

Restoration of Flat-Rock Forest Communities along the New River - Phase I

Proposal

Introduction

New River Gorge National River was established in 1978 to protect a 55-mile segment of the New River watershed in West Virginia. The park, which encompasses nearly 88,000 acres, is characterized by a steep gorge cut through nearly 1,500 feet of sandstone bedrock. This phenomenon has encouraged the development of a diverse mixture of habitats and ecotones. Beginning in North Carolina, the northward-flowing warm waters of the New River create a much more temperate climate at the gorge bottom than that found on the exposed gorge rim above. Seasonal flows of the river further modify the environment at the gorge bottom, as rich sediments and alluvium are either deposited on or eroded from the resilient sandstone.

The plant and animal communities along the banks of the river adapted to this warmer climate as well as the seasonal cycles of the river. Rich riparian communities of sycamore (*Platanus occidentalis*), ash (*Fraxinus* spp.), buckeye (*Aesculus octandra*), sweetgum (*Liquidambar styraciflua*), birch (*Betula* spp.), tulip poplar (*Liriodendron tulipifera*), and oaks (*Quercus* spp.), developed on protected sites with deep alluvial soils. However, other sites were much more exposed to the whims of the river. Anecdotal evidence suggests that every 50 to 100 years, a significant flooding event occurred in the gorge. Sites exposed to the high water and current were either severely eroded, or perhaps in some cases entirely eliminated.

This harsh environment might have been responsible for the development of a unique community that thrived on the "flat-rock" sandstone shelves immediately above the river and often associated with an area of rapids. Here, vegetation survived on a thin stratum of infertile sandy soil and consisted of species normally associated with much more xeric conditions than typically found on a river bottom. The principal species included Virginia pine (*Pinus virginiana*) and eastern redcedar (*Juniperus virginiana*).

It is postulated that catastrophic flooding of the New River scouring these sandstone shelves resulted in a stand replacement-type disturbance. Naturally dry because of the shallow bedrock, pioneer species such as the pines and cedars colonized the site. Here, these species could retain their early successional dominance because of the regular flooding of the river, xeric conditions, and poor site fertility. The resulting "Flat-Rock Community" is limited to only a few suitable sites along the entire 320-mile length of the New

River. Four of these sites are known to exist within the boundary of New River Gorge National River and range in size from 1 to 10 acres.

In 1947 Bluestone Dam was completed near Hinton, immediately upstream of what is now New River Gorge National River. Built primarily for flood control, this structure has effectively contained both the annual and cyclic floodwaters of the New River. No catastrophic floods have occurred since its completion, and the flat-rock sandstone shelves have remained high and dry for more than 50 years. As a result, site disturbance caused by the flooding action has ceased, and natural succession has favored the transitions to more shade-tolerant mesic-site species. Riparian hardwoods as well as a mixture of mesic- and xeric-site oaks such as post oak (*Quercus stellata*) and chestnut oak (*Quercus prinus*) are invading the flat-rock shelves traditionally dominated by the pines and the cedars.

Statement of Problem

The unique and rare sandstone flat-rock communities situated along the banks of New River Gorge National River are in peril of being lost to invading hardwood species. This appears to be a successional trend directly linked to the loss of naturally recurring catastrophic flooding after the construction of an upstream dam more than 50 years ago. Subsequent construction of homes along the New River prevents any possibility of utilizing the flow of the river to re-create this disturbance. But, unless sufficient disturbance is re-introduced into the community, its continued decline is inevitable. Since water can no longer be utilized, some other disturbance—such as fire—is necessary to prevent the loss of this fragile community.

The Role of Fire

Along with catastrophic flooding and major earth movements, fire has long been recognized as a significant factor in site disturbance. Pyne, Andrews, and Laren (1996) noted, "There is growing appreciation that disturbances, like fire, are processes that alter landscape structure and pattern, and ultimately, species composition." The authors further noted that "fire creates a variety of regeneration environments suitable for species colonization." The nature of fire to significantly alter the natural environment can lead to the speculation that fire could, under certain predetermined conditions, be utilized as a mechanism of major site disturbance having effects similar to major flooding.

Table 1 summarizes some of the common effects associated with flooding and fire.

