NYC Watershed Model Forest Program

Annual Report

August 2016 – December 2017

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PROGRAM OVERVIEW

The NYC Watershed Model Forest Program is a collaborative effort among the Watershed Agricultural Council Forestry Program (WAC), NYC Department of Environmental Protection (NYCDEP), SUNY College of Environmental Science and Forestry (SUNY-ESF), and the model forest host landowners - Cornell Cooperative Extension of Greene/Columbia Counties, Cornell Cooperative Extension of Delaware County, Frost Valley YMCA, and Green Chimneys. The program fulfills the research and demonstration component of the WAC mission.

The model forest program currently consists of four model forests: Clearpool (Putnam County), Frost Valley (Ulster County), Lennox (Delaware County) and Siuslaw (Greene County).

The model forests are primarily used to demonstrate compatibility between working forests and water quality protection. Educators, students, landowners, loggers and the general public come to the model forests to learn about a variety of topics, including silviculture, ecology, timber harvesting, best management practices for water quality (BMPs), invasive species, and tree identification.

Model forest guided tours and workshops provide opportunities for visitors to interact with knowledgeable professionals in an outdoor classroom setting. Visitation is a critical component of the program. Research has shown that landowners prefer to "walk the land" with a professional forester over other methods of receiving information about the management of their forests (Kilgore et al., 2007). Moreover, the model forests offer urban school groups an opportunity to experience forests and learn about the many goods and services they provide.

The model forests also provide opportunities for self-guided tours through the use of interpretive signage. These educational signs relay information on an assortment of forestry-related topics, such as Best Management Practices (BMPs), silviculture, and invasive species. In recent Model Forest Committee meetings, it was decided that signs developed in the future should target a younger audience. Lennox, Frost Valley, and Clearpool primarily function as camps for children and young adults. The current signs at the model forests are considered too technical for the average model forest user.

Discussions continue about the possibility of incorporating Quick Response Codes (QR Codes) onto future signs. QR Codes are black and white barcodes that are scanned by a phone or electronic device which is connected to the internet (photo 1). The scanned barcode brings the user to a webpage with more information on the sign topic. It is believed that model forest users would scan the sign barcode and reference additional information at various knowledge levels once leaving the model forest. While this tool may be useful, one of the major challenges moving forward is the limited cell and internet service in the model forest.

Photo 1: Example QR Code.

So far this year, meetings have been held at Siuslaw, Frost Valley, and Lennox model forests to discuss methods for designing more effective signs using the TORE method. With this approach, the focus is on making thematic, organized, relatable, and enjoyable signs to capture the attention and interest of the audience (Appendix A).

This year, at the Society of American Forester (SAF) National Convention, Emily Paye presented an interactive poster illustrating the signage updates underway at the model forests. Using sample signs and an iPad survey, she asked convention attendees which sign they thought was most effective at communicating watershed stewardship to a wide variety of audiences. Based on the data collected, it appears the TORE-modified signs are more effective. Of the 37 respondents, 15 selected the updated water bar sign, 12 selected the old water bar sign, 9 selected the updated pipe culvert sign, and 1 selected the old pipe culvert sign (see Appendix B to view the poster).

The model forests also serve as training grounds for loggers. Trained Logger Certification workshops and courses are regularly held at model forests. These courses range in topics from BMP installation to silviculture and forest ecology.

Recently, Joshua VanBrakle completed an extensive annotated bibliography that covers all research published relating to WAC, any research done within the four model forests, or any research or study where the primarily geographical focus was the NYC Watershed. Given their access to multiple scientific databases, Emily and René contributed roughly 30 citations to the effort.

Culmination of ESF research on BMP costs is feature in the latest issue of the Journal of Forestry (Appendix K).

An overview of ESF research during the past couple decades is featured in the journal, Scientia (Appendix L).

The latest research on logging costs, now in review in the Journal of Forestry, was presented at the 2016 National SAF Conference in Madison, WI and the New England SAF Conference in Bangor, ME (Appendix M).

Personnel Updates

Marilyn Wyman is retiring from Cornell Cooperative Extension in Greene County. She has been an asset to the model forest group and will be sorely missed.

Joshua VanBrakle has accepted a position with the Pennsylvania Land Trust Association and will be leaving the Watershed Agricultural Council to move back home to Harrisburg, PA. We are pleased to discover that Josh has been contracted to continue working on the signage update.

Emily Paye has taken over Jamie Regula's role as Model Forest Program Student Coordinator. Emily is in her first year at ESF working on her Master's degree. Her research will focus on BMP implementation in the Catskill/Delaware watershed. This will be an extension of Joshua VanBrakle's work assessing the reach of the BMP program using ArcGIS.

Matt Smetana has joined Clearpool Model Forest as the new Model Forest Facilitator. In this relatively new position, Matt will be primarily responsible for writing curriculum as they prepare to launch a new high school program.

Two-Year Work Plans

The two-year work plans were updated for Siuslaw, Frost Valley, Lennox, and Clearpool model forests (Appendix C). Plans were developed with input from model forest coordinators and members of the working group. The plans were delivered to the Forestry Committee in November, 2016. The work plans are used as "living" documents which are regularly re-assessed and updated.

CLEARPOOL MODEL FOREST

Visitation

Clearpool Model Forest (CMF) continues to attract large numbers of visitors, mainly in the form of school groups. The number of visitors to CMF decreased by 161 in 2016/2017 compared to the previous year (Table 1).

Table 1. Clearpool visitation for 2016/2017

Date	Event	Target Audience	Number of Participants
9/6/2016	Training new outdoor educators	educators	8
9/15/16	Brearley School – discovery hikes	Middle school students	65
9/22/16	Brooklyn Friends – discovery hikes	8th Graders	65
9/26/16	Collegiate Charter School – discovery hikes	9th graders	70
9/29/16	Hewitt School – hikes, pond study	Middle school	60

10/3/16	Women's Academy of Excellence – discovery hikes	9th graders	70
10/13/16	Immaculate Conception School- hikes, predator prey	Middle school	120
10/14/16	North Salem MS – hike	Middle school	90
10/17/16	Bronx Community Charter School – hike, predator prey, pond study, survival	5th grade	55
10/19/16	Corlears – Water conservation, pond study, watersheds, discovery hike	3&4th grade	35
10/26/16	Ed Dalpe – wetland ecology, geology, hike	Middle school	15
10/27/16	Metropolitan Montessori School - water conservation, geology, hike, survival	3rd grade	22
10/28/16	PS 130 – waste water treatment, water conservation	4th grade	40
	Individual Hikers on the trails during weekends	General public	15
11/2/16	Reece School – Discovery Hike, Forestry, Geology	Middle school	40
11/4/16	Harbor Heights – Hike, forestry, botany, geology, wastewater ornithology, mammals	High school	50
11/19/16	Father Son Weekend – discovery hikes, pond study, forest ecology	Adults and children	55
11/21/16	York Early College Academy – forest ecology, wetland ecology	High school	90
	People hiking on their own during this time period	General public	25
01/7/17	NYSOEA – preparation meeting for conference. People stuck around to go hiking	adults	15
1/7/17	NYSOEA Meeting – Campus Tour, Discussion on BMPs and Wastewater Treatment Plant	adults	20
1/27/17-1/28/17	Liberty Leads – Forest Ecology, Adaptations, watersheds, maple sugaring	High school students	130
2/6/17-2/10/17	Staff Training – forestry, watersheds, wastewater	staff	8
2/20/17	Winter Camp – mammal adaptions, forest ecology	7-11 yr olds	17
2/27/17	Hemlock Wooly Adelgid Training	Staff	8
2/28/17	MS 126 – watersheds, wastewater	Middle school students	30
2/28/17-2/29/17	Community Action School - forest/wetland ecology, survival, predator prey systems	High School Students	60
3/5/17	Father Daughter Day – Forestry, survival, plant id	Fathers and daughters	40
3/13/17	Maple Sugaring Event	Community members all ages	250
3/19/17	GC NYC – discovery hike	High school	15
4/6/17-4/8/17	Speyer Legacy School – forestry, watersheds, wastewater	High school students	40
4/9/17	Amphibian Hunt	Community members all	75

		ages	
4/19/17	Bronx New School – forestry, plant id	Middle school age	40
4/19 /17	Harbor Heights – Forestry, watersheds, geology	Middle school age	50
4/20/17	Sloatsburg Elementary – wetland ecology, forest ecology, pond study	5th grade	70
4/30/17	Girl Scout Weekend – forestry, wetland ecology, watersheds	4-7 grade	80
5/2/17	YWLS – forestry, wetland ecology, watersheds	High school age	40
5/4/17	PS 130 – waste water, watersheds	Middle school	40
5/6/17	Environmental Study Center - wastewater	Adults	20
5/6/17	PS 54 – watersheds, wastewater	Middle school	40
6/1-6/2/17	Brooklyn friends – pond study, hike	Middle school	70
6/7/17-6/9/17	Wcc – hemlock/invasive, hike, pond study	Middle school	80
6/16/17	NYC environmental study center	adults	30
9/1/17-9/8/17	Educators Training	Educators	10
9/12/17	DEP Educators – WWTP, model forest	teachers	50
9/28/17	Hewitt School – pond study, hike	Middle school students	50
10/4/17	Calhoun school – ecology, water conservations, WWTP	Middle school students	50
10/5/17	Institute for Collaborative Studies – ecology, watersheds, hike	Middle school students	65
10/18/17	Corlears – forest ecology, hikes	Middle school students	25
10/20/17	GC class – botany, forest ecology	Middle school students	12
10/24/17	CS 44, Bronx – Ecology, botany	Middle school students	40
10/26/17-10/28/17	NYSOEA conference	adults	180
Total			2,740

CMF Committee

Matt Smetana was introduced and welcomed as the new Model Forest Facilitator and will be responsible for writing the new curriculum as Clearpool adds a new high school program. Tyler and Brendan from WAC will be visiting Clearpool in February to train staff on forest ecology, plant identification and some watershed pieces. This has already been coordinated.

Maintenance

Trail maintenance is on-going on all of the trails.

Work was completed near the kiosk to repair erosion damage and the newly paved landing is ready for visitors.

NYSOEA

Clearpool hosted the New York State Outdoor Environmental Education Conference in October 2017. SUNY-ESF Ph.D. student Maneesha Jayasuriya presented her riparian study research at the conference (See Appendix D for a copy of her presentation).

Educational Expansion

Green Chimneys Clearpool Campus requested funding to assist with the purchase of an Enviroscape that will be used to educate students and visitors about watersheds, the human impact on water quality and how individuals can help protect their watershed. This tool provides hands-on experience and scientific discussions that can be focused to meet the needs of the visiting schools and WAC's mission including but not limited to the protection of water quality, concepts of working landscapes, and environmental stewardship. (Appendix E).

Shiitake Laying Yard

Clearpool seeks to develop a Demonstration Shiitake Laying Yard where they can teach farmers, woodlot owners, and Clearpool students the ins-and-out of inoculating and managing shiitake logs for commercial production (and backyard fun).

Woodlot owners and Farmers often look for ways to defray the tax burden associated with land ownership. Value-added products with low overhead and start-up costs are one way landowners can ease that financial burden. Here in the northeast research has shown that oak, beech, and sugar (hard) maple are good substrates for shiitake spawn. Inoculation of logs is fast, low cost, and safe. Harvesting of suitable logs from woodlots can be part of sustainable land management strategies. With a little money and a little training, landowners can harvest shiitake for their own use or for sale at markets (Appendix F).

FROST VALLEY MODEL FOREST

Visitation

Visitors to the Frost Valley Model Forest (FVMF) were largely students and campers who participated in environmental education classes. Unfortunately, Frost Valley personnel do not track whether these classes visit the model forest or not. Therefore, the reported numbers are likely inflated. (Table 2).

Table 2. Frost Valley visitation for 2016/2017

Date	Event	Target Audience	Number of Participants
9/10/16-11/5/16	Watershed, forest ecology hikes, model forest tours	2^{nd}-9^{th} graders, adults	4331

11/11/16	WAC Bus tour	NYC Teachers	50
11/15/16-1/20/17	Model forest hikes, Forest/Watershed Ecology classes	4^{th}-9^{th} grade, adults	4000*
1/25/17-2/25/17	Forest Ecology/watershed ecology hikes	5^{th}-12^{th} grade	1,400
6/15/17-9/15/17	Forest Ecology, Watershed, Hikes	Middle/high school	500
Sept.-Nov. 2017	Watershed and Forest Ecology Classes and Hikes	Students	700
	Tour	Undergraduates	35
Total			11,016

Signage

A meeting was held on the Frost Valley campus to organize signage updates. The group walked the property to assess which signs need to be replaced or added.

Trail Maintenance

The Model Forest road was brush hogged summer 2017.

SIUSLAW MODEL FOREST

Visitation

The number of visitors to Siuslaw Model Forest (SMF) decreased slightly in 2016/2017 compared to the previous year (Table 3). Its host landowner, CCE of Green/Columbia counties, continues to provide an assortment of programs and events that attract a wide audience.

Table 3. Siuslaw visitation for 2016/2017

Date	Event	Target Audience	Number of Participants
9/10/16	Columbia University Students Visit	Youth	11
9/15/16	Ginseng Cultivation Workshop	Landowners	22
9/16/16	Forest Ecology and Silviculture Training	Loggers and landowners	9
9/20/16	Columbia Greene Community College students Siuslaw Model Forest	Youth	21
9/20/16-9/21/16	Environmental Awareness Day Siuslaw Model Forest	Youth	9/20-140 9/21-210
10/14/16	Windham Ashland Jewett Science club	Youth	14
10/20/16	Columbia and Greene Counties Chamber Leadership tour	Chamber members	25

10/23/16	Fall Foraging and Feasting	Landowners	14
10/26/16	Biodiversity Assessment training	Landowners	15
Walk-in Visitors			17*
11/3/16	Forest Pests and Diseases	ARC and SMF	7
11/5/16	American Chestnut presentation	ARC and SMF	23
11/18/16	Windham Ashland Jewett Science Club	ARC and SMF	13 students 3 adults
11/18/16	Windham Ashland Jewett Science Club	ARC and SMF	13 students 3 adults
1/6/17	NYCDEP/WAC Forestry Exchange	DEP/WAC	17
Nov/Dec	Visitors*	SMF	12
1/9/17	Greenville Middle School Ecology Club Snow Shoe event	Youth	17
1/11/17	Webinar of Growing Chinese Medicinal Plants in Forests	Forest landowners	5
1/21/17	Learning Beekeeping	Forest landowners	31
7/6/17	4-H Forestry Nationals Prep	4-H members	6 teens 1 adult
7/14/17	Invasive species program	Landowners	13
7/15/17	Mushroom Foray	Landowners	15
7/17/17	MFO refresher class	MFOs	20
7/17/17	4-H Forestry Nationals Prep	4-H members	4 teens 1 adult
7/25/17	4-H Forestry Nationals Prep	4-H members	4 teens 1 adult
Visitors*			14
8/1	Siuslaw Model Forest Advisory Committee meeting	SMF comm.	12 attended 3 call-ins
8/26	Mushroom Foray	Landowners	10
8/9	Bowery Creek Training	Municipal officials	16
9/7	Monarch Butterfly Training	Teachers	8
9/7	Garden Club Ecology Walk	Gardeners	8
9/12-13	Environmental Awareness Day	Students	240 students 20 adults
9/16	Columbia University Students w/WAC	Students	8
9/19	Stream Assessment - Training	Highway personnel	24
9/15	Forest Ecology and Silviculture	Loggers	11
9/21	Learn to Grow Ginseng	Landowners	26
10/5	Columbia Greene Community College Environmental Science students	Students	12
10/20	Windham Ashland Jewett Science club	Students	10 youth 2 adults (475)
Visitors*			14
Total	*not all visitors signed in		1,147

SMF Committee
Marilyn Wyman attended WAC Forestry committee meetings on July 20th and September 21st. She also attended Model Forest signage meetings at Frost Valley Model Forest on September 7th and Lennox Model Forest on October 31st.

Demonstrations
Cultivating medicinal plants in a forest has the potential to generate income as well as preserve plant resources. American ginseng is an important medicinal plant being grown in the Catskill area. A Chinese Medicinal Plant demonstration was developed to further explore agroforestry in SMF.

American Chestnut Foundation
SMF hosted an American Chestnut program at the ARC on Nov 5th, 2016 with Allen Nichols from the NY State chapter of the American Chestnut Foundation on what can be done to help reintroduce the American chestnut back into the forest. He also discussed how the SMF can be involved in the reintroduction efforts.

New Museum Installation
The SMF provided the branches for a new art installation at the New Museum in NYC. The artist used the branches gathered from the model forest to create large art pieces. SMF was instrumental in the efforts to collect and load the branches to be used in the pieces (see Appendix G for the installation flyer).

Harvest
The harvested compartments were inventoried and the data collected was input into NED for analysis. This project was started and completed throughout the summer and fall of 2017.

