variables, bank stability and bottom type, have high values for all park streams indicating stable banks and no trend toward excessive sand bed load. Depth shows some tendency to vary with discharge (correlation coefficient of depth upon discharge = .612; R squared = 37%). Shade shows some tendency to vary inversely with stream width (correlation coefficient = -.745; R squared = 55%) and beaver activity to vary directly with stream width (correlation coefficient = .789, R squared = 62%). Natural barriers appear to be somewhat more common on streams with higher beaver activity (correlation coefficient = .563, R squared = 31%). With the exception of these relatively weak relationships, no notable correlations were found between bottom type versus natural barriers, bottom type versus logging evidence, bottom type versus bank stability or between other pairs

Table 1: Average values of various parameters of PRNL streams - summer, 1986. Average (spring and fall) discharge values (Handy and Twenter, 1985) for two seasons are shown in parenthesis after each stream name.

STREAM (disch.)	depth (in.)	width (ft.)	nat. bar.	stab.	beav.	shade	pools	bottom	log.
MINERS (37.5 cfs)	13.1	16.9	1.1	2.5	.49	28.4	.46	1.17	.59
HURRICANE (21 cfs)	7.7	19.9	2.6	3.0	.77	41.7	.57	1.23	.63
7-MILE (20.3 cfs)	12.8	23.9	2.3	2.7	.71	30.0	.71	1.28	.64
L.BEAVER (30.3 cfs)	7.9	7.1	2.0	2.8	.18	81.7	.05	1.01	.47
SPRAY (9.4 cfs)	4.3	9.7	1.9	3.0	.35	75.2	.26	2.30	.43
CHAPEL (12.1 cfs)	4.7	6.7	1.3	2.8	.36	56.8	.92	1.84	.48
MOSQUITO (18 cfs)	6.1	14.7	1.6	3.0	.64	50.5	.64	2.06	.62
SABLE (12.9 cfs)	9.9	12.1	1.5	2.4	.84	46.9	.25	.97	.10
LOWNEY (NA)	8.7	12.7	2.1	3.0	.56	47.5	.19	.69	.44
BILLS (NA)	2.5	3.2	.5	3.0	.00	57.5	.00	2.00	.50

"nat. bar."= natural barriers in the stream (0=none, 3=many);
"stab."= bank stability (0=low, 3=high);
"beav."= beaver activity present/absent;
"shade"= % shade;
"pools"= pool development in stream bed (0=none, 3=many);
"bottom"= bottom rating for spawning and stability (sand/silt=0, rock=1, cobble=2, gravel=3);
"log."= presence vs. absence of logging evidence

of parameters.

Dominant streamside vegetation is shown in Table 2. The hypothesis that Alnus rugosa (tag alder) increased in the wake of the logging within PRNL (as it apparently did on the Hiawatha National Forest) cannot be supported by our data. No general correlation was found between evidence of logging and prominence of tag alder. Within PRNL, streamside vegetation is dominated by tag alder only on low gradient stretches. Thuja occidentalis (northern white cedar) also usually occurs in low gradient situations. Where stream gradients exceed 1%, riparian trees are not common.

Based on examination of GLO notes from Ives' 1851 land line survey, it is possible some change in streamside vegetation occurred in the 1930s after logging (Gordon Moote, Sr., personal communication, re: logging). The 1851 notes reflect predominance of 10-16 inch white cedar and no mention of tag alder along the two mile, low gradient stretch of the Miners River above Miners Falls. Today tag alder is common along with white cedar and abundant cedar stumps.

Natural barriers in park streams appear to increase directly with prominence of streamside white cedar except on the upper Miners River. The present lack of barriers along the upper Miners may be a result of previously mentioned logging.

Table 2: Dominant streamside tree cover. In most cases, species abbreviations consist of the first two letters of genus and species names (e.g. ALRU = Alnus rugosa). Species list of Latin and common names is given in Appendix 1.