Table 1. Brief comparison of probable effects of fire and flooding on selected environmental factor

Factor	Flooding	Fire
Soil organic layer	Direct removal through erosion and scouring. Amount may vary by the exposure of location.	Consumption through pyrolysis and oxidation. Amount will vary by fire intensity, flame depth, residence time, etc.
Soil mineral layer	Direct removal through erosion and scouring. Deposition may occur in sheltered areas.	Indirect removal by wind or water following fire. Deposition may occur in sheltered areas
Species Composition	Complete removal of species by action of current. Survival of species dependent upon size, exposure, and stability of the root system.	Survival dependent upon fire behavior (intensity, flame length, flame depth, residence time, etc.) Survival also dependent upon ages sizes, and fire tolerance characteristics of the individual species.

The effects of fire on soils would appear to have very similar outcomes to those resulting from flooding. Both disturbances would remove all or part of the organic and mineral soil layers while leaving some areas relatively undisturbed. Fire may recycle more nutrients back into the soil and increase site fertility more than flooding. Alluvial deposition from flooding could not only add nutrients, but additional soil to the site as well. On the other hand, flooding could erode soil from more exposed areas than might be expected from fire alone.

While both fire and flooding would appear to favor early successional or colonizing species, the net effects of fire and flooding on vegetation are less clear. As stated earlier, the principal species found in the Flat-Rock Communities are Virginia pine and eastern redcedar. While both of these are considered colonizing species, neither would be considered fire-dependent, and indeed, both may even be considered fire-in tolerant (Tirmenstein 1991, Sullivan 1993). While at face value, this may appear to eliminate fire as a potential disturbance factor, this is not necessarily true. Flooding also would not be a respecter of either species, removing those individuals that are most exposed to the current, are weaker, and/or are most poorly rooted.

In summary, while it cannot be concluded that fire would provide the disturbance necessary for the perpetuation of the Flat-Rock Community, it also cannot be concluded that fire could not provide the disturbance needed to

maintain the dominance of the early successional pine and cedar. Fire could perpetuate the community or eliminate it entirely. Fire may create a favorable seed bed for locally common exotic species, such as Japanese honeysuckle (*Lonicera japonica*), further increasing the competition on the pines and cedars, or fire could create a favorable seed bed for the pioneering pines and cedars. Even if fire is a viable alternative, it is unknown what prescription parameters would create the most appropriate site disturbance. Simply put, too many unknowns exist to implement a prescribed fire regime and have predictable outcomes. Research is necessary in order to utilize prescribed fire to effectively manage and perpetuate the rare and fragile Flat-Rock Community at New River Gorge National River.

Location

Brookside Island is a former summer camp situated on a 29-acre rocky sandbar surrounded by the New River approximately 6.5 miles downstream of Bluestone Dam. Approximately 7 acres of the island is best described as a declining Flat-Rock Community, while the remainder consists primarily of riparian hardwoods. The middle of the island is predominantly mature Virginia pine. The area has been classified as a rare plant community by the state natural heritage office. Both National Park Service and state resource managers recognize that the Flat-Rock Community is declining on the island, and both have agreed that if measures are not taken to preserve the community, it will eventually succeed to riparian and/or xeric-site hardwoods. There is also a common agreement that this site would be an appropriate area to study potential treatments to perpetuate the Flat-Rock Community.

Objectives

This project will examine changes in the Flat-Rock Community resulting from various treatments designed to improve the reproduction and viability of desirable associated species and the elimination of encroaching species, such as undesirable hardwoods. The study will also increase the current understanding of fire as disturbance factor in maintaining non-fire-dependent species. While prescribed fire will be the principal treatment, secondary treatments may include mechanical, chemical, and/or any combination of treatments. Statistically significant changes will be determined through extensive analysis of treatment and control plots.

The specific objectives are:

Phase I

1. Complete a literature review detailing the current state of knowledge regarding:
 - a. The ecology and management of selected edaphic climax communities.

- b. The ecology and management of Virginia pine, eastern redcedar, and cedar glades.
 - c. The effect of periodic catastrophic flooding on ecological communities.
 - d. The use of prescribed fire in maintaining non-fire-dependent species.
2. Conduct a field inventory of overstory, understory, and ground layer vegetation found in the Flat-Rock Community on Brookside Island, and determine density, dominance, and abundance of major indicator species.
 3. Use dendrochronological analysis to determine the age class and distribution by species of overstory trees found in the Flat-Rock Community on Brookside Island.
 4. Design an experiment to test a combination of prescribed fire, mechanical, and/or chemical treatments for regenerating key tree species in the Flat-Rock Community on Brookside Island.