Signage
SMF requires assistance with content and design development. Tracey, Audrey and Emily are coordinating the tasks. Most signs are in development at this point, but a final Agroforestry sign has been completed (see Appendix H for the Agroforestry sign).

Deer Exclosure
SMF finished building an additional deer exclosure with New York Forest Owners Association Capital District Chapter funding in November 2016.

Trail Maintenance
Two new trails were added which will be incorporated into the revised trail guide. There has also been post-harvest work to stabilize trails, including cleaning out BMPs (i.e. culverts), reseeding sections and clearing debris. The trail was cleared of general winter debris in January 2017 (see Appendix I for a draft of the new trail map).

LENNOX MODEL FOREST

Visitation

The Lennox Model Forest has increased visitation numbers since the 2015-2016 season. Many new educational activities and signs are being discussed and implemented to encourage campers to utilize the model forest more regularly.

Table 4. Lennox visitation for 2016/2017

Date	Event	Target Audience	Number of Participants
7/2/17-8/4/17	Wilderness Survival		24
7/2/17-8/4/17	Backpacking 2		84
7/2/17-8/4/17	Nature		98
Total			206

Signage

LMF is looking forward to spring and the implementation of the Best Management Practices on the model forest as discussed at prior meetings. A decision was made to add signs to the main campus in order to reach a larger audience, as some students and most parents picking up/dropping off students do not go into the forest and would therefore not be exposed to the signs.

Complete Watershed

LMF would like to explore the concept of linking the current model forest with the forest below the road to show students the complete watershed. This would also make the LMF more accessible to people who can't hike to the other side of the road.

Trail Maintenance

A flail mower is needed for mowing the Lennox Model Forest. The current tractor isn't powerful enough to do the job. It may be more cost effective to hire a vendor to mow the trails a couple of times a year.

LITERATURE CITED

Kilgore, M.A., J.L. Greene, M.G. Jacobson, T.J. Straka, and S.E. Daniels. 2007. The influence of financial incentives in promoting sustainable forestry on the nation's family forests. *J. For.* 105(4): 184-191.

Appendix A:
TORE Powerpoint, J. VanBrakle

Average reading speed is…

300 words/minute

45 seconds * 300 words/minute = 225 words

Realistically, they will read 185

The title is the **only** thing you can count on most people reading.

Put the theme in the title.

T - Thematic
O - Organized
R - Relevant
E - Enjoyable

How long do most sign visitors stay at a sign?

1-2 seconds

6 Ways to Strengthen Themes

1. Make them highly relevant to your audience.
2. Use similes, metaphors, and analogies.
3. Use strong, active verbs.
4. Use "you."
5. Keep it brief – a single sentence.
6. Mimic the audience's language.

What is the maximum time a visitor will spend at a sign?

45 seconds

How many themes should a sign have?

1

EVERYTHING on a sign MUST:

Reinforce
Explain
Support
Help Readers Act On

The THEME

4 Information Levels

1. **Title** – states the theme
2. **Headings/Pictures** – subthemes that explain the theme
3. **Body text** – few facts needed to support theme/subthemes
4. **How viewers can act** – 1-2 suggestions

How many subthemes should a sign have?

No more than 4
(0 is best)

What Makes Something Relevant?

Meaningful

Audience can connect material to something it already knows.

Personal

Audience can connect material to something it already cares about.

- Themselves
- Loved ones
- Universal concepts
- Strong emotions
- People

Ways to Make a Sign Meaningful

1. Cut jargon.
2. Use simple language.
3. Use analogies for unfamiliar concepts.
4. Show examples.
5. Highlight contrasts.

Ways to Make a Sign Personal

1. Self-referencing
   - "Have you ever…"
   - Use the word "you"
   - Use the words "me" & "us"
2. Labeling
   - "New Yorkers"
   - "Those who care about wildlife"
3. Use examples readers can see
   - "This water bar" vs. "waterbars"
   - "This clearcut" vs. "clearcuts"

Ways to Make a Sign Enjoyable

1. Large, colorful photos & graphics
2. Compelling, thought-provoking titles & questions
3. Interaction
4. Conversational tone
5. Active verbs
6. Show cause and effect
7. Focus on an individual

Appendix B:

SAF Poster Presentation:

Sign, Sign, Everywhere a Sign,
E. Paye, R. Germain, & J. VanBrakle

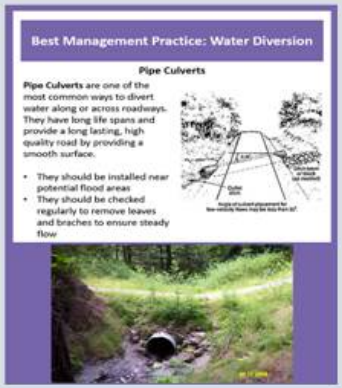
SIGN, SIGN, EVERYWHERE A SIGN

UPDATING THE SIGNAGE IN THE NYC WATERSHED MODEL FORESTS

Emily Paye & René Germain - SUNY College of Environmental Science and Forestry
Josh VanBrakle - Watershed Agricultural Council

CAST YOUR VOTE:

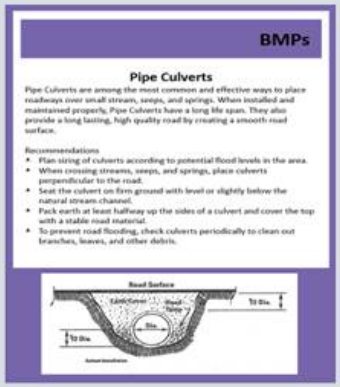
Which sign most effectively communicates watershed stewardship to a wide spectrum of audiences?

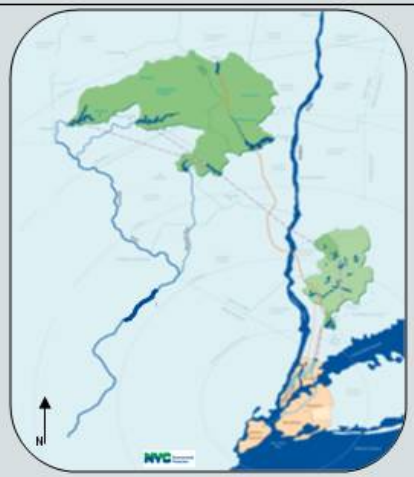


The New York City Model Forests serve as outdoor classrooms to demonstrate forest management practices that balance working forests and water quality.

TORE (Thematic, Organized, Relatable, Enjoyable) is one of the main techniques being used to make Model Forest signs more concise.

Focusing the Themes, keeping your information Organized, Relating the information to the reader, and making the content Enjoyable for the reader is the most effective way to relay your message.





Appendix C:
Two-Year Work Plans

Clearpool - Work Plan - 2016 & 2017

ACTIVE- FUNDING APPROVED, PROGRESS MADE

Project Name	Project Purpose	Planning Status	Approval	Expected Implementation	Project Contact	Progress/Notes
Sugarbush Improvement/Expansion	Improvement/Demonstration	In progress	N/A	TBD	Amy Tyillian	Clearpool is re-evaluting their initial proposal.
	Description: Clearpool currently taps about 50-60 trees each spring. They are looking to expand this operation and install tubing. Expansion will occur in the southern portion of the forest, east of the main road. Their current proposal includes contrcuting a sugar shack.					
	Location: Sugar bush					
Trail/BMP Maintenance	Maintenance	Ongoing	N/A	As needed	Amy Tyillian	Routine maintenance should be done annually
	Description: Ensure trail is in good condition, brush or blowdowns are cleared, BMPs are maintained and cleared of debris.					
	Location: Throuhgout model forest.					
Pace University Research	Research/ Outreach	Early	N/A	Ongoing	Amy Tyillian	
	Description: Pace University is looking to work in collaboration with Clearpool to conduct research on the model forest. They are interested in the origional CFI data and preliminary reports on the model forest.					
	Location: Clearpool Model Forest.					
Signage	Demonstration	In progress	N/A	Ongoing	Amy Tyillian	
	Description: Develop BMP signs to describe the various BMP demonstrations.					
	Location: SW area of Model Forest.					
Shiitake Mushroom Laying Yard	Outreach/Education	Ongoing	TBD	Jan-18	Amy Tyillian	
	Description: Create a Shiitake-cultivation laying yard in partnership with Clearpool Model Forest to demonstrate best practices and encourage value-added products from working woodlots.					
Biotic Tally- Amphibians	Research	Completed	N/A	Annual Event (April)	Amy Tyillian	Annual Event
	Description: A workshop is conducted where visitors help count amphibians.					
	Location: Throughout model forest.					
WAC Staff Educator Training	Outreach / Education	Completed	N/A	Winter 2017	Amy Tyillian, Tyler Van Fleet, Karl Von Berg	
	Description: A yearly training provided by WAC will instruct the staff at Frost Valley on the model forest and working landscapes.					
	Location: Clearpool Model Forest.					
Hosting the New York State Outdoor Environmental Education Conference	Outreach/Education	Completed	TBD	Oct-17	Amy Tyillian	
	Description: Clearpool will be hosting this conference and is looking to have a representative from the model forest and WAC present.					
	Location: Clearpool Model Forest					
Enviroscape	Outreach/Education	Completed	TBD	Jul-17	Amy Tyillian	
	Description: Green Chimneys comes together with WAC and purchased an Enviroscape to use as a tool when teaching about watersheds and water conservation to our students and visitors.					

INACTIVE- MORE PLANNING IS REQUIRED

Prescribe Treatments for Initial Compartments in NE Corner	Management/Demonstration	Early Discussions	N/A	On Hold	Amy Tyillian, Brendan Murphy, & René Germain	
	Description: Silvicultural treatments will be based on CFI data. Use intersection of roads to demonstrate 3 or more treatments that are visible from one location.					
	Location: Northeast corner. Compartments C, B, and D.					
Small patch cut or shelterwood west side of lake	Management/ Demonstration	Not started	TBD	On Hold	Amy Tyillian, Brendan Murphy, & René Germain	
	Description: Small 3-5 acre patch cut or shelterwood to favor oak regeneration. Half of the cut area would be treated to remove the laurel while the other half would not.					
	Location: Along foot trail on the west side of the lake.					

Frost Valley - Work Plan - 2016 & 2017

ACTIVE- FUNDING APPROVED, PROGRESS MADE

Project Name	Project Purpose	Planning Status	Approval	Expected Implementation	Project Contact	Progress/Notes
Main Camp Kiosk	Outreach/Education	High Priority	N/A	Winter 2018	Anthony Kordzeil	
	Description: A kiosk informing visitors about forestry has been established in the YMCA camp. One panel has been left for a description of the model forest and its uses. This panel must be created as soon as possible.					
	Location: FV YMCA Camp					
Forest Road and Entrance Signage	Outreach/Education	High Priority	N/A	Winter 2018	Anthony Kordzeil	
	Description: Develop signage for back of locks and model forest entrance to encourage greater utilization of the model forest. Determine which blocks would be best suited for an interpretive sign. Evelop and submit proposal to working group.					
	Location: Along forest roads/skid trails.					
BMP Maintenance/Installation	BMP Demonstration	Ongoing	N/A	Winter 2018	Anthony Kordzeil	
	Description: Funding will allow one maintenance worker to visit the model forest twice annually to inspect and clean out BMP's, including culverts, broad based dips, rubber belt deflectors, etc. Under this funding Frost Valley will also maintain the entrances to the model forest and work will include mowing, snow plowing, and any other needed maintenance.					
	Location: Model forest road and kiosks.					
WAC Staff Educator Training	Outreach / Education	Ongoing	N/A	Winter 2018	Anthony Kordzeil, Tyler Van Fleet, Karl Von Berg	
	Description: A yearly training provided by WAC will instruct the staff at Frost Valley on the model forest and working landscapes.					
	Location: Frost Valley Model Forest.					

INACTIVE- MORE PLANNING IS REQUIRED

New Cable Bridge Crossing Assessment	Re-Establish Access	Preliminary Research Finished	N/A	On Hold	Anthony Kordzeil	This project is on hold due to biophysical limitations.
	Description: 2 cable bridges that spanned the Neversink were washed out during Tropical Storm Irene. The previous bridge locations are no longer accessible due to serverly eroded streambanks. The old cable bridge provided FV educators quick access to the model forest. Without the cable bridge crossings, the use of the model forest by FV educators has been greatly reduced.					
	Location: Frost Valley Model Forest.					
SW Entrance Stream Crossing Assessment	Re- Establish Access	Preliminary Research	TBD	On Hold	Anthony Kordzeli	
	Description: The SW entrance to the model forest road is inaccessible due to a washed out culvert. This culvert has washed out several times in the past 5 years. Therefore, a long-term solution is required. After the initial investigation it appears that due to biophysical contraints and high bridge costs that this project must be put on hold.					
	Location: SW stream crossing (washed out culvert)					
Deer Management Demonstration	Demonstration	Early Discussions	TBD	On Hold	Anthony Kordzeli	
	Description: Deer browse is at least partially to blame for the poor regeneration in block O (strip clearcut). Rather than attempt to exclude deer from this area, this block can be used to concentrate individual deer during hunting season using food plots. The food plots would serve as a demonstration for managing deer herds. Therefore, an interpretive sign would be					
	Location: Block O					
Prescriptions for SW Compartments	Demonstration	Early Discussions	N/A	TBD	René Germain and Anthony Kordzeli	Will inform SW development plan
	Description: Blocks E,G, D, & C have not received a harvest. Harvests in one or more of these blocks can be used to satisfy the firewood demand of FV facilities, particularly where stocking would not support a commercially viable sawtimber harvest.					
	Location: Potential Blocks E, G, D, and C					
SW Model Forest Development Plan	Planning	Early Discussions	N/A	TBD	René Germain, Jamie Regula, Anthony Kordzeli	
	Description: The SW part of the model forest is underutilized due to lack of demonstration and the washed out culvert at the SW entrance. A SW Model Forest management plan will document a vision for increasing utilization of this area of the model forest. The plan should address four major components: (1) demonstrations, (2) access, (3) interpretive signage, (4)					
	Location: SW Model Forest					

Lennox Model Forest - Work Plan - 2016 & 2017

ACTIVE- FUNDING APPROVED, PROGRESS MADE

Project Name	Project Purpose	Planning Status	Approval	Expected Implementation	Project Contact	Progress/Notes
Sign Update	Demonstration / Improvement	In Progress	N/A	Spring 2018	John Hannum, Emily Paye, Rene' Germain	John will notify Emily and René about the topic and number of signs needed. They will draft the proposal budget.
	Description: The signs at Lennox are outdated and need to be replaced. Some signs may be but on the YMCA camp side of the road to inform students about the model forest. Determine costs and present proposal to the working group for approval. Decision has been made to implement signs within the main campus as well to reach a greater number of students and visitors.					
	Location: Along forest roads/skid trails.					
WAC Staff Educator Training	Outreach / Education	Ongoing	N/A	Summer 2018	John Hannum, Tyler Van Fleet, Karl Von Berg	
	Description: A yearly training provided by WAC will instruct the staff at Lennox on the model forest and working landscapes.					
	Location: Lennox Model Forest.					
BMP Maintenance/Installation	BMP Demonstration	Completed	N/A	Fall 2017	John Hannum, Tom Foulkrod	
	Description: Develop plan for maintaining existing BMPs and/or installing new BMPs. Some BMPs should be installed just beyond main gate for accessibility. BMPs should not impede access by four wheelers and pickup trucks. WAC will contract BMP installation separate from timber harvest.					
	Location: Forest roads, skid trails.					

INACTIVE- MORE PLANNING IS REQUIRED

Model Forest Brochure	Outreach / Education	Not started	N/A	On Hold	John Hannum, Jamie Regula, Heather Hilson	Was on hold until after the harvest. Need to discuss if this is still relevant.
	Description: Develop introductory brochure targeted to the general public to promote the use of the model forest. Brochure should include map, compartment prescriptions, BMP demonstrations, etc. Develop and submit proposal to Working Group.					
	Location: Lennox Model Forest.					
Update Map	Outreach / Education	Not started	N/A	On Hold	John Hannum, Matt Kelly, Heather Hilson	On hold until timber harvest. Proposal, planning and design can start ahead of harvest.
	Description: Update map according to new compartment letters and silvicultural prescriptions. Also include new BMPs and any new foot trails that have been established.					
	Location: Lennox Model Forest.					
BMP Demonstration on Steep Skid Trail	BMP Demonstration	In Progress	N/A	On Hold	John Hannum, Karl Von Berg, Tom Foulkrod	This slope is located at the back of the model forest where visitors rarely visit. The committee needs to decide if this is worth the investment.
	Description: Identify relatively steep skid trail (>18% grade) for new BMP demonstration. The purpose is to more accurately reflect conditions encountered by landowners. WAC will contract BMP installation.					
	Location: Relatively steep skid trail.					