Species	MINE	MOSQ	CHAP	SPRA	LBEA	BILL	LOWN	7MIL	HURR	SABL
ALRU	15	9	6	1	6		6	5	6	10
THOC	18	8	2		2		4	6	15	
TSCA		1			2		1	2	3	
SORB										
FRAX		2								
PIGL	3	1	1						2	
PIMA	1		1							
ABBA	3	2		1				1	2	1
BEAL		11	1	1	3	2			1	3
ACPE					1					1
ACSP			1							
ACSA		13	10	16	2	2	3			15
FAGR			2	4						
ACRU					1					
PIST	1									
BEPA	1	1	1				1		1	
PIBA										1
PIRE	1									

Banks of the Mosquito River, Chapel Creek and Spray Creek are dominated by upland hardwoods (ACSA=sugar maple; BEAL=yellow birch) over most of their courses. Tag alder and white cedar are prominent only were gradients are low.

Within the PRNL shoreline zone, stream profiles show some differences which are manifest in streamside vegetation patterns. Mosquito, Spray, Bills, Little Beaver, and Miners show general concave profiles, some with knickpoints (irregularities in the slope of a stream) in various states of recession. Hurricane and Sevenmile show convex profiles, at least within the stretches examined. This is a function of varying composition and resistance to erosion of rock units exposed along the streams. Streams with a local concave profile are cut into the Cambrian Munising Formation (knickpoints are formed by the more competent Trempealeau dolomitic sandstone), while those with a convex profile course across the top and eventually over the underlying resistent Jacobsville Sandstone (see Hamblin, 1958). Along streams with concave profiles, the lower stretches support riparian trees (ALRU and THOC) along gentle gradients; along streams with convex profiles, upper stretches are characterized by low gradients and riparian trees.

CONCLUSIONS/ RECOMMENDATIONS

Based on our investigation, it does not appear that PRNL streams contain a residual sand bed load associated with past or present land use. This is apparently in contrast with the situation within the nearby Hiawatha National Forest. We suggest that this difference is primarily a function of the steeper stream gradients within PRNL (Lake Superior watershed) compared to the more gentle gradients of the Lake Michigan watershed. While the Lake Superior and Lake Michigan watersheds in central Upper Michigan experienced similar land use histories, the two stream systems have recovered differentially with the passage of time. Sand stripped from banks during the logging era was quickly flushed through the shorter, steeper stream systems draining to Lake Superior, while similar deposits still remain in the channels of the major streams of the Hiawatha National Forest that drain to Lake Michigan. Alder has not increased greatly in its extent along PRNL streams since the cutover, while the opposite is true within the Hiawatha (USDA-FS, 1986). Within PRNL, alder is prominent only in low gradient stream stretches which do not display signs of logging (which is prominent elsewhere).

The finding of high bank stability within PRNL suggests that stream banks within the shoreline zone do not supply large quantities of sand downstream. Absence of excessive extant sand bed load in a subject stream stretch does not necessarily imply that upstream banks are stable and not supplying sand (Alexander, personal communication). On these short, steep watersheds, sand could be "traveling through" rapidly and not be evident in stream bottoms. Two additional projects should be completed on PRNL streams: 1) a survey of transient bedload on representative streams (Hansen, 1974) and 2) a survey of bank stability upstream from the shoreline zone within the IBZ. The bulk of IBZ land is managed by the Michigan Department of Natural Resources (MDNR) and Benson Forests, a timber management firm which purchased the holdings of Cliffs Forest Products Co. in early 1991.