Phase II

1. Locate the study sites and establish plots.
2. Collect pre-treatment site and vegetation data.
3. Impose treatments.

Phase III

1. Monitor the vegetative effects of the treatments for at least two growing seasons following treatment.
2. Establish a system for further monitoring.
3. Analyze data and prepare reports and publications.

Special Conditions

1. The discovery of any threatened or endangered species during the inventory phase of the research project may limit the experimental treatment.
2. All prescribed burns will have an appropriate prescribed fire burn plan approved by the superintendent, NERI, and be conducted by qualified National Park Service personnel within the policy and guidelines established by the National Park Service. The Fire Management Officer, NERI, will be responsible for the development and implementation of the burn plan in cooperation with the researcher.
3. All treatments (prescribed fire, mechanical, chemical, etc.) will meet all NEPA and other associated compliance requirements.
4. Lodging for field workers will be provided by the National Park Service.

Deliverables

1. Literature review in the form of a report to the National Park Service, by December 31, 2000.
2. Forest cover map and field inventory of trees and shrubs on Brookside Island. Inventory will include species density, dominance, abundance, importance values, and age class distribution for primary species. Inventory report to be submitted by December 31, 2000.

Budget

Item	Amount
Salaries (Research Associate)	\$15,500
Student Wages	3,840
Fringe Benefits	1,741
Travel	3,495
Supplies (field supplies, film, flagging, etc.)	2,495
Services (copying, data service, library, etc.)	2,494
Total Direct Costs	29,565
Indirect Costs (15%)	4,435
Total	34,000

Summary

Through the works of humankind, the Flat-Rock Community at New River Gorge National River is steadily declining. Inevitably, it will be lost if intervening measures by humankind are not taken to perpetuate it. At this point, it is impossible to say if the community can be saved. It is also not possible to determine if prescribed fire has a role in the continued maintenance of the community. Only through careful research can the answers be determined.

This project expands the role of prescribed fire into some exciting new realms. The knowledge of “if” and “how” to apply fire to mimic other natural disturbances opens new doors for the role of fire. And, the knowledge of “if” and “how” to utilize prescribed fire to manage non-fire-dependent species opens possibilities applicable to many other ecosystems far beyond the flat-rock sandstone shelves of New River National River.

References

- Pyne, S. J., P. L. Andrews, and R. D. Laven. 1996. Introduction to Wildland Fire. 2nd ed. John Wiley & Sons, Inc., New York, NY. 769 pp.
- Sullivan, J. 1993. *Pinus virginiana*. In: Fischer, W. C., comp. The Fire Effects Information System (Database), Missoula, MT: USDA Forest Service, Intermountain Research Station, Intermountain Fire Sciences Laboratory. Magnetic tape reels; 9 track; 1600 bpi, ASCII with Common LISP present.
- Tirmenstein, D. A. 1991. *Juniperus virginiana*. In: Fischer, W. C., comp. The Fire Effects Information System (Database), Missoula, MT: USDA Forest Service, Intermountain Research Station, Intermountain Fire Sciences Laboratory. Magnetic tape reels; 9 track; 1600 bpi, ASCII with Common LISP present.

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Restoration of Flat-Rock Forest Communities along the New River — Phases II and III

Proposal

Introduction

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Location

Camp Brookside is a former summer camp situated on a 29-acre rocky sandbar surrounded by the New River approximately 6.5 miles downstream of Bluestone Dam. Approximately 7 acres of the island is best described as a declining Flat-Rock Community, while the remainder consists primarily of riparian hardwoods. The middle of the island is predominantly mature Virginia pine. The area has been classified as a rare plant community by the state natural heritage office. Both National Park Service and state resource managers recognize that the Flat-Rock Community is declining on the island, and both have agreed that if measures are not taken to preserve the community, it will eventually succeed to riparian and/or xeric-site hardwoods. There is also a common agreement that this site would be an appropriate area to study potential treatments to perpetuate the Flat-Rock Community.

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The specific objectives are:

Phase II

- Impose treatments.

Phase III

1. Monitor the vegetative effects of the treatments for at least two growing seasons following treatment.
2. Establish a system for further monitoring.
3. Analyze data and prepare reports and publications.