Siuslaw Model Forest - Work Plan - 2016/2017

ACTIVE (FUNDING APPROVED / IN PROGRESS)

Project Name	Project Purpose	Planning Status	Approval	Expected Implementation	Project Contact	Progress/Notes
Post Harvest Inventory	Research / Management	In Progress	2017	Summer 2017	Marilyn Wyman, René Germain	
	Description: Post harvest inventory (almost) completed for 2016 harvested compartments. Data entered into NED. Missing 4 plots, pending review.					
	Location: Throughout model forest., specifically compartments B, C, D, and H.					
General Maintenance	Maintenance	Ongoing	Approved for $2800 per year	Ongoing. Submit invoice / summary every 6 months.	Marilyn Wyman	
	Description: Continue to provide summaries/invoices on six month intervals for mowing, brush removal, hazard tree removal and other maintenance needs for Siuslaw. Include the following information: estimated hours of labor, total cost, activity schedule, budget, equipment needs, and area to be treated. Identify who will do work					
	Location: Throughout model forest					
Amphibian and Bird Population Monitoring	Research	In Progress	N/A	On-going	Craig Thompson-birds	Monitoring ongoing. Data available.
	Description: Collect data on amphibian and bird populations in the model forest to determine species present and abundance. Monitor trends over time.					
	Location: Throughout model forest					
Visitors' guide / Trail map	Demonstration / Outreach Material	In Progress	N/A	Spring 2018	Marilyn Wyman, Heather Hilson, Jamie Regula, Tracet Testo, Audrey Kropp	Update to reflect deer exclosures, post harvest siviculture, chinese medcinal plants, and pollinator garden.
	Description: Create an updated trail map which shows locations of demonstrations and other model forest features including BMPs. Two trails added between November 2016 and January 2017					
	Location: Entire Model Forest					
Invasive Species Control	Demonstration / Management	Planning needed.	In disucssion.	Pending funding.	Marilyn Wyman, Tom Pavlesich, Audrey Kropp, Tracey Testo	May coordinate with CRISP and WAC initiative. Use invasive species management plan as guideline
	Description: Redo Invasive Speices inventory. Identify management strategies. Incorporate into a demonstration / sign. Determine location. One discussion inlolved comparative impact of seeding skid trails and observe impact on establishment of invasive species.					
	Location: Previous model forest inventory transects.					
Signage Project	Education / Improvement	In Progress	Funding Approved	Silviculture signs to be developed following harvest (TBD). Also tree value and pond signs.	Marilyn Wyman, Emily Paye, René Germain, Heather Hilson, Audrey Kropp, Tracey Testo.	Disucssion about the wordage and use of QR codes. 18 approved for funding. To date, 12 have been completed.
	Description: New sign topics have been decided upon and developed. Topics include invasive species, comparative value of trees and silivultural treatments, BMPs.					
	Location: Throughout model forest, along forest road and main skid trail.					
Timber Harvest 2016	Demonstration / Management	Completed	SMF committee approved the compartments and prescriptions	Winter, 2015-16	Mary Spring, René Germain, Marilyn Wyman	Completed
	Description: Six compartments harvested.					
	Location: Compartments B, C, D, H					
BMP Maintenance	Maintenance	Completed		Fall 2016-2017	Marilyn Wyman, Karl Vonberg, Tracey Testo, Ron Frisbee	
	Description: Evaluate/Reinstall Deteriorating BMPs, skid trails and stream crossing					
	Location: Throughout model forest					
Deer Exclosures	Demonstration	Completed	N/A	Fall 2016-Spring 2017	Trcey Testo, WAC	Use invasive species
	Description: Implement exclosures designs. Utilize funds from harvest.					
	Location: 3 new exclosures and 2 existing ones.					

Biodiversity Assessment	Management/Education	Completed	Funding Approved	Fall 2016-Spring 2017	Audrey Kropp, Tracey Testo, Austin Winegard	
	Description: Host a biodversity assessment training and conduct an assessment on the SMF. Generate a report and provide content related to biodiversity assessment for use on MyWoodlot.					
	Location: Throughout model forest.					

INACTIVE - NEEDS PLANNING AND/OR APPROVAL						
Project Name	**Project Purpose**	**Planning Status**	**Approval**	**Expected Implementation**	**Project Contact**	**Progress/Notes**
Agroforestry Demonstration	Demonstration	In Progress	TBD	TBD	Marilyn Wyman and Tracey Testo	Project carried over from previous work plan
	Description: Develop a proposal that explains how the proposed project will assist in achieving Model Forest Program goals. Include proposed budget (labor and materials), area					
	Location: TBD					
Silviculture guide	Demonstration/ outreach material	Planning needed to add new harvests	N/A	TBD	Marlyn Ywman, Audrey Kropp, Tracey Testo, Jamie Regula, Ron Frisbee	Guide needs to include updated map with new compartments and post harvest work.
	Description: Create a 6 panel brochure showing silviculture prescriptons/demonstrations for all compartments. Guide can include BMP locations and descriptions. Will use same					

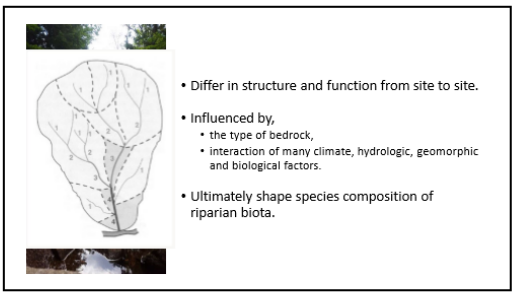
Appendix D:

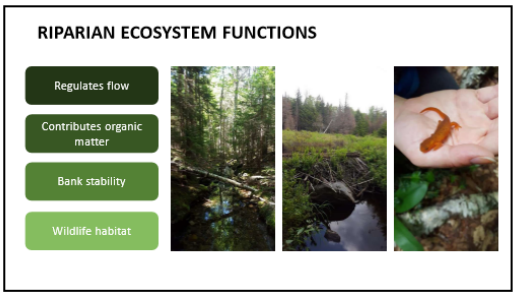
Riparian Study NYSOEA Presentation, M. Jayasuriya

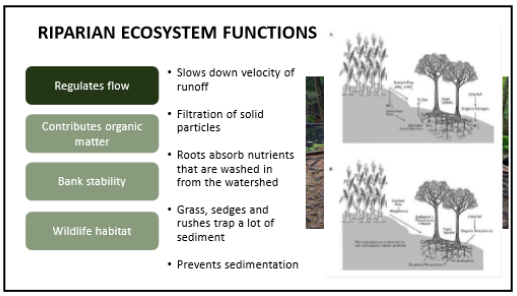

Riparian Areas
How important are they?
Maneesha Jayasuriya M.S. (SUNY-ESF)
Ph.D. Student
Department of Forest and Natural Resources Management
SUNY-ESF
NYSOEA Annual Conference 2017
Green Chimney's Clearpool Campus


Structure and Function of
Riparian Areas


WHAT ARE RIPARIAN AREAS?


• Differ in structure and function from site to site.
• Influenced by,
• the type of bedrock,
• interaction of many climate, hydrologic, geomorphic and biological factors.
• Ultimately shape species composition of riparian biota.


RIPARIAN ECOSYSTEM FUNCTIONS
Regulates flow
Contributes organic matter
Bank stability
Wildlife habitat

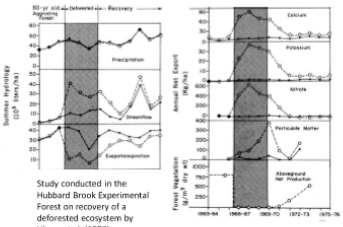

RIPARIAN ECOSYSTEM FUNCTIONS
Regulates flow
Contributes organic matter
Bank stability
Wildlife habitat
• Slows down velocity of runoff
• Filtration of solid particles
• Roots absorb nutrients that are washed in from the watershed
• Grass, sedges and rushes trap a lot of sediment
• Prevents sedimentation

RIPARIAN ECOSYSTEM FUNCTIONS

- **Regulates flow**
- Contributes organic matter
- Bank stability
- Wildlife habitat

RIPARIAN ECOSYSTEM FUNCTIONS

- **Regulates flow**
- Contributes organic matter
- Bank stability
- Wildlife habitat

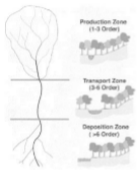


Study conducted in the Hubbard Brook Experimental Forest on recovery of a deforested ecosystem by Likens et al. (1978)

RIPARIAN ECOSYSTEM FUNCTIONS

- **Regulates flow**
- Contributes organic matter
- Bank stability
- Wildlife habitat

- Materials delivered from headwaters to downstream
- Deposition of coarse material at headwaters (Production Zone)
- Deposition of fine materials downstream- in floodplains (Deposition Zone)
- Flood pulse concept ➡



RIPARIAN ECOSYSTEM FUNCTIONS

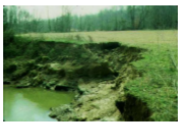
- Regulates flow
- **Contributes organic matter**
- Bank stability
- Wildlife habitat

- Autochthonous inputs
- Nutrients
  - Broken down by shredders, collectors and grazers
- Habitat
  - Spawning sites for fish
  - Salamanders

RIPARIAN ECOSYSTEM FUNCTIONS

- Regulates flow
- Contributes organic matter
- **Bank stability**
- Wildlife habitat

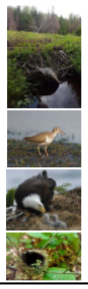
- Roots minimize and prevent bank erosion
- Stability to scouring channels especially during high flow
  - Helps prevent aquatic habitat destruction
- Shade and temperature regulation



RIPARIAN ECOSYSTEM FUNCTIONS

- Regulates flow
- Contributes organic matter
- Bank stability
- **Wildlife habitat**

- High species diversity
- Interaction between streams and riparian – "pool riffle" habitat
- Importance of riparian vegetation – beaver dams
- Some species spend all or a portion of their lives in riparian habitat



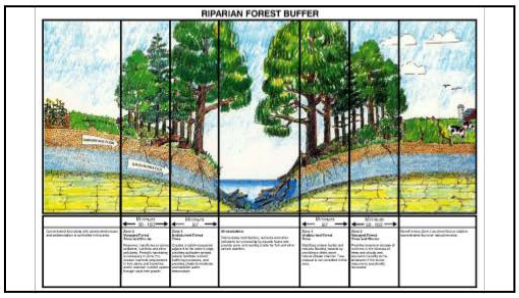
RIPARIAN ECOSYSTEM FUNCTIONS

- Regulates flow
- Contributes organic matter
- Bank stability
- Wildlife habitat

• Dispersal corridors – loss can result in habitat fragmentation

If you can't measure it, you can't manage it

Peter Drucker



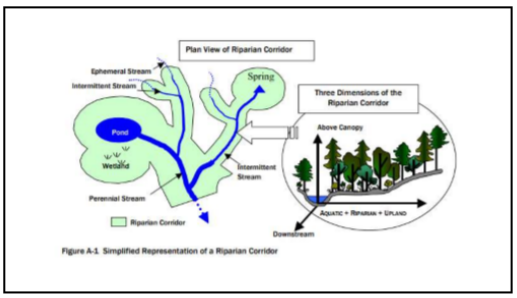


Figure A-1. Simplified Representation of a Riparian Corridor

THE MANAGEMENT CHALLENGE

- Differing objectives
- Optimum conditions
- Fulfilling growing needs
- Policy

Differing objectives

- Focus on riparian land and water are different
  - opportunities for commerce,
  - water supply,
  - harvesting trees,
  - fish and waterfowl habitat.
- We should have a community vision instead of a single user vision

Optimum conditions

- Optimum conditions of land and water functioning together.
- Do we really know this?
- Historic conditions?
  - Is it the best option?
- Ex: Restoring a riparian area to become functional?
  - To what extent?
- At what cost?

Fulfilling growing needs

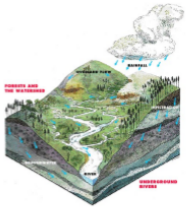
- Economies are involved
- Trying to protect/manage the most number of functions or trying to prioritizing functions
- Create the least amount of opportunity cost for the landowners.

Policy

- Balancing act between protecting public trust interests and historical private property rights.
- Differing objectives for land management in different ownerships can influence the efficacy of protection measures at the scale of the river basin.
  - In the state of Oregon, policy protection for riparian areas varies by ownership (e.g., federal, state, or private), land use (e.g., forest, agriculture, rural residential, or urban) and stream attributes
  - Agricultural lands : outcome based standards (rely on voluntary adoption)
  - Federal, state, and private forest lands : prescriptive standards
  - Buffer widths vary from 0 to ~ 500 ft. (152 m)

(Boisjolie et al. 2017)

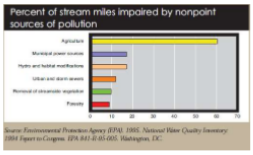
PROTECTING OUR STREAMS



- Headwater streams make up 60 – 80 % or more of the entire watershed network (Benda et al. 2005; Wipfli et al. 2007).
- Greater portion of flow passes through riparian along headwater streams
- Inadequate protection of headwater streams, negatively impacts the integrity and sustainability of downstream ecosystem services and their benefits.

PROTECTING OUR STREAMS

- Over 50% of freshwater supply in U.S. originates from forested lands.
- Forestry is a minor contributor to water pollution.
- Forestry practices account for only 2.9% of all impairment.
- "All natural sources combined" account for 5% of impairment



Forestry contributes to less than 10% of total impaired river and stream miles according to a report in 1995.

- Section 208 of the Clean Water Act defines timber harvesting and silvicultural operations as non-point source pollution.
- Sources: removal of streamside vegetation, road construction and use, timber harvesting, and mechanical preparation for the planting of trees.
- Sediment is considered to be the most important non-point source pollutant in forest operations.
- Negative impact on water quality and wildlife.

RIPARIAN MANAGEMENT ZONES (RMZ)

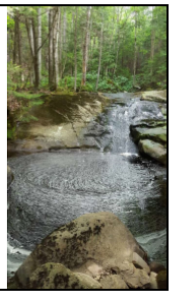
- It is a Best Management Practice (BMP)
- Designed to reduce non-point source pollution during forest operation.
- Regulatory or non-regulatory approach to meet non-point source pollution recommendations and goals for water quality.

RMZs AS BMPs

- RMZ buffers can range of 20 – 450 ft. from the stream bank.
- Ecological functions from vegetation are realized at first 15 – 100 ft.
- Eliminate machine traffic within 30 ft. of a stream (Keim and Schoenholtz 1999).
- RMZs can show upto 99 % efficiency in trapping sediments (Ward and Jackson 2004).

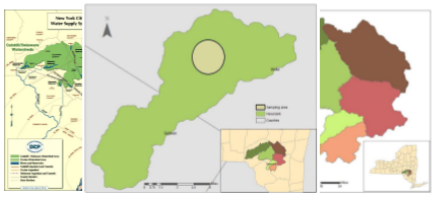
RATIONAL & OBJECTIVES

- The width of a RMZ can be either
  - fixed width
  - variable width
- RMZs are often based on a fixed-width buffer approach.
- They **may or may not** represent the actual extent of a "functional" riparian area.
- Fixed-width buffers can have unnecessarily negative consequences on forest management activities.
- Is there a significant difference between the two buffer types?
- What are the opportunity cost?



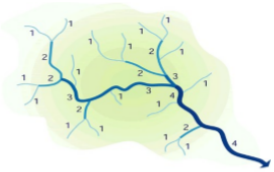
METHODS

Study area



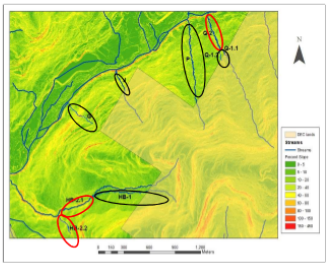
Methods

Defining stream orders



Strahler stream order classification

Methods

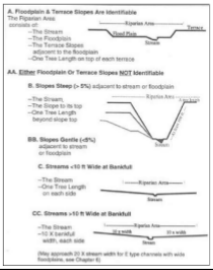


Methods

Sampling Method

"Functional" definition for riparian area:

Riparian areas are three-dimensional ecotones of interaction that include terrestrial and aquatic ecosystems, that extend down into the groundwater, up above the canopy, outward across the floodplain, up the near-slopes that drain to the water, laterally into the terrestrial ecosystem, and along the water course at a variable width. (Ilhardt et al. 2000)

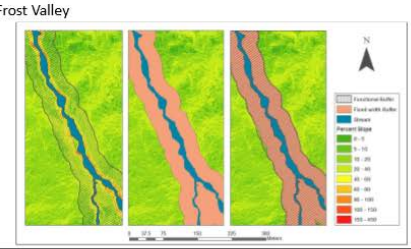


Methods

Sampling in Frost Valley

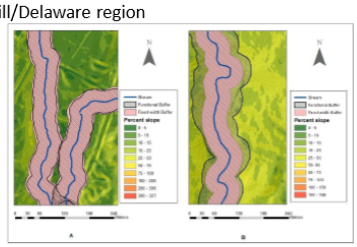
RESULTS

Frost Valley



Results

Catskill/Delaware region



A shows how the fixed-width buffer over-delineates land as riparian along two first order streams while **B** shows how the fixed-width buffer under-delineates riparian area along a second order stream.