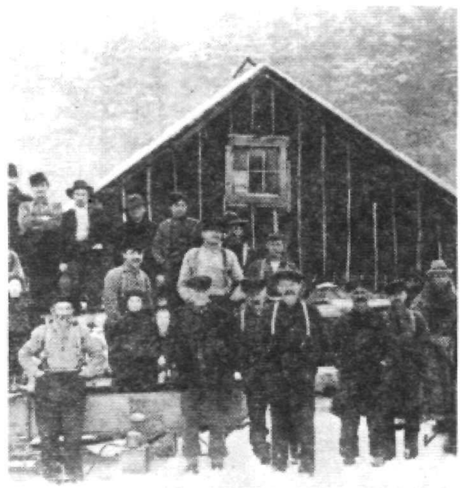

Photo courtesy of Alger County Historical Society

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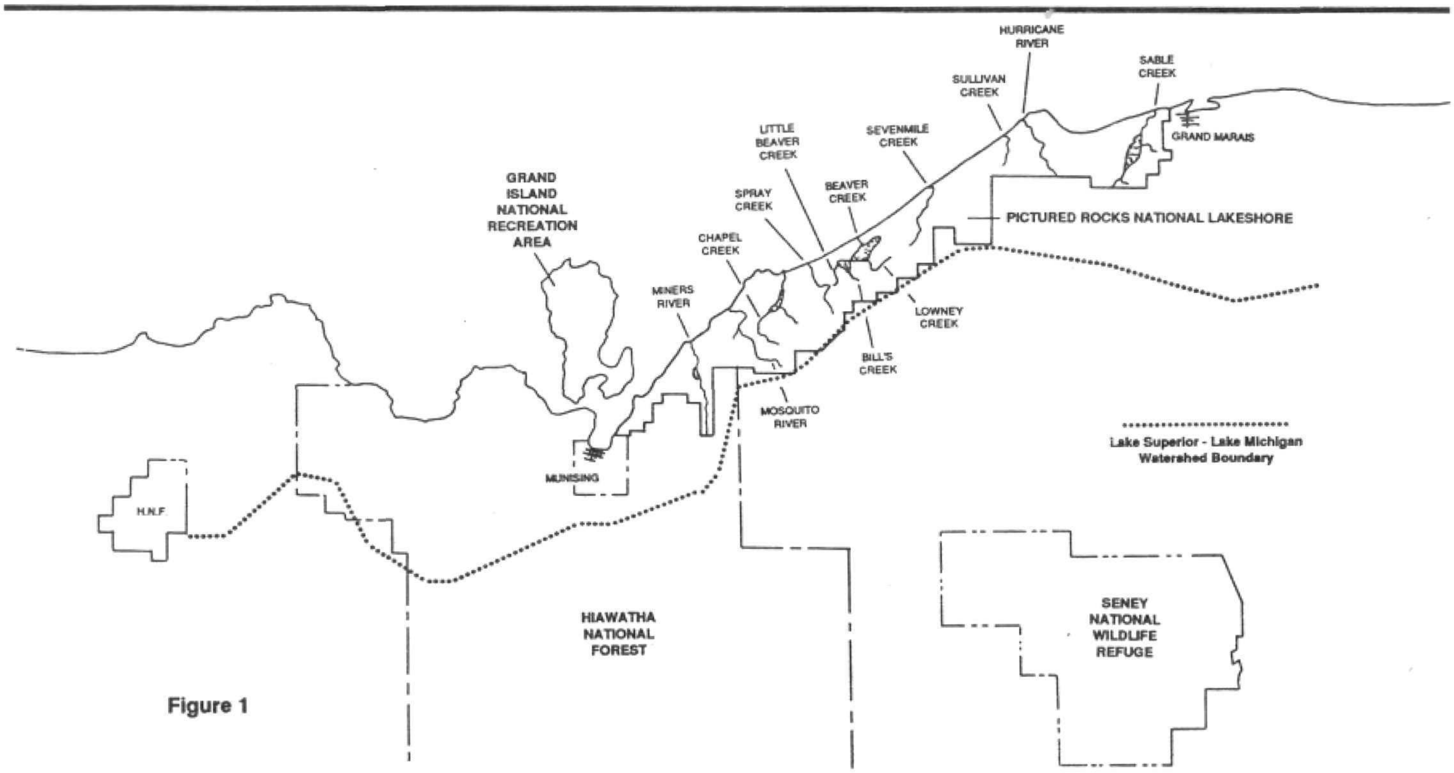

Figure 1

APPENDIX 1:

Latin and common names of trees recorded in the survey:

ABBA = Abies balsamea, balsam fir
ACPE = Acer pensylvanicum, striped maple, moosewood
ACRU = Acer rubrum, red maple
ACSA = Acer saccharum, sugar maple
ACSP = Acer spicatum, mountain maple
ALRU = Alnus rugosa, tag alder, speck led alder
BEAL = Betula alleghaniensis, yellow birch
BEPA = Betula papyrifera, paper birch, white birch
FAGR = Fagus grandifolia, beech
FRAX = Fraxinus sp., ash (green and black)
PIBA = Pinus banksiana, jack pine
PIGL = Picea glauca, white spruce
PIMA = Picea mariana, black spruce
PIRE = Pinus resinosa, red pine
PIST = Pinus strobus, white pine
SORB = Sorbus sp., mountain ash
THOC = Thuja occidentalis, white cedar
TSCA = Tsuga canadensis, hemlock

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