Special Conditions

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3. All treatments (prescribed fire, mechanical, chemical, etc.) will meet all NEPA and other associated compliance requirements.
4. Lodging for field workers will be provided by the National Park Service.
5. The project plan will be reviewed by the West Virginia Office of Natural Heritage.

Methods

Treatments — Phase II

Three vegetation management treatments will be imposed on 24 x 24 mm plots, each replicated three times, for a total of nine. The first treatment, a light treatment, will involve cutting all target tree and woody shrub stems, followed by a cut stump herbicide application using an approved chemical. Target stems include all stems except Virginia pine, eastern redcedar, post oak, and others as indicated by NPS staff. Cut stems and tops will be lopped and scattered over the plot, or redistributed to plots scheduled for burning. The second treatment, a heavy treatment, will include the same cutting and herbicide treatment described above, followed by a fall or winter prescribed burn. Cutting and herbicide treatments will be conducted during the spring and/or summer of 2001, with the burning conducted during the fall of 2001 or the winter of 2002. The final treatment will involve untouched controls.

Post-Treatment Measurements and Data Analysis (Phase III)

Pre-treatment vegetation variables will be compiled for each sample plot. For overstory trees, dominance will be expressed as basal area per ha, while density will be expressed as the number of stems per ha. Mean diameter,

mean height, relative dominance, and relative density will also be calculated for each species. For understory trees, dominance will be expressed as basal area per ha, while density will be expressed as the number of stems per ha. Mean diameter, relative dominance, relative frequency, and relative density will also be calculated for each species. The regeneration stratum density will be expressed as the number of stems per ha. Relative density and relative frequency will also be calculated for each species. Mean relative dominance, relative density, and relative frequency will be used to calculate importance values (Mueller-Dombois and Ellenberg 1974).

Following the treatments, for at least two growing seasons, these variables will be assessed and compared to the controls, as well as post- and pre-treatment levels. Cut stumps will be monitored for sprouting, and vegetation transects will be used to determine if exotic species invasion is a problem. Also, surveys of rare and/or endangered plants will be conducted in cooperation with NFS and natural heritage staff. Data will be analyzed using analysis of variance and other standard techniques.

Time Line

6/01 - 9/01: Impose plot treatments (Phase II)
Preliminary data analysis (Phase III)
11/01 - 4/02: ng (Phase II)
5/02 - 8/02:
9/02 - 4/03: Data Analysis (Phase III)
5/03 - 8/03: Field Sampling (Phase III)
9/03 - 12/03: Data Analysis and Report Preparation (Phase III)

Deliverables

1. Progress report and summary of pre-treatment data (12/01).
2. Project summary report (12/02).
3. Draft report and data files describing the results of two seasons of post-treatment vegetation monitoring (12/03).
4. Final project report (3/04).