DISCUSSION

- The 100-ft. fixed-width buffer is inter-changeable with the variable-width riparian buffer along the streams at the Model Forest as well as timberlands with similar topography and forest cover type.
- A 100 ft. fixed-width buffer incorporates more timberland along 1st order streams
- However, a 100 ft. fixed-width buffer is inadequate along 2nd order streams.

Discussion

Variables defining a functional riparian area

1. Stream order
- First order vs. second order
- Headwaters vs higher order streams
  - Identifiable floodplains
  - Broader riveins

2. Average canopy tree height
- Our study: 23.47 (77 ft.)
- Skally and Sagor (2001) used 27.43 m (90 ft.)
- Holmes and Goebel (2011) used 18.29 m (60 ft.)
- Ilhardt et al. (2000) uses a 30.48 m (100 ft.) in his definition of a functional riparian area.

Discussion

3. Slope

- Opportunity cost for landowners – withholding commercial management within RMZs.
- These riparian areas hold nearly 7,000 bdft/ac of sawtimber volume, representing a stumpage value of over $1,000/ac.
- Percent land area dedicated to RMZs in operational forests depends on stream density.
- Variable-width approach is ideal for defining RMZs.
- Silvicultural prescriptions should be tailored to fit the ecological characteristics of the riparian area.

WORK IN PROGRESS

WORK IN PROGRESS

- Testing outcomes on various cover types, featuring a greater range of topographic relief and valley geomorphology.
- How wetland plants respond to the concept of a functional riparian area
- Quantify forest stocking and stumpage value under various RMZ guidelines.
- Determine carbon sequestration potential within RMZs
  - Develop protocol for carbon trade

QUESTIONS?

- Floodplains - periodically flooded by overflow of river and by precipitation
- Nutrients rush in from areas where flood begins
- Nutrients deposited in floodplains become suspended with increasing water levels (moving littoral)
- Pulse of water is the primary driver of high productivity and decomposition rates
- When water starts to recede, nutrients deposit in the floors of the floodplains

8

Appendix E:
Clearpool Enviroscape Proposal

Clearpool Enviroscape

WAC Model Forest Funding Proposal

Executive Summary

Green Chimneys Clearpool Campus is requesting funding to assist with the purchase of an Enviroscape and its carrying case that will be used to educate students and visitors about watersheds, the human impact on water quality and how individuals can help protect their watershed. Our Outdoor Education Department spends a significant amount of time educating NYC and local community schools about the importance of the forest in relation to watersheds at various locations including within the model forest, in classrooms and at school sites. We have limited resources that enable students and individuals to visualize and understand the watershed system as a whole. This tool provides hands-on experience and scientific discussions that can be focused to meet the needs of the visiting schools and WAC's mission including but not limited to the protection of water quality, concepts of working landscapes, and environmental stewardship.

The Problem

Green Chimneys Clearpool Campus invests a large amount of time educating NYC schools about water conservation, watersheds and drinking water but unfortunately we are limited in our resources to make a significant impact on teaching watersheds. The Clearpool Campus provides an excellent opportunity to be immersed within a watershed by being surrounded by the mountains and having our own lake that feeds into the Boyd's reservoir (part of NYC drinking water system). The issue truly at hand is that this abstract concept can be difficult to teach without a visual model that can be manipulated to show the system in its entirety. In addition to schools visiting our campus, we have many opportunities to travel to schools to provide pre and post trip education. An Enviroscape would enable us reach more individuals while providing a higher level of understanding of the watersheds.

The Opportunity

We have found that an interactive and effective way to teach about watersheds and water conservation is through the use of an Enviroscape. The Enviroscape is a versatile hands-on tool that allows students of all ages to better understand the big picture of

watersheds. An Enviroscape can be used outdoors or indoors on sunny or rainy days and for pre/post trips to further the student's education. The mobility of the Enviroscape with its carrying case allows us to educate beyond general visits to our campus. In addition, Green Chimneys Residential and Day Schools would utilize this opportunity to teach about watersheds to their special needs students.

Project Narrative

We are proposing that Green Chimneys comes together with WAC to purchase an Enviroscape to use as a tool when teaching about watersheds and water conservation to our students and visitors. The Program Managers of Outdoor Education Department will educate and train the seasonal staff as well as the school teachers to present the curriculum built around the Enviroscape. Educators will also be trained in the maintenance and proper care of the Enviroscape.

Goals and Objectives

By purchasing an Enviroscape, we will be able to further the education of our students by providing a bird's eye view of what a watershed entails and how every piece of that watershed impacts other sections. It will be used as a great hands-on tool in our on-site school classrooms, with our visiting schools and for outreach to schools not able to visit our campus.

Outputs

The Enviroscape is an effective tool for teaching about watersheds and therefore would enable us to work with other Model Forests to share our resources and provide additional watershed training for staff. Students would receive valuable and memorable watershed education which would allow them to understand their impact on the environment.

Evaluation

Teachers will provide feedback on the retention rate of learning information using a hands-on visual such as the enviroscape. We will also ask our partnership schools to complete a pre and post trip evaluation that will confirm the effectiveness of the demonstration.

Project Timeline

We are hoping to purchase the Enviroscape in July 2017 in hopes to have the pieces in time for the fall 2017 education season.

Budget

What we want to purchase:

Items	Cost
Watershed Non-point solution Enviroscape	$795
Carrying Case	$479
Shipping and Handling	$100
Total:	**$1374**

Who is paying for this?

Green Chimneys Clearpool School and Outdoor Education is able to provide $700 towards the cost of the Enviroscape. We are requesting WAC's assistance to cover the rest of the cost in the amount of $674. For a total of $1374 that includes shipping and handling.

Annexes

Enviroscape – Watershed Nonpoint Source Model
http://www.enviroscapes.com/watershed-nonpoint-source-model.html

Enviroscape – Carrying Case
http://www.enviroscapes.com/accessories/carrying-case.html

Enviroscape Lesson Plans
https://www.epa.gov/sites/production/files/documents/enviroscape.pdf

Clearpool Watershed Classes:
http://clearpool.greenchimneys.org/school-group/nature-based-program/

Appendix F:

Clearpool Shiitake Mushroom Laying Yard Proposal

Shiitake Mushroom Cultivation at the Clearpool Model Forest:

Creating a Shiitake-cultivation laying yard in partnership with Clearpool Model Forest to demonstrate best practices and encourage value-added products from working woodlots.

Executive Summary:

Woodlot owners and Farmers often look for ways to defray the tax burden associated with land ownership. Value-added products with low overhead and start-up costs are one way landowners can ease that financial burden. Enter the Shiitake mushroom. Log-grown Shiitake mushroom cultivation is not new, and was practiced Japan for thousands of years. Here in the northeast research has shown that oak, beech, and sugar (hard) maple are good substrates for shiitake spawn. Inoculation of logs is fast, low cost, and safe. Harvesting of suitable logs from woodlots can be part of sustainable land management strategies. With a little money and a little training, landowners can harvest shiitake for their own use or for sale at markets.

We propose to develop a Demonstration Shiitake Laying Yard where we can teach farmers, woodlot owners, and Clearpool students the ins-and-out of inoculating and managing shiitake logs for commercial production (and backyard fun). We will use the funds to purchase equipment, supplies, and fencing, and to provide educational programs at Clearpool Model Forest for both hobbyists and agri-businesses. This yard will also provide an on-site educational experience for Clearpool students incorporating concepts of science, business and math, and promoting a wider understanding of our relationship with the natural world. Our goal is to promote awareness of the model forest and its resources, and through that interaction a greater recognition in our individual role in land stewardship.

The Problem:

We want more Putnam county and East of the Hudson residents to know about Clearpool model forest and its resources. The installed BMPs, informative kiosk, deer exclosure and marked trails are under-used.

The Opportunity:

Part of our plan includes programs for the public: Shiitake culture has been very popular in past offerings. Couple that with the Cornell Small farms and NY Farm Viability Institute push to develop shiitake mushrooms as a NYS market crop, and we envision greater use and visibility of the model forest because of the Shiitake laying yard.

Project Narrative (*Also please also see attached one-page logic model.)*

Collaborators

Cornell Cooperative Extension Resource Educator, Jen Lerner (was Stengle)
Cornell Cooperative Extension Volunteers
Clearpool campus Green Chimneys Educators and Staff
Watershed Ag Council Forester

Actions:

- **Develop a laying yard & public workshop plan**: CCE staff will work with CCE volunteers and Clearpool staff to plan 1-, 2-, & 3-year goals for the shiitake laying yard in coordination with spring and fall workshops for the public, watershed landowners and farmers. This will include ordering materials, developing the laying yard infrastructure, log-inoculation and management, harvesting and marketing. CCE educators and Volunteers along with Clearpool staff will perform the labor and maintenance, and facilitate workshops.
- **Develop Management Plan**: Clearpool Staff and CCE Educators will work with WAC forester to develop management plan to reach 1-, 2- and 3-year goals, and harvest or obtain logs at a sustainable rate.

- **Increase public awareness of the model forest** through web presence and program promotion: Add promos about new Shiitake Laying Yard to our websites, and highlight online resources like MyWoodlot.com and Cornell Small Farms program shiitake resources.

- **Develop Education tie-in for Clearpool campers and day students**: Cornell Cooperative Extension(CCE) and Clearpool Green Chimneys education staff will work to integrate the laying yard visits into educational offerings, highlighting the science, math, and business aspects of growing shiitake mushrooms.

Goals and Objectives:

- Clearpool Model Forest becomes a trusted and recognized resource for agroforestry and forest BPMs in the East of Hudson region. Our goal is to reach 70 program attendees in 2018.

- Program attendees and volunteers are more aware of, and more likely to adopt Woodlot BMPs.

- Students attending camps and day programs better understand science concepts like fungi biology & tree biology.

- Program attendees and volunteers are more familiar with online shiitake resources from MyWoodlot.com and Cornell Small Farms.

Outputs:

- **Spring and Fall log inoculation and laying yard management programs** (Spring Fall 2018). While these will be hands-on how-to programs, attendees will tour the BMPs and have an introduction to the Model Forest mission.
- **Shiitake Farm Viability program (**January 2018)**:** as part of this 3 year Cornell Small Farms project, farmers and woodlot owners in the lower Hudson valley will attend a two-day program on developing a market and business plan for local log grown shiitake.
- **Web presence and promotion**: (January 2018) write press releases about the laying yard, and add promotion of the resource to our websites. Include link-outs to web-resources including MyWoodlot.com and Cornell Small Farms Program's shiitake resource page.
- **Youth Education:** (Spring 2018) Begin to develop and integrate log inoculation, tree biology and other science concepts into the existing educational program at Green Chimneys' Clearpool campus. While revenue from an operation this small is not expected to be large, it still provides an opportunity for students to practice budgeting, and to market the produce at the Bonnibel farm store.

Evaluation:

Program attendees (70), through program evaluation questionnaires:

1. Report an increased likelihood to adopt best management practices for their woodlots (if they own or manage land).
2. Report better familiarity with online resources (MyWoodlot.com and Cornell Small Farms Program)
3. And, report that they will be likely to return to the model forest either for a program or to enjoy its resources.

Clearpool Campers and Day Students utilize the laying yard for informal science education and, as program develops, for math, business and applied science program.

Project Timeline

Early January 2018	Set dates for Spring and Fall public workshops via email.	Clearpool and CCE staff and Educators
January 2018:	Host NYFVI/Small Farms Shiitake Enterprise program with Cornell Staff (Their budget will cover cost for site and lunch) Promote upcoming inoculation and laying yard workshops.	CCE Educator, Clearpool staff
Early February 2018:	Meet to form teams, discuss timeline, duties, and project promotion. Set dates for Public workshops, and look at forest stands, laying yard location. Prep site (schedule arborist to remove snag over laying yard area)	WAC Forester, Clearpool Staff, CCE and Clearpool Educators, and CCE Volunteers
February 2018	Add links to web pages and write promotional article to be used by all involved.	Clearpool/Green Chimneys, CCE, WAC
February/ March 2018:	Established laying yard structures and perimeter fencing. Harvest trees or secure shiitake bolts for inoculation. (approx 2 to 6 weeks before public workshop)	Clearpool staff, CCE educator w/ WAC forester input
March 2018	Inoculation workshop (1-2 days before: prep site and demonstration)	CCE Staff and Volunteers. Clearpool staff and educators.
April -Sept 2018	Maintain laying yard, flip logs, water and check fencing	Clearpool staff and CCE volunteers.

Sept 2018	Harvest trees or secure shiitake bolts for inoculation. (approx 2 to 6 weeks before public program)	Clearpool staff, CCE educator w/ WAC forester input.
Sept 2018	Promote upcoming program.	CCE, WAC, Clearpool/Green Chimneys
October 2018	Fall Inoculation Program: partner this with firewood information and invasive species regulations as they relate to firewood.	CCE Educator and Volunteer, Clearpool Staff
November 2018	Maintain laying yard, add shade cloth or other winter protection.	Clearpool staff and CCE volunteers.
January 2019	Review: what worked & what didn't. What should we change or repeat. New audiences? New avenues of promotion to pursue?	WAC Forester, Clearpool Staff, CCE and Clearpool Educators, and CCE Volunteers

FOUR YEARS	year 1	year 2	year 3	year 4
Addt'l logs	40	60	60	40

Budget: Shiitake Mushroom Laying Yard Budget includes:
1) Site Preparation
2) Materials
3) Education
4) Maintenance

1) SITE PREP (Tree removal and fencing)

MATERIAL / ACTION	UNIT	QUANTITY	PRICE/UNIT	TOTAL COST
Removal of snag (big old American elm)	Arborist (climbing or bucket truck)			$1000
Fencing (plastic mesh) 8’	re-use from deer exclosure			$0.00
12 Gauge wire	roll/ 1,300’	1	35.00	$35.00
Hog Ring pliers	re-use from deer exclosure	1		$0.00
Hog Rings	pkg/100	2	$7.00	$14.00
Plastic electric fence insulators	pkg/25	4	$12.00	$48.00
Rust-proof 3” Galvanized nails	pkg/1 lb	3	$5.00	$15.00
Deck screws	box/1 lb	2	$9.50	$19.00
Fender Washers 1.25” to 1.5”	box/100	1		$11.00
Batten Boards (pressure treated decking) 1.24” x 5.5”	1.25’ x 5.75’ x 8’’ length	35	$8.00	$280.00
			TOTAL PREP	**$1422.00**

2) MATERIALS:

NOTE: Year 1 (40 logs/bolts) with the intent to scale up to 200 total in yard by 4th year of project.

MATERIAL COSTS (Year 1)	UNIT	QUANTITY	PRICE/UNIT	TOTAL COST
5" x 48" green oak logs	bolts	40	($2.00)	$80.00
Mushroom spawn	gal	2	$25	$50.00
Cheese Wax	pounds	5	3	$15.00
Wax melter/skillet	unit	2	20	$40.00
Wax daubers	case	1	25	$25.00
High speed drill	drill	2	145	$290.00
Drill bits	bit	4	13	$52.00
Brass inoculator	unit	6	35	$210.00
Inoculator repair kits	unit	2	7	$14.00
Water tank	tank	1	100	$100.00
Used refrigerators	unit	1	100	$100.00
Shade cloth/winter protection	yards	6	42	$252.00
Misc. (sprinklers/buckets)		1	40	$40.00

Labor-drill, plant, cut plugs, plug, rack	hr	70	6	$420.00
			Total establishment costs (year 1)	**$1688.00**

MATERIAL COSTS (Year 2)	UNIT	QUANTITY	PRICE/UNIT	TOTAL COST
5" X 48" green oak logs	bolts	60	$2	$120.00
Mushroom spawn	gal	2	$25	$50.00
Cheese Wax	pounds	5	3	$15.00
Total materials costs (year 2)				**$185.00**
MATERIAL COSTS: (Year 3)	bolts, spawn, wax, shade cloth	60		**$437.00**
MATERIAL COSTS (Year 4)	bolts, spawn, wax	40		**$145.00**
			TOTAL MATERIALS (all 4 Years)	**$2455.00**

3) EDUCATION:

CCE Educator and volunteers time, speakers

Inoculation & Spring program 30 hrs per year @

Inoculation $ Fall program 30 hrs per year @

CCE Volunteers 60 hours (volunteer)

Clearpool Green Chimneys educators and staff, time

Educator staff and time for the development of curriculum as part of Green Chimneys - Clearpool program, value added to model forest and laying yard.

4) MAINTENANCE

Clearpool Green Chimneys Staff

Maintenance of laying yard, perimeter fencing, access ways,

Harvesting, packaging and/or dehydrating, marketing (Bonnibel Farm) 16 hours per year $15 per hour

Harvesting trees and Bolt procurement 32 hrs per year @ $25 per hour

ANNEXES:

Plastic Mesh Fencing (From Peter Smallidge, Brett Chedzoy, and Emily Staychock, Cornell University)

Plastic mesh fencing involves higher material costs but less time invested in labor for installation. Plastic mesh fencing is available on the Internet through numerous suppliers using a search for "poly mesh deer fence." Mesh size used in this project is approximately 2" x 2", but other sizes might be equally effective. Current designs started with a 10 ft x 330 ft roll of mesh fence on a cardboard spindle, cut in half with a chainsaw. The fence height was 5 ft (Figure - 160858). Some vendors offer 7 ft fencing which is likely to be more effective at excluding deer by allowing for a lower apron at ground level and taller height, but with added costs of labor to install.

Materials

-Plastic mesh fence 5' to 7' high. Ten-foot long spools can be cut in half. Prices vary from $0.48 to $0.68/foot on the full-length spool.12 gauge high tensile wire, single strand
-Wire tensioner and splicing clips (Figure - 160547 or 3399)
-Batten strips of pressure treated lumber, approximately 10-inch pieces of 2x4 or 5/4 x 6 deck boards. One per tree.
-Plastic electric fence insulators (Figure - 3397)
-Rust proof (e.g., galvanized) 3" to 3.5" nails
-Deck screws or galvanized joist hanger nails
-1.25" to 1.5" fender washers

-Hog rings and hog ring pliers to secure mesh to wire
-Brightly colored synthetic baling twine

Plastic mesh fencing installation instructions

1. Determine your perimeter and flag low-value trees to serve as living fence posts. Try to locate a tree every 40-50 feet (avoid spans greater than 60 feet). If possible, select trees to be on the "inside" of the fence. Avoid abrupt corners on the fence (Figure – 3395). Best results occur if trees are selected before any harvesting occurs, and those trees must be protected from damage or removal during the harvest.
2. To simplify access, clear significant brush from fence line. It may be less expensive to re-position the fence than to clear the brush.
3. Attach one plastic insulator to each 10" batten strip using deck screws or joist hanger nails. Pre-drill holes for fender washers and nails to limit splitting of the board. Attach batten strips to trees so that the insulator is approximately 54 to 58 inches above ground.
4. Thread 12 gauge wire through insulators, and tighten using wire tensioner and splicing clips.
5. Unroll and position fence to suspend from the wire.
6. Use hog rings on 18 – 24" intervals to attach the plastic mesh fence to the wire.
7. Gates are created by severing the fence vertically, and attaching an apron of fence that extends approximately 4 ft on either side of the opening.
8. If ground topography leaves gaps under fence, pile brush or slash to prevent deer from crawling under the fence. A continuous windrow of brush or slash on the outside edge of the fence will enhance the effectiveness of the fence, and obviate the need for baling twine in the next step.
9. Install baling twine approximately 30" offset from fence and 30" off ground. Height is important, but distance from fence can vary from 1 ft to 4 ft. Wrap twine around saplings, around wooden stakes, or use fiberglass rods with clips. (Figure - 130611)

The fence should be inspected two to three times per year, and after storms.

Total Cost: With labor estimated at $15/hour and materials the total project cost averages $0.59/running foot.

A modification of this mesh design that is likely to be more effective includes the use of 7 ft mesh fence and an additional strand of wire approximately 12 inches off the ground. The vertical section of the fence is approximately 6 ft to 6.5 ft, allowing for an apron plus the low wire to restrict deer moving under the fence. The cost for materials would be marginally higher, but labor costs would be as much as double because of the extra effort to install another wire, handling a 7 ft vs. 5 ft spoon, and using a ladder to hog-ring the fence to the top wire. The 7ft and 5 ft designs have been co-located and will be compared for effectiveness through ongoing research.

Appendix G:
New Museum Art Installation

Where did these branches come from?

The branches and sticks used for this exhibit came from the Siuslaw Model Forest in Acra, New York. Located in the Catskill Mountains and operated by Cornell Cooperative Extension of Columbia and Greene Counties, Siuslaw Model Forest is one of four NYC Watershed Model Forests. These Model Forests demonstrate sustainable forest management practices that balance water quality, wildlife habitat, ecosystem functions, and human needs. The Siuslaw Model Forest provides in-woods educational programs in a setting that includes mixed deciduous forests, pine plantations, streams, ponds, and many wildlife species. These classes matter because the Catskill Mountains are the source for New York City's drinking water, and they supply more than 1 billion gallons of clean water to 9 million New Yorkers every day. Good forest stewardship protects that drinking water, because healthy forests act as natural water filters.

Walking through Siuslaw Model Forest.

Part of good forest stewardship includes careful, well-planned tree harvesting that allows other trees to grow healthier and to encourage the next generation of native trees such as maples and oaks. These practices can also make the forest more diverse and often support a greater variety of wildlife. The sticks used for this exhibit came from trees harvested on the Siuslaw Model Forest in 2016.

Loading sticks from Siuslaw onto a truck for delivery to the city.

Siuslaw Model Forest was pleased to help
To discover more about stewarding forests, check out our partner website, **mywoodlot.com**.

Siuslaw MODEL FOREST

My Woodlot www.MyWoodlot.com

Materials collected from CCE's Siuslaw Model Forest were incorporated into an exhibit by artist Petrit Halilaj in New York City.

New Museum Celebrates Fall Exhibitions

September 27, 2017 at The New Museum

Last night, the New Museum continued its celebrations in honor of its 40th anniversary by packing the house with eager museum-goers who have been patiently waiting for the museum's fall exhibitions. The Museum presented "Alex Da Corte: Harvest Moon" as the debut installation in a new storefront window display in 231 Bowery. "Trigger: Gender as a Tool and a Weapon," also opened alongside "Helen Johnson: Ends" in its Lobby Gallery, premiering a new series of paintings for the artist's first exhibition in an American institution. These exhibitions join "Kahlil Joseph: Shadow Play" and "Petrit Halilaj: RU" which inaugurated the Museum's South Galleries, the first phase of the Museum's expansion into its adjacent building at 231 Bowery.

Appendix H:
Revised Agroforestry Sign

Siuslaw
MODEL FOREST

FOOD FROM THE FOREST

If you take care of the woods, the woods will take care of you. A healthy woods can provide food and medicinal products that you can eat yourself or sell. The practice of growing food in the woods is called **agroforestry**.

The woods may seem too shaded a place to grow food, but many crops do well under the protection of trees. Fruits, nuts, maple syrup, honey, and mushrooms are just a few of the many foods you can grow, find, and harvest in the woods.

Agroforestry crops are a valuable part of a well-managed forest. Below are three examples of ways you can harvest food from the forest.

GROW healthy Sugar Maple trees and tap them for sap in the spring to make maple syrup.

PLANT crops like this ginseng plant and add financial value to your woods.

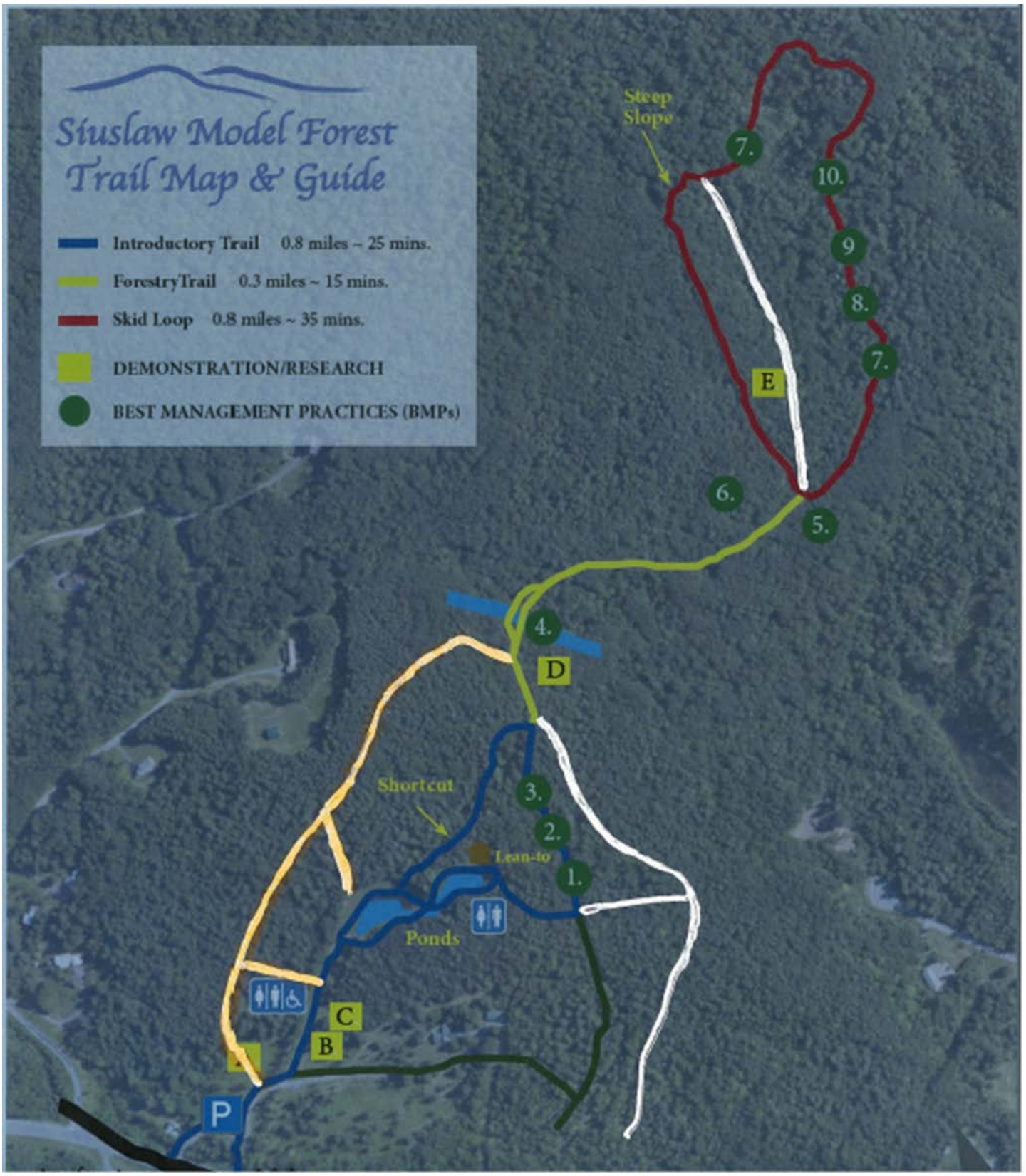
FIND mushrooms, like these chanterelles, to eat. Be sure of your plant identification before you eat any wild food.

If you want to add these crops to your woods,
check out the how-to videos and other instructions at:

mywoodlot.com/forest-farming

My Woodlot
MyWoodlot.com

Appendix I:
Revised Siuslaw Trail Map


Siuslaw Model Forest
Trail Map & Guide
Introductory Trail 0.8 miles – 25 mins.
ForestryTrail 0.3 miles ~ 15 mins.
Skid Loop 0.8 miles ~ 35 mins.
DEMONSTRATION/RESEARCH
BEST MANAGEMENT PRACTICES (BMPs)
Steep Slope
7.
10.
9
8.
7.
E
6.
5.
4.
D
Shortcut
3.
2.
Lean-to
1.
Ponds
C
B
P

Appendix J:

Model Forest Reporting and Funding Proposal Templates

NY Watershed Agriculture Council Model Forest Report
Reporting period: _____
Please fill out and return by: _____

1. My Model Forest completed the following education events during the last reporting period:

Education Events			
Date	Event	Target Audience	Number of Participants
Total			

2. My Model Forest needs funding for the following projects. Projects that are eligible for funding are – maintenance, new demonstrations, outreach material, and education material. Refer to page 43 of the Forestry Program Handbook for more information.

Funding Needs			
#	Funding Need	Estimated Budget	Time Frame

3. My Model Forest needs help with the following projects to make them happen:

Help Wanted for Projects			
#	Project	Type of Help	Time Frame

4. My Model Forest completed the following projects during the last reporting period. Projects include but are not limited to maintenance, establishing new demonstrations and purchasing new outreach or education material.

Project Accomplishments	
#	Project

5. Our staff could use training in the following topics in order to better use our Model Forest

Training Needs		
#	Training Topic	Time Frame

6. Additional comments

WAC Model Forest Funding Proposal Template

Executive Summary

Two paragraphs that summarize the entire proposal. Reading only the Executive Summary, a reader should be able to understand:

- What the problem is
- How the funding request will solve the problem
- How much money is being requested
- How that money will be used
- How the project will further WAC's and the Model Forest Host's mission.

The Problem

One paragraph that describes the challenge faced by the Model Forest and/or its target audience that your project aims to resolve.

The Opportunity

One paragraph that describes the project you are requesting funding for and how it will solve the problem you identified.

Project Narrative

A detailed description of the project you are proposing. Length will vary based on the complexity of the project and the amount of funding requested. This section should include information about:

- *Who* will be involved in the project and why they're qualified to do the work
- *What* those involved will be doing
- *Where* the work will occur
- *How* the work will be completed.

Goals and Objectives

A list of what you will achieve by completing the project. Goals are *what* you will accomplish; objectives are *how* you will accomplish those goals. Each goal should have at least one objective. Goals and objectives should be SMART:

- *Specific*: well-defined and clear to anyone with a basic knowledge of the project
- *Measurable*: has specific metrics that measure success (acres/year, landowners/workshop, pre and post test scores)
- *Achievable*: within the availability of resources, knowledge, and time
- *Relevant*: advances WAC's and the Model Forest Host's mission
- *Time-based*: enough time to achieve the goal/objective, but not so much time that there is no urgency.

Outputs

A list and description of the products that will be produced as a result of completing this project. Special attention should be paid to products that have value beyond the Model Forest itself. Examples: MyWoodlot content, material that can be used at other model forests, and data that can be used by researchers and school groups.

Evaluation

A description of how project success or failure will be determined, and how that success or failure will be reported to WAC.

Project Timeline

A timeline that shows when each component of the project will be carried out.

Budget

A breakdown of how much money will be spent on what. The budget should identify specifically what requested funds will be used for as well as identify any matching funds and what they will be used for. While there is not a formal matching requirement for model forest funding, proposals with matching funds have historically been viewed more favorably by the Model Forest Working Group and the Forestry Committee.

Annexes

Include supplemental information as necessary for your project. Example appendices are project maps, relevant research papers, literature cited pages, and sample reports or outreach materials.

<u>Regardless of the project, an ideal Model Forest funding proposal:</u>

- Is clear, well-written, and jargon-free
- Has a strong educational focus
- Makes the best, most efficient use of requested funds
- Provides value over time (i.e., is not a one-off event)
- Results in tangible outcomes WAC can show its funders to encourage their continued support for the Model Forest Program
- Furthers the Model Forest Host's mission and WAC's mission "to promote the economic viability of agriculture and forestry, the protection of water quality, and the conservation of working landscapes through strong local leadership and sustainable public-private partnerships."

Appendix K:
Impacts on Forestry Best Management Practices, M. Kelly, R. Germain, & S. Bick

RESEARCH ARTICLE

J. For. 115(6):503–512
https://doi.org/10.5849/JOF.2016-031R1

harvesting & utilization

Impacts of Forestry Best Management Practices on Logging Costs and Productivity in the Northeastern USA

Matthew C. Kelly, René H. Germain, and Steven Bick

Best management practices (BMPs) effectively mitigate erosion and sedimentation during and immediately after harvest operations. The responsibility for implementing BMPs typically falls on loggers, with implications for higher harvesting costs and, possibly, reduced logging productivity. Two methods were used to assess the impacts of BMPs on logging operations in the northeastern United States. First, a case study was conducted using shift-level production and activity data and machine rate calculations to assess the impacts of BMP implementation for eight harvest operations, ranging from single-operator hand-felling systems to fully mechanized whole-tree and cut-to-length systems. Second, a survey was conducted in which loggers were asked to estimate the number of days required to complete a hypothetical timber harvest with and without a set of prescribed BMPs and to indicate their minimum acceptable contract rates for each. The combined results revealed a range of costs from $0/ac to $62/ac and decreases in productivity between 0 and 20%.

Keywords: BMPs, water quality, timber harvesting, work study analysis, logger survey, watershed forestry

Forest operations can accelerate soil erosion and sediment delivery, with the potential to impair water quality. The Federal Water Pollution Control Act of 1972 and later the Clean Water Act Amendments of 1977 and 1987 identify forestry as a contributor of nonpoint source pollution (Cubbage 2004). In response, states have developed best management practice (BMP) guidelines for protecting water quality during and immediately after harvesting. These guidelines typically include a variety of BMP categories, including forest roads, skid trails, log landings, streamside management zones, stream crossings, wetlands protection, timber harvesting, site preparation, and reforestation. The degree of regulation varies among states, ranging from nonregulatory approaches with or without enforcement to regulatory approaches that mandate use of BMPs. Nationally, monitoring efforts have shown that BMPs are properly implemented 91% of the time (National Association of State Foresters 2015), which is up slightly from the 89% rate estimated by Ice et al. (2010).