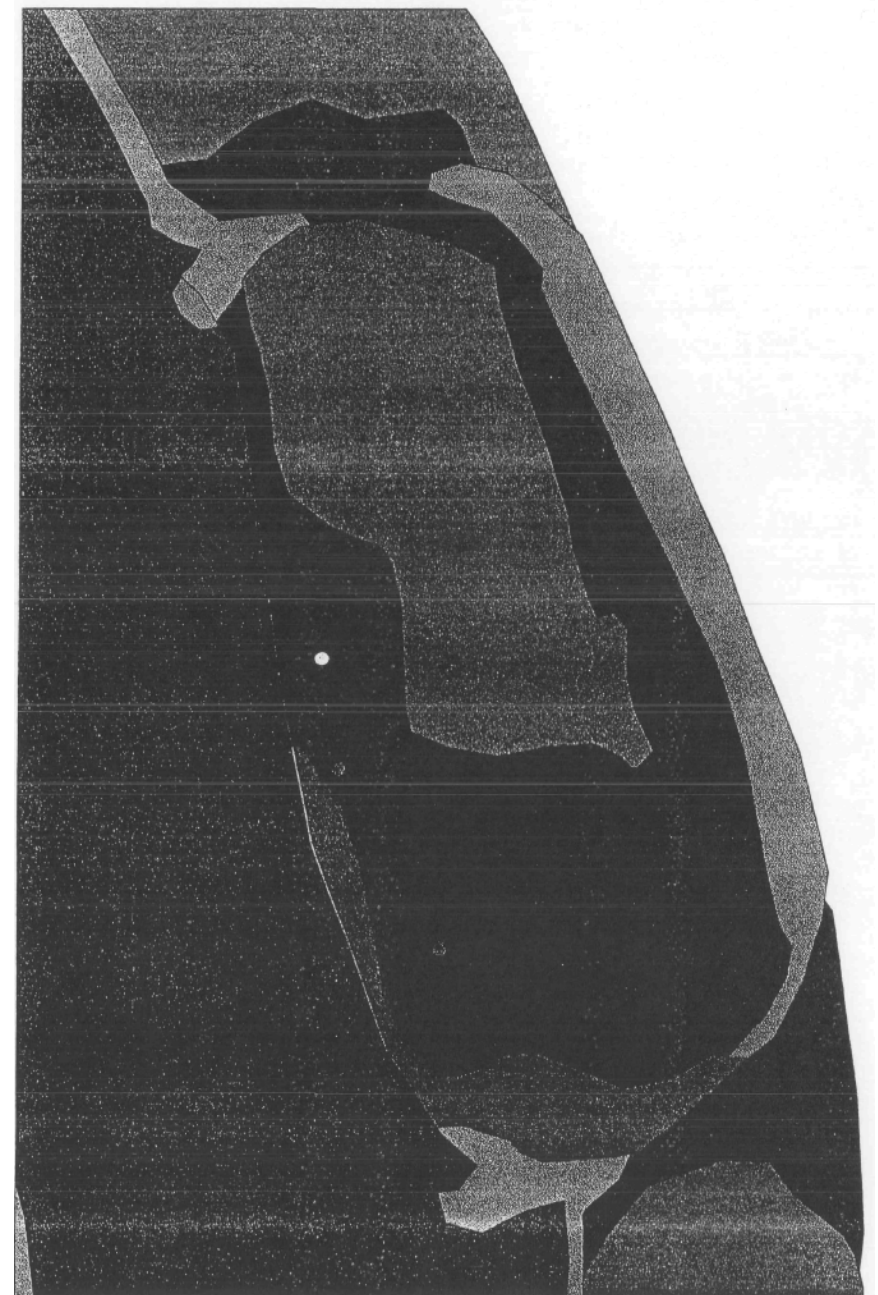
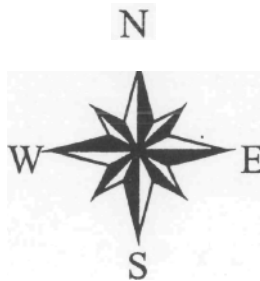
Plant Communities of Camp Brookside New River Gorge National River, WV

(Map provided by the West Virginia Natural Heritage Program)

- Plot 1
- Plot 2
- Plot 3
- Plot 4
- Plot 5
- Plot 6
- Plot 7
- Plot 8
- Plot 9

Camp Brookside Plant Communities

- *Juniperus virginiana*-*Pinus virginiana*
- *Juniperus virginiana*-*Pinus virginiana*-*Quercus stellata*
- Riparian herbaceous vegetation
- *Platanus occidentalis*-*Betula nigra*/Riparian woodland
- *Platanus occidentalis*-*Fraxinus pensylvanica*/*Carpinus caroliniana* riparian forest
- Herbaceous wetland
- Developed area
- River



60 0 60 120 Meters

Summary

Through the works of humankind, the Flat Rock Community at New River Gorge National River is steadily declining. Inevitably, it will be lost if intervening measures by humankind are not taken to perpetuate it. At this point, it is impossible to say if the community can be saved. It is also not possible to determine if prescribed fire has a role in the continued maintenance of the community. Only through careful research can the answers be determined.

This project expands the role of prescribed fire into some exciting new realms. The knowledge of "if and "how" to apply fire to mimic other natural disturbances opens new doors for the role of fire. And, the knowledge of "if and "how" to utilize prescribed fire to manage non-fire-dependent species opens possibilities applicable to many other ecosystems far beyond the flat-rock sandstone shelves of New River Gorge National River.

Outcomes of this research will include an evaluation of the fire and cutting treatments as a means to discriminate against undesirable vegetation and promote the growth, health, and regeneration of the desired pines and cedars. Ecological restoration is successful if the desired site and vegetation conditions can be created, and they maintain themselves. Since this restoration is an attempt to "set back" succession, continued disturbances will likely be necessary in the future.

References

- Mueller-Dombois, D., and H. Ellenberg. 1974. Aims and Methods of Vegetation Ecology. John Wiley and Sons, New York. 547 pp.
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