Properly implemented BMPs have been proven effective for protecting water quality (Loehle et al. 2014, Barrett et al. 2016, Cristan et al. 2016). The benefits of BMPs are realized in healthy ecosystems (Vowell 2001) and clean drinking water supplies. BMPs also help prevent forest roads and skid trails from washing out, thereby ensuring their use for future operations. Typically, BMPs are implemented by loggers who incur costs directly or pass them on to landowners or sawmills by way of reduced stumpage prices or increased contract rates. Consumers of wood products may also bear the cost of BMPs in the form of higher prices for goods (Sun 2006). In this way, BMPs can place economic strain on the forest products industry and local communities (Shaffer et al. 1998).

To relieve economic pressure, BMP cost-share programs provide financial assistance to offset implementation costs. Examples of such programs include the Environmental Quality Incentive Program administered by the Natural Resources Conservation Service in partnership with state agencies, the Vermont Portable Skidder Bridge Initiative, and the BMP Program administered by the New York City Watershed Agricultural Council Forestry Program. The latter pays loggers for implementing BMPs on forest roads and skid trails within the Catskill and Delaware

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Acknowledgments: *This project was supported by the Northeastern States Research Cooperative through funding made available by the USDA Forest Service, as well as by the Watershed Agricultural Council Forestry Program. We thank Gary Sabourin of the Vermont Department of Forests, Parks and Recreation for his contributions to designing the survey instrument. We also thank the logging professionals who participated in this study.*

Watersheds, which supply drinking water to New York City (VanBrakle et al. 2013.

Previous studies have estimated BMP costs using a variety of methods (Blinn et al. 2001, Cubbage 2004). Shaffer et al. (1998) used a mailed survey in which Virginia loggers were asked to provide average unit costs of 10 BMPs, taking into consideration costs of labor, equipment, supplies, and time. The authors estimated unit costs of water bars, broad-based dips, and temporary bridges to be $15, $25, and $737, respectively ($23, $39, and $1,145 in 2014 dollars). Unit costs were then scaled up to entire tracts, resulting in a range of costs per acre from $8.11 to $48.35 ($12.60 to $75.11 in 2014 dollars) depending on physiographic region and whether the harvest site was greater than 75 ac. Similarly, Lickwar et al. (1992) estimated costs of six BMPs on 22 harvest sites located throughout Florida, Alabama, and Georgia. Unit costs were determined largely from past research and from consultation with forest contractors, forest engineers, and researchers. The authors used topographic maps and harvest data from each study site to estimate total costs, resulting in BMP cost estimates of $2.34/thousand board feet (MBF) ($4.88 in 2014 dollars) and $12.45/ac ($25.95 in 2014 dollars). Shouse et al. (2001) observed dozers and skidders installing water bars on skid trails in Kentucky using time study methods. They detected a significant difference in mean cycle times per water bar between dozers (1.5 minutes) and skidders (3.5 minutes) and estimated costs per delay-free water bar of $2.00 for the dozer and $4.67 for the wheeled skidder ($2.67 and $6.24, respectively, in 2014 dollars).

The impacts of BMPs on logging productivity and their relationship to various harvest systems has been given little attention in the literature. The objective of this study was to estimate the impacts of BMPs on logging productivity and costs within the context of typical northeastern US harvest operations. Two distinct methods were used. First, a case study of eight logging operations was conducted using a work-study approach (Košir et al. 2015) to assess the impacts of BMP implementation on harvest costs and productivity. Second, a written survey was administered to loggers throughout the region to assess the effects of BMPs on logging productivity and to determine acceptable contract rates to account for a hypothetical set of BMP requirements. The results are expected to inform policy decisions regarding BMP cost-share programs as well as the larger forest products industry throughout the Northeast.

Methods

Work Study Approach

Shift-level production and activity data were collected from eight harvests located in New York (5), Massachusetts (1), Vermont (1), and Pennsylvania (1) between 2013 and 2014 (Figure 1). The eight contractors who participated in this study were recommended by consulting and procurement foresters. To ensure that crews were familiar with BMPs, efforts were made to identify crews with one or more members who had completed a logger certification training program, such as New York's Trained Logger Certification program and the New Hampshire Professional Loggers program, which require training in BMPs. Each participating contractor was asked to identify an upcoming job that was expected to last approximately 30–40 days. The purpose of this constraint was to limit the effort required of loggers and to ensure that data for entire harvest operations were collected within a reasonable period. Silvicultural treatment and forest type information was obtained directly from the timber sale prospectus or from supervising foresters and confirmed visually during site visits. Note that the harvests selected may not be representative of the larger population of logging operations in the region, given a small sample of eight and the potential bias toward crews with reputations for adequately and efficiently addressing BMP concerns. Moreover, given variations in terrain, silvicultural treatment, equipment mix, and weather, the eight harvests are considered a collection of case studies rather than a representative sample.

Throughout the entire duration of each harvest, crew members recorded daily start, end, and break times, as well as general site conditions. They also recorded production of their assigned machines and all delays greater than 10 minutes. Each delay was identified as one of five delay types: maintenance, mechanical, personal, BMP, and other (e.g., meeting with foresters and personal phone calls). Delay factors (Spinelli and Visser 2008) were calculated by dividing the number of hours spent on each delay type by the total productive machine hours (PMHs) required to complete the harvest. Reporting delay factors is generally preferred over reporting delays as percentages of the total scheduled machine hours (i.e., the sum of total PMHs and total delays) because the latter method produces results that are highly dependent on the amount of time spent on all delay types (Spinelli and Visser 2008).

Machine rates were calculated following Miyata (1980), Food and Agriculture Organization of the United Nations (FAO) (1992), and Brinker et al. (2002). Equipment information (e.g., purchase price, year, model, and hours) gathered during contractor interviews was used to determine ownership costs (e.g., depreciation, interest, and taxes) and operating costs (e.g., repair and maintenance, labor, and fuel) (Table 1). Two contractors were unwilling to share financial information. Thus, machine rates for these two harvests were estimated based on published rates (e.g., Thompson 2001; Brinker et al. 2002; Germain et al. 2016) and calculated rates for similar machines ob-

Management and Policy Implications

To protect water resources while maintaining an economically viable logging sector, logging contract rates and stumpage prices must reflect the costs of implementing BMPs, which can be highly variable. Fair compensation for BMPs is particularly important in states that have voluntary or quasi-regulatory policies regarding the use of BMPs. Encouraging effective implementation of BMPs by reducing the burden on loggers is in the best interest of landowners, loggers, and the general public. Cost-share programs can be an important mechanism for easing these burdens. However, subsidizing BMP implementation may distort the market for logging services by artificially reducing contract rates or increasing stumpage prices. From an operations management perspective, logging contractors and crew supervisors should pursue strategies that minimize the impacts of BMPs on logging productivity, such as assigning operators of nonconstrained machines to implement BMPs at various times throughout the harvest or subcontracting close-out operations. Overall, the results of this study provide a benchmark for loggers and practicing foresters throughout the Northeast with regards to BMP costs and impacts on productivity.

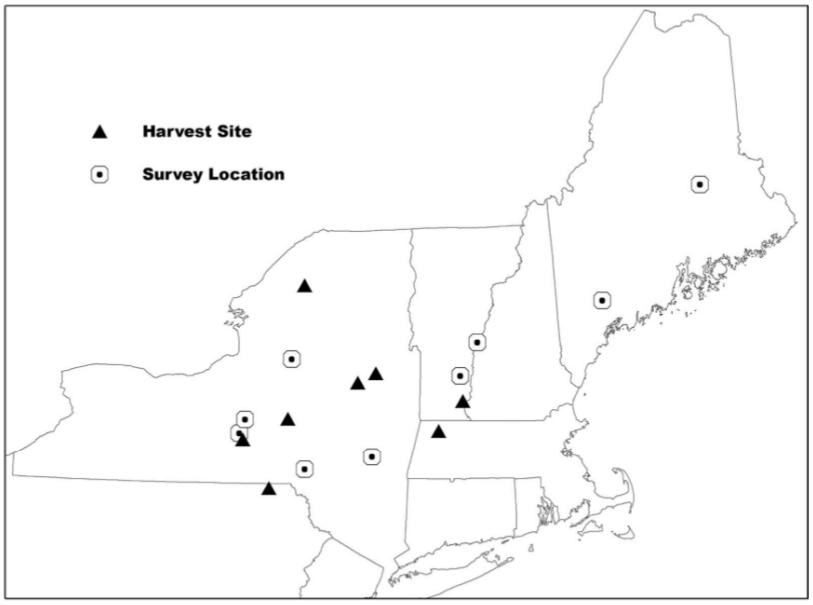

Figure 1. Sites of eight observed harvests and locations where paper surveys were administered in person at various logger events (e.g., training workshops and equipment exposition).

Table 1. Machine rate calculation inputs and assumptions.

Cost type	Variable	Source/description
Ownership	Purchase price (P)	Price gathered from interview
	Salvage (S)	Percent of purchase price (Brinker et al. 2002)
	Depreciation (D)	Straight line: $D = (P - S)/N$
	Years of useful life (N)	Machines with normal utilization rates, based on Brinker et al. (2002). Machines with very low utilization based on FAO (1992): (hours of useful life − hours at time of purchase)/(annual scheduled hours · utilization rate)
	Interest cost	0.05 × average annual investment (AAI), where AAI = $[(P - S) \cdot (N + 1)]/[2N] + S$ (Miyata 1980, Brinker et al. 2002)
	Insurance	% of purchase price per Brinker et al. (2002)
	Utilization	per data (PMHs/SHs)
Operating	Repairs and maintenance	% of depreciation, varies by machine type (Brinker et al. 2002)
	Fuel	Gallons per hour (from data, interview, or Brinker et al. 2002) × $3.50/gal (approximate price of off-road diesel in summer of 2013)
	Oil/lubricants	36.8% of annual depreciation (Brinker et al. 2002)
	Labor wage	Owner-operator = $30/SH, all else = $20/SH
	Labor benefits	20% of wage

SH, scheduled hours

served in this study. Machine utilization rates were calculated by dividing PMHs by the number of hours required to complete the harvest (i.e., the harvest duration). Machine utilizations were used to convert machine rates in terms of $/PMH (Miyata 1980). A $20/hour wage was used for all workers other than owner-operators. This wage is slightly higher than the median wage earned by logging workers throughout the United States in 2015 ($17.41/hour) (US Bureau of Labor Statistics 2015). A $30/hour wage was assumed for owner-operators with an additional 20% applied to all labor costs for benefits (i.e., workers compensation insurance).

BMP implementation costs were calculated by multiplying the machine rate ($/PMH) by the hours spent on BMPs for a given machine. Additional overhead costs ($120/day) were added if it was determined that BMP implementation extended the number of days required to complete the harvest. BMPs that occurred during harvest activities were determined to have extended the harvest only if implementation delayed the flow of logs from stump to landing (e.g., implementation affected a bottleneck machine) or if BMPs were implemented either before or after harvesting operations. It is important to note that the BMP costs reported here represent implementation costs only. Materials and supplies costs were not included in the analysis. Furthermore, the $120/day in overhead costs (Germain et al. 2016) was assumed for all crews to simplify the analysis. In actuality, this rate may not reflect the true overhead costs for all crews.

Logger Survey

Although the work-study method just described yielded detailed data from actual operations, the interpretation of those results was limited to the individual harvests because of the small sample size ($n = 8$) and high variation among harvests. Therefore, it was necessary to develop an alternative method for assessing BMP costs across a larger sample of contractors. To this end, loggers from Maine, New Hampshire, New York, and Vermont were surveyed in person at various training and exposition events held between fall of 2013 and spring of 2015 (Figure 1). At each event, loggers were invited to anonymously complete a two-part questionnaire (a copy of the questionnaire is found in Supplemental File S1[S]).

The first part of the questionnaire included questions regarding respondents' years in logging, their position within the company (i.e., business owner, crew supervisor, or crew member), their typical crew size, and the percentage of annual volume their company produced from purchased stumpage versus contract work. Loggers were then prompted to identify the equipment that comprised their typical harvest system (e.g., cable skidder, grapple skidder, or forwarder). The second part of the questionnaire prompted loggers to consider two hypothetical timber sales, which were identical with the exception of the required level of BMP implementation. Harvest A was absent BMPs, whereas Harvest B required the following BMP installations:

- 20-ft temporary bridge used for three stream crossings
- 50 water bars
- 150 linear feet of corduroy (i.e., poles or cull logs laid over wet areas [Cullen 2001]) in three sections of skid trails
- Seeding and mulching of six stream approaches and reshaping six stream banks

The two timber sales were identical in acres (100), species mix (northern hardwoods), silvicultural treatment (crown thinning), estimated volume removals (150 MBF of sawtimber, 400 cords of low-grade material), average skid distance (1,500 ft), and average tree diameter (18 in.).

Geospatial maps of both timber sales were created (Figure 2) using ArcGIS 10.2 with a skid trail layout designed to comprise 10% of the total harvest area, following recommendations by Germain and Munsell (2005). Thus, assuming an average trail width of 16 ft (Shouse et al. 2001), 27,000 linear ft was determined to approximate 10% of the harvest area. The requirement of 50 water bars for Harvest B was informed by New York's BMP guidelines, which recommend a 250-ft spacing between water bars on 2% slopes. Here, an average spacing of 500 ft was assumed, resulting in 54 water bars (27,000 ft/500 ft), which was then rounded down to 50 to simplify the survey instrument.

Loggers were asked to answer two questions related to each timber sale: How many days would it take you and your typical crew to complete this harvest? and What is the minimum contract rate you would be willing to accept for this job? Loggers were prompted to provide rates for both sawtimber ($/MBF) and low-grade material in terms of $/cord or $/ton. Differences between days required to complete each harvest indicated expected changes in productivity, whereas differences between minimum acceptable contract rates for each harvest represented the level of compensation that would be required for the prescribed BMPs.

Based on responses to the previous two questions, expected daily revenue was calculated for each timber sale using the following equation:

$$\text{daily revenue} = \frac{\text{total revenue}(\$)}{\#\text{ of days}} \tag{1}$$

$$\text{total revenue} = \frac{\$}{\text{MBF}} \cdot 150\ \text{MBF} \cdot + \begin{cases} \frac{\$}{\text{TON}} \cdot 1200\ \text{tons if} > \frac{\$}{\text{cord}} \cdot 400 \\ \frac{\$}{COR} \cdot 400\ \text{cords, otherwise} \end{cases}$$

Total revenue was calculated by multiplying minimum acceptable contract rates for both product types (sawtimber and low-grade) by their associated sale volumes. Because some respondents included minimum contract rates for low-grade material in both $/ton and $/cord, the rate that produced the greatest dollar value was used in the calculation. For example, if a logger provided minimum contract rates of $20/ton and $50/cord, the revenue generated from low-grade material was assumed to be $24,000 based on the contract rate in tons ($20/ton × 1,200 tons), which was higher than that of the rate in cords ($50/cord × 400 cords = $20,000). Absolute and relative differences (% change) in daily revenues between the two harvests were calculated.

Survey responses were grouped by mechanized and nonmechanized systems, which were determined by the inclusion of a feller buncher or harvester in the respondent's typical equipment mix. Nonparametric Mann-Whitney-Wilcoxon (MWW) tests (Neuhäuser 2014) were conducted using SPSS 23 to test for differences between groups. In general, the null hypothesis for a MWW test is that two samples have equal distribution locations and are therefore from the same population. This test was used because of the nonnormal distribution of key variables, including differences in days to completion and minimum contract rates, which were generally skewed toward larger values (Sprent and Smeeton 2007).

Results

Work Study Results

Data from the eight harvests represented 249 work days and 3,991 worker-hours. Operations varied in crew size, equipment mix, harvest costs, and productivity (Table 2). Six crews felled by hand, whereas two were fully mechanized, using either a feller buncher (Harvest 6) or harvester (Harvest 7). The six hand-felling crews all worked in northern hardwood forests with varying components of eastern hemlock (*Tsuga canadensis*) and eastern white pine (*Pinus strobus*). The Harvest 6 crew operated in an upland oak forest, and the Harvest 7 cut-to-length system operated in a red pine (*Pinus resinosa*) plantation. All eight harvests were prescribed even-aged treatments; five received a regeneration method treatment (i.e., shelterwood, patch cut, or clearcut), and the other three received intermediate thinning treatments. Harvest costs ranged from $1.44/ft^3 (Harvest 5) to $0.40/ft^3 (Harvest 7) and were inversely related to productivity, which ranged from 51 ft^3/hour (Harvest 1) to 668 ft^3/hour (Harvest 7).

Time spent implementing BMPs varied from 0 to 37 hours among the eight harvests, and delay factors ranged from 0 to 14.3%

[S] Supplementary data are available with this article at http://dx.doi.org/10.5849/JOF-2016-031R1.

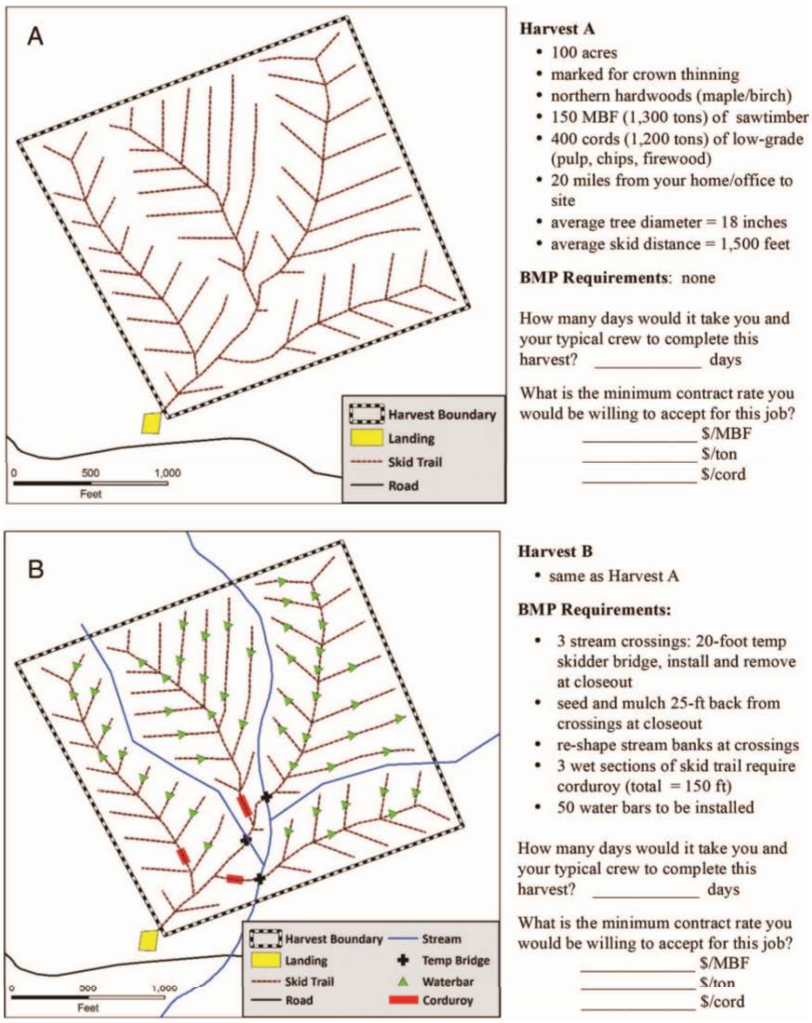

Figure 2. Two hypothetical timber sales used in a logger survey to elicit the impacts of BMPs. Both harvests are identical except that Harvest A (top) has no BMP requirements, whereas Harvest B (bottom) has substantial BMP requirements.

(Table 3). The 14.3% delay factor for Harvest 1 was the highest among the observed operations and the only one greater than 4%. Harvest 1 was cut by a single logger using a conventional cable skidding system who encountered a substantial amount of BMPs, including multiple stream crossings, several sections of skid trails that required corduroying, and installation of temporary water bars at various points throughout the harvest due to rain events.

The Harvest 6 crew spent 37 hours on BMPs, which was the most among the eight harvests in absolute terms. However, a delay factor of only 3.8% was calculated because of the large number of PMHs required to complete that harvest (963). The BMPs implemented during Harvest 6 included re-grading forest roads and landings, spreading gravel, and installing broad-based dips. The slasher/loader operator completed nearly all of the BMP work for this job, because the slasher/loader was nearly twice as productive as the grapple skidder. As a result, much of the BMP work concurred with felling and skidding activities and had no impact on harvest productivity (i.e., BMPs did not extend the harvest). In contrast, Harvests 1, 2, and 3 were cut by three different contractors who single-handedly carried out all elements of their respective operations. Because of the nature of single-logger operations (Kelly and Germain 2016), these harvests were extended by exactly the number of hours spent on BMPs, resulting in reduced productivity. System productivity was not impacted by BMPs for Harvests 4, 6, and 8, whereas the crew for Harvest 7, which operated on relatively flat land with no stream crossings during a period of dry weather, reported no BMPs. Overall, decreases in productivity resulting from BMPs ranged from 0 to 9.4% (Table 3).

Table 2. Characteristics, costs, and productivities for eight harvest operations.

Variable	Harvest							
	1	2	3	4	5	6	7	8
Equipment mix	Chainsaw Cable skid Dozer	Chainsaw Grapple skid Slash/load	Chainsaw Grapple skid Slash/load	Chainsaw Cable skid Slash/load Dozer	Chainsaws Forwarder	Feller buncher Grapple skid Slash/load Triaxle truck Dozer	Harvester Forwarder	Chainsaws Grapple skid Cable skid Slash/load
Crew size	1	1	1	2	1–5	3	2	3–5
Forest type	Northern hardwoods	Northern hardwoods/ hemlock	Northern hardwoods	Northern hardwoods/ hemlock	Northern hardwoods/ white pine	Upland oak	Red pine plantation	Northern hardwoods/ hemlock/ white pine
Treatment	Thinning/ TSI	Shelterwood	Thinning	Thinning	Patch cut/ thinning	Shelterwood	Clearcut/thinning	Shelterwood
Harvest area (ac)	23	70	90	41	30	56	22	100
Average skid distance (ft)	625	1,678	1,374	1,262	1,672	356	800	2,668
Landings used	3	1	2	2	1	3	1	1
Average tree diameter (in.)	12.5	14.9	17.4	13.9	19.8	16.0	12.0	17.0
No. of stems cut	294	1,726	1,324	1,070	1,257	2,505	n/a	2,013
Total volume (ft^3)	7,603	43,934	43,220	13,334	26,730	76,512	52,360	56,525
ft^3/ac	331	627	480	325	891	1,366	2,380	566
ft^3/hr	51	184	116	115	70	183	668	245
Total cost ($)	10,440	24,577	26,958	12,220	38,362	90,985	21,191	43,585
Daily cost ($/day)	475	1,024	509	764	852	1,716	1,766	1,503
Unit cost ($/$ft^3$)	1.37	0.56	0.62	0.92	1.44	1.19	0.40	0.77

* No data.

Table 3. Hours spent on BMP implementation and their impact on productivity.

Variable	Harvest							
	1	2	3	4	5	6	7	8
Total PMH	97	227	340	189	665	963	119	245
Total BMP hours	13.9	8.7	2.0	3.3	9.7	37.0	0	4.0
Delay factor (%)	14.3	3.8	0.6	1.8	1.5	3.8	0	0.5
BMP hours/ac	0.60	0.12	0.02	0.08	0.32	0.66	0	0.04
% BMP hours spent pre- or postharvest	15	23	100	0	0	0	0	0
% reduction in productivity caused by BMPs	9.4	3.6	0.5	0	1.2	0	0	0
Reported BMPs	5+ WB, BBDs, rubber mat bridges, corduroy, smooth and regrade	WBs, slash mats, smooth and regrade, stream crossing	Smooth and regrade skid trails & landings	11 WBs, 4 temporary WBs, 2 BBDs, 3,000 ft skid trail smooth and regrade	Slash mats, panel mats, temporary bridge	Spread stone, regrade road and landings, WBs, BBDs	None	20+ WBs
Machine(s) used to implement BMP	Dozer	Grapple skidder	Grapple skidder	Dozer	Forwarder	Dozer		Grapple skidder
Average steepness (out of 3)	1.1	2.0	1.6	1.0	1.1	1.1	1.0	2.1
Average wetness (out of 3)	2.1	1.9	1.8	1.4	1.6	1.3	1.1	1.3

WB, water bar; BBD, broad-based dip. Steepness: 1 = gentle (0–9%), 2 = moderate (10–20%), 3 = steep (>20%). Wetness: 1 = dry, 2 = moderately wet, 3 = very wet.

BMP costs ranged from 0 to 10.7% of total delay-free harvesting costs among the case study harvests. On a per acre basis, costs of implementing BMPs ranged from $0 to $43. The magnitude of BMP costs was a function of the amount of time spent implementing BMPs and the cost of the equipment used and whether additional overhead costs accumulated as a result of the harvest being extended. The combination of these factors was unique for each harvest. For example, the total costs of BMPs was greater for Harvest 2 ($887.87) than for Harvest 1 ($826.51) despite Harvest 1 requiring 5.2 more hours of BMP implementation (Table 4). This was largely due to differences in equipment costs. The grapple skidder used to implement the majority of BMPs for Harvest 2 was more expensive to own and operate ($107/PMH) than the dozer used to implement a large portion of BMPs for Harvest 1 ($67/PMH). Moreover, dozers have been shown to be significantly faster at installing water bars than skidders (Shouse et al. 2001). Thus, the efficiency of the machine used to implement BMPs will influence the degree to which BMPs impact operations.

Survey Results

A total of 123 surveys were administered during 11 logger training and exposition events held throughout New York, Vermont, New Hampshire, and Maine. Ten questionnaires were discarded as grossly incomplete, leaving 113 for analysis. Despite the relative completeness of the remaining

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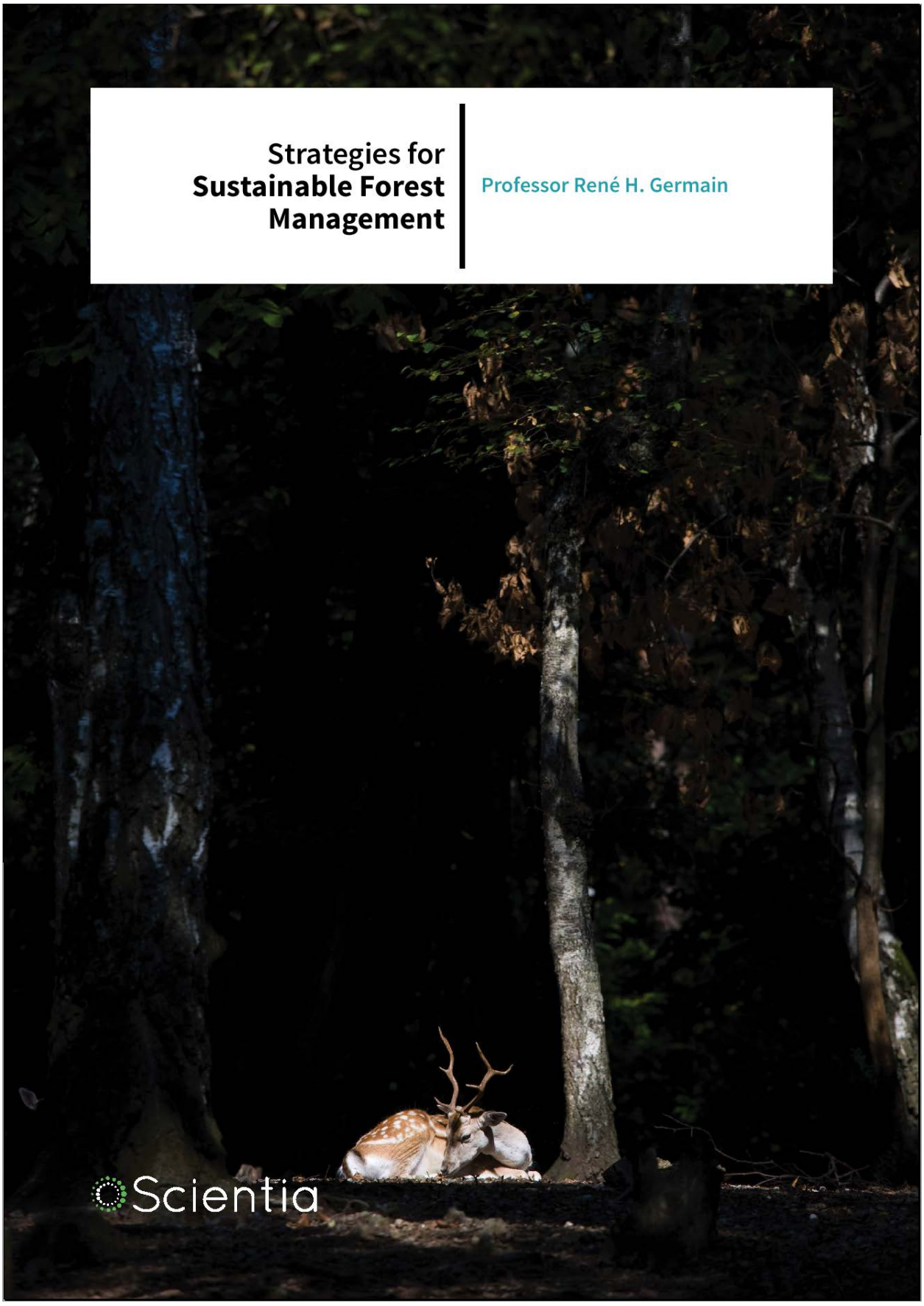
Appendix L:
Scientia Profile on R. Germain


Strategies for
Sustainable Forest
Management
Professor René H. Germain
Scientia

STRATEGIES FOR SUSTAINABLE FOREST MANAGEMENT

Forested land improves urban water quality, but needs to be appropriately managed and protected from the impacts of land use changes. **Professor René Germain** at SUNY ESF is passionate about improving the sustainability of forest management, and carries out research and outreach programs to build knowledge and explore better management practices.

The Model Forests of the New York City Watershed

Forests are vital habitats for many species and make important contributions to human welfare. As well as timber, they provide essential ecosystem services such weather, and purifying air and water supplies for both rural and urban communities. Despite this, forested land is threatened globally due to increasing demand for land as a result of a growing human population. Well-designed management strategies are essential to ensure the long-term future of forests and all the benefits they offer.

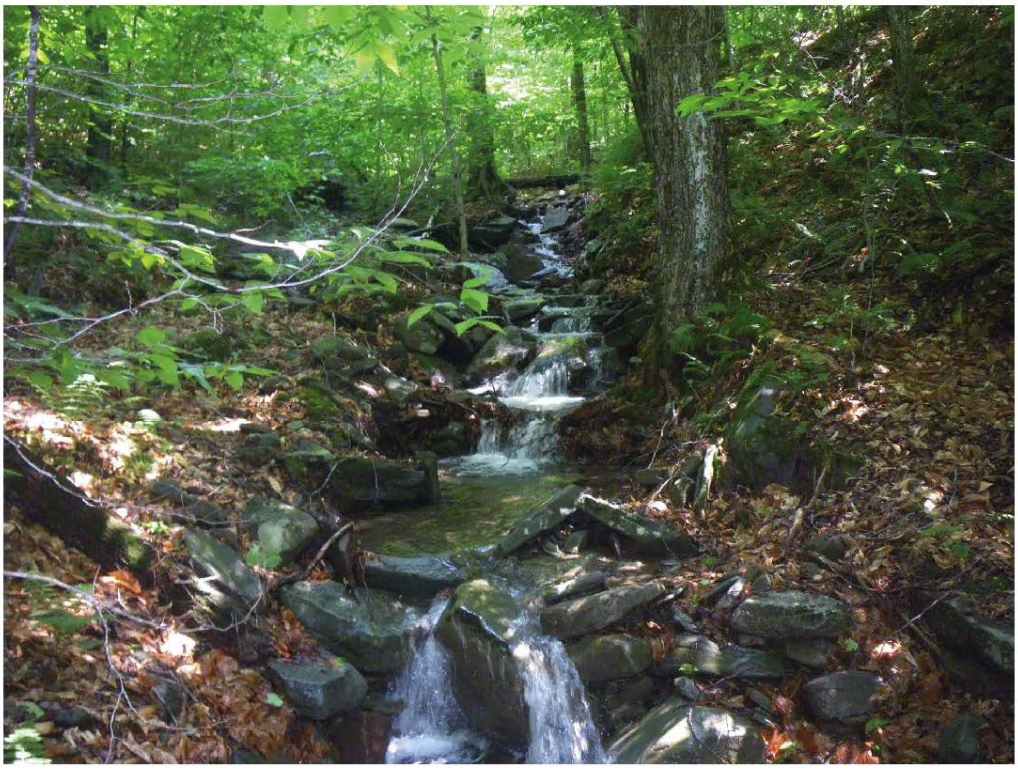
Professor René Germain is a scientist working to improve the sustainability of the forest products industry in the US. He explores how land use changes and different forestry systems affect management practices. Based at the State University of New York College of Environmental Science & Forestry (SUNY-ESF) in Syracuse, New York, he also has first-hand experience of forestry through previous work as a forester and vice-president of a lumber company. This experience has given him particular insights into what makes a sustainable forestry system, and which knowledge gaps need to be filled to improve management.

Professor Germain is convinced that a practices is targeted outreach and education programmes. Since 1998, he has coordinated the Model Forests Program, a network of four demonstration forests in the New York City (NYC) Watershed that are designed to showcase good forest stewardship. The NYC Watershed is a 2,000 square-mile lushly forested area containing nineteen reservoirs, three controlled lakes, and three major watersheds – the Catskill, Delaware, and Croton.

The Model Forests are collaborative projects. Though overseen by the Forestry Program of the non-profit NYC Watershed Agricultural Council (WAC), multiple organisations contribute to their ownership, maintenance and stewardship, including the US Forest Service, the NYC Department of Environmental Protection, SUNY-ESF, Cornell Cooperative Extension, Frost Valley YMCA, and Green Chimneys. The Model Forests 'outdoor laboratories' are for scientists to compare the long-term effects of different silvicultural approaches on forest ecosystems management practices (BMPs), widely-used tools to maintain water quality and improve the sustainability of forestry operations.

Each Model Forest is linked to an environmental education centre. Visiting these forests is an exciting opportunity for landowners, policy-makers and the public to see first-hand how logging, nature, and water quality protection can coexist. The experience helps visitors build understanding and find common ground, improving their ability to contribute to sustainable and economically viable forestry.

In their 2007 article in the *Journal of Extension*, Professor Germain and his colleagues discuss the effectiveness of the Model Forest approach. 'The Frost Valley



Model Forest is used extensively by the YMCA as part of their environmental science curriculum to 30,000 students annually,' they explained. 'Thus far, the Frost Valley YMCA Model Forest represents our greatest success story in terms of truly integrating research, Extension, and outreach.' On the research front, in a 2011 article in the *Journal of Forest Ecology and Management*, Professor Germain and colleagues from the US Geological Survey report the relation of harvesting intensity to changes in soil and stream chemistry, confirming that light forest thinning operations have negligible effects on water quality.

Forest Fragmentation Can Accelerate Development

One of the greatest threats to water quality in the NYC Watershed is the loss of forestland through land use change. One such change is the gradual transition away from forest resource management to rural residential use through the fragmentation of forests into small 'parcels' of land, which are then used for development.

The increasing parcelization of forests has strong implications for resource management. When parcels drop below a certain size threshold, managing them becomes economically unviable, further increasing the incentive for owners to allow development. This also means that managers are less likely to be able to implement better forestry practices due to their higher costs.

In NYC, parcelization could have a significant impact on the city's water quality and come with a heavy price-tag for the taxpayer. The NYC Watershed supplies over 9 million people in the greater NYC area. Because the Watershed's forests are so efficient at filtering the water supply naturally, the US Environmental Protection Agency has granted NYC a waiver from the federal requirement that surface drinking water supplies pass through a filtration plant. By not needing to build this plant, NYC saves an estimated $10 billion in construction costs and more than $300 million annually in operating expenses.

WAC, NYC and New York State are all keenly aware of the importance of the Watershed's natural filtration, and together they have protected 34% of the Watershed's land area through fee purchases and conservation easements. However, the remaining 66% of Watershed land is privately owned and vulnerable to land use change.

Although there is anecdotal evidence of increasing forest parcelization in the NYC Watershed and beyond, there has been little systematic assessment of its impacts. One open question has been the exact rate at which parcelization is occurring. Professor Germain and his colleagues explored the average parcel size of forests in the NYC Watershed over the 16-year period between 1984 and 2000. The results, published in the *Journal of Forestry* in 2005, show a significant decline in parcel size from 19 to 16 acres. A 2016 paper published in the Journal of Conservation Planning reports an average parcel size of 13 acres in 2010, with one-third of the parcels below the resource management acreage threshold of 30 acres, as reported by Professor Germain and his colleagues in 2009 in the *Journal of Forest Policy and Economics*. The general picture is of increasingly fragmented, small forest parcels, with a continued shift towards the lower size categories. This is worrying news

for the stability of NYC Watershed forests and their ability to filter the water supply, as these smaller forest parcels are more vulnerable to development.

Residential land is associated with impervious surfaces such as brick, stone and pavement, which have a much lower ability than forested land to absorb water. Increasing impervious surface area can raise the likelihood of flooding and of transporting chemical residues into the water supply. Although denser settlements generally have a higher level of impervious surfaces, even low-density rural residential development can damage water quality, through runoff that transports pollution from lawn chemicals, septic systems, animal waste and sediment. Recent research has shown that water quality can be harmed when impervious surfaces occupy as little as 2.4% of a watershed's area.

In their 2012 article in the *Northern Journal of Applied Forestry*, Professor Germain and his colleagues used a combination of field data, digital imagery and landowner surveys to compare the land cover of NYC Watershed parcels subdivided between 1984 and 2005 to that in parcels which remained intact. They showed that with each new subdivided parcel, impervious surface area increases by an average of 3200 square feet (297 square meters), which is likely to impact local water quality. Improved management practices have been effective at reducing pollution from agriculture and forestry operations, and Professor Germain and his team believe that new policies could continue this positive trend, by regulating residential development.

Towards Better Management Practices

BMPs are an essential way of improving forest management. Properly implemented, they can protect local water from the soil erosion and sediment transport that often accompany logging, which could otherwise pollute the water supply. From 1997 to 2015, the non-profit WAC promoted BMPs in the NYC Watershed by funding private landowners to get forest management plans. The plans included detailed information about ways these landowners could manage their forests. Professor Germain led a formative evaluation of BMP implementation in the early 2000s, reporting in a 2005 article in the Northern Journal of Applied Forestry that despite this extensive outreach and extension effort by WAC to promote BMPs, implementation was unacceptably low.

In 2009 and 2011, WAC worked with Professor Germain and his colleagues to find out whether these plans really led to better practices on the ground. They conducted field surveys of recently logged private forests in the NYC Watershed and scored them on their use of BMPs. The results, published in the *Journal of Forestry* in 2013, showed that forests with management plans only scored better in two of six BMP categories.

Because of these research findings, WAC changed its approach to landowner outreach. The non-profit redirected its management plan funding to help landowners enroll in New York's Forest Tax Law Program, which lowers a landowner's property taxes if the owner agrees to follow their management plan and not parcelize or develop their land for ten years. WAC also created a new website for landowners, MyWoodlot.com, that provides owners with ideas and projects to promote forest stewardship.

In addition to working with landowners, WAC also promotes BMPs with foresters and loggers. BMPs often come at a high cost to loggers, so WAC's BMP Program pays loggers a cost-share to install BMPs on forest roads, skid trails, and stream crossings in the NYC Watershed.

Although cost-share programs like WAC's can be an important mechanism to improve forest management practices, their role in ensuring a stable future for the forest depends on whether loggers are able to install BMPs efficiently. If the cost of implementing BMPs is prohibitive, loggers may not use them even if offered a cost-share.

Professor Germain and his collaborators used a case study and a survey to assess how BMPs affect logging costs and productivity. The results, published in a 2017 article in the *Journal of Forestry*, show that both of these effects are highly variable, with BMP costs ranging from $0–62 per acre, and productivity decreasing by 0–20%. Professor Germain's team found that certain operation strategies can reduce these losses, such as using a dozer rather than a grapple skidder to install water bars, and installing BMPs with machines otherwise not in use. Professor Germain and his team also call for a fairer distribution of BMP costs, with other stakeholder groups like sawmills and landowners providing some of the funding instead of relying on loggers alone to absorb the loss.

Ensuring the sustainability of forestry is critical for the viability of the forest products industry. In turn, a viable forest products industry provides income that helps landowners keep their forests as forests, rather than parcelizing them into rural residential developments. Thanks to the efforts of Professor Germain and his colleagues, our improved understanding of land use change drivers and BMPs will help secure forests and their roles in natural and human wellbeing for future generations.

Meet the researcher

Professor René H. Germain
SUNY College of Environmental Science & Forestry
Syracuse
USA

Professor René Germain obtained his BSc in Forestry from the University of Vermont in 1983. In 1988, he received his Master of Science in Business Administration from Boston University, and went on to complete a PhD in Forest Resources Management in 1997 at the SUNY College of Environmental Science & Forestry. He continued his work at SUNY ESF, as Assistant Professor from 1998 to 2003, Associate Professor from 2003 to 2010, and Professor from 2010 onwards. He has also worked in the forest products industry. Professor Germain focuses on research into sustainable forest systems and outreach through the NYC Watershed Model Forests Program, which he coordinates.

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US Forest Service
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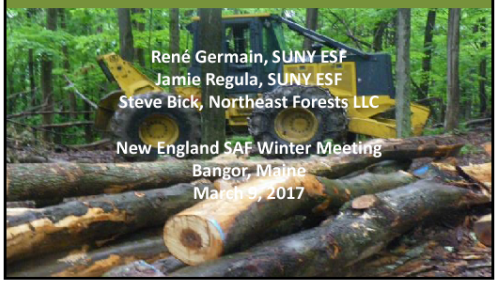
Appendix M:

New England SAF Presentation, Logger Viability, R. Germain

Loggers of the Northeast:

Are they Thriving, Striving or just Surviving?



René Germain, SUNY ESF
Jamie Regula, SUNY ESF
Steve Bick, Northeast Forests LLC

New England SAF Winter Meeting
Bangor, Maine
March 9, 2017

Background

- The economic sustainability of logging contractors is critical to successful forest management.
- Expectations have increased due to the expansion of harvesting regulations and the adoption of forest and logger certification programs.
- Unfortunately, these rising expectations have resulted in increasing logging costs.

Previous Research

- Studies have focused on estimating cost and productivity of individual machines and entire harvest systems. (Miyata, 1980; Brinker et al., 2002; Hiesl and Benjamin, 2015; Germain et al., 2016)
- Others studies have attempted to control for external variables and set out to measure their effects on productivity and costs. (Greene et al., 1997; Conrad, 2014; Allred et al., 2011; Thompson et al., 2011)

Study Objectives

- Examine the profitability of logging contractors with differing harvest systems and job characteristics across New York State and Northern Pennsylvania.
- Determine which factors most impact logging productivity and profitability.

Variables Impacting Productivity & Profitability

- Harvest volume per acre
- Species value
- Average logs per stem
- Area of sale
- Average skidding distance
- Topography
- Access system
- BMPs
- Amount of non-commercial timber stand improvement

Implications for Loggers

High variability!

Lack of predictability!

6

Economic Viability at Stake!

- Contract loggers commonly paid by the thousand board feet (MBF) to cut, skid, land.
- Rates range from as low as $110/MBF to $200/MBF (pulpwood/chipwood $12 – $22 /ton).
- Rates should fluctuate from job to job based on achievable productivity rates, but often they do not, leaving loggers exposed to financial losses.

7

Background

PRACTICE OF FORESTRY

The Tree That Built America—Not Making the Grade

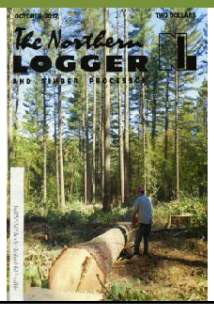
Two simple examples of how logging job characteristics can impact logging costs.

Case Study One – Background

This 96-year old Huntington Forest white pine stand represents among the best stocked forest stands in the Northern Forest (of any species) with a standing volume of 60MBF/acre.

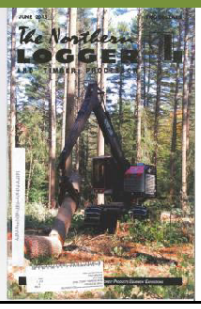
The Harvest

Northern Logger – "Poster Child"



October 2012

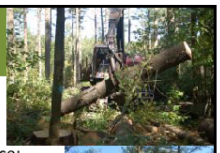
Northern Logger – "Poster Child"



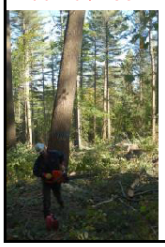
June 2013

Northern Logger – "Poster Child"

Logging Costs?



Production:
100mbf/week

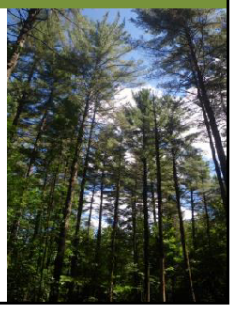


- Skid Distance: 600ft
- Logs/Stem: 5-6
- 650bdft/stem
- Cut Volume: 20mbf/ac of white pine
- Flat terrain
- Minimal BMPs

Logging Costs?

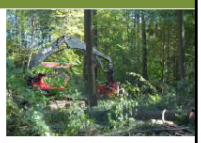
In this case, you are cutting 20mbf/ac and logging conditions are favorable.

Logging costs were $94/mbf.



Case Study Two – Background

100-year old natural white pine stand with 20mbf/acre, includes hemlock.



Production:
25mbf/week

- Skid Distance: 1500 - 2000ft
- Logs/Stem: 2-3
- Cut Volume: 4.2 mbf/ac white pine & hemlock pulp
- Flat terrain/minimal BMPs

Logging Costs?

In this case, cutting 4mbf/ac and logging conditions are less favorable.

Logging costs were higher – in the range of $155/mbf – so margins are more challenging.

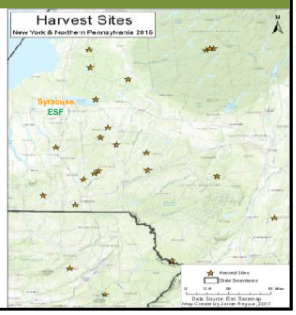
The Study:

- Working in partnership with procurement foresters we interviewed 25 loggers.

- 30-minute interviews were conducted at the landings around the close out of the job.

Research Area

Majority of the harvests in northern hardwoods – with a few in mixed-wood forest cover types



Methods

- Harvest system
- Equipment information
- Employees
- Sale area
- Volume
- Products
- Access system
- BMPs

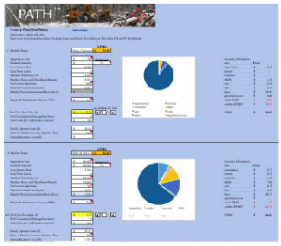
Data Analysis

Productive machine hour is the time the machine is performing its scheduled function.

- Fixed Costs
  - Depreciation
  - Interest
  - Insurance
- Operating Costs
  - Maintenance & Repair
  - Fuel
  - Lube
  - Wages
  - (Depreciation)

Data Analysis

- PATH *(Planning and Analysis in Timber Harvesting) (Bick, 2017)* was used to calculate:
  - productive machine hour (PMH) costs
  - Operating Costs
  - Net Profit

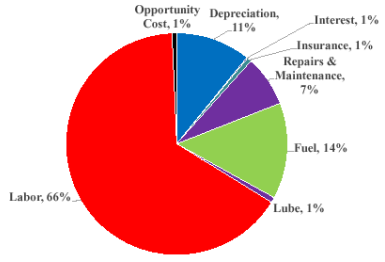


Do loggers know their costs?

Some caveats:

- Most had very good data for variable costs.
- Some issues with repair and maintenance.
- Many struggled estimating fixed/overhead costs.

Average Distribution of Costs



88% - Variable **12% - Fixed** (No new equipment

Our Thresholds: Striving, Thriving or Just Surviving

Surviving
•Partially cover costs while loss of equity to uncompensated depreciation

Striving
•Break-even by meeting operating costs, including depreciation

Thriving
•Cover costs, make profit and return on investment

Important Caveat!

These results represent a "snapshot" of one of many jobs these loggers will complete in a year.

Results

ID	Harvest System	Acreage	Volume MBF	MBF/Acre	Total Volume ft^3	Ft^3/Acre	Unit Cost $/$ft^3$
A	Single Hand Operator	33	78	2.36	6,500.52	197	$2.41
B	2 Person Hand Crew	11	48.6	4.42	7,634.32	694	$1.55
C	Single Hand Operator	120	132.2	1.10	11,017.55	92	$2.11
D	2 Person Hand Crew	15	33.62	2.24	4,529.89	302	$1.70
E	Single Hand Operator	100	85.3	0.85	7,108.90	71	$1.91
F	2 Person Hand Crew	35	31.1	0.89	2,591.87	74	$2.65
G	3 Person Mechanized	143	45.5	0.32	106,456.10	744	$0.70
H	2 Person Hand Crew	48	20	0.42	37,142.22	774	$0.84
I	2 Person Hand Crew	60	58.3	0.97	22,778.72	380	$1.29
J	Single Hand Operator	36	113	3.14	14,153.42	393	$1.25
L	Single Hand Operator	40	25	0.63	32,043.04	801	$1.00

Result[redacted]ont.)

ID	Harvest System	Acreage	Volume MBF	[redacted]/Acre	Total Volume ft³	Ft³/Acre	Unit Cost $/ft³
M	3 Person Hand Crew	30	40	1.33	14,085.60	470	$0.71
N	4 Person Mechanized	85	113	1.33	29,001.42	341	$1.10
O	3 Person Hand Crew	90	133.4	1.48	82,797.56	920	$1.14
P	2 Person Hand Crew	58	112	1.93	25,718.08	443	$1.09
Q	Single Hand Operator	35	97.72	2.79	17,103.98	489	$2.10
R	4 Person Hand Crew	300	588.2	1.96	72,060.59	240	$1.99
S	Single Hand Operator	200	200.1	1.00	25,636.33	128	$1.52
T	4 Person Hand Crew	80	130.26	1.63	19,815.87	248	$1.52
U	4 Person Hand Crew	200	212	1.06	17,668.08	88	$2.41
V	Single Hand Operator	5	16.7	3.34	1,391.78	278	$1.59
W	Single Hand Operator	57	98.6	1.73	36,377.32	638	$0.96
X	2 Person Hand Crew	77	115	1.49	18,544.10	241	$1.67

Results

Distribution of Crew Size

1 Person Crew 2 Person Crew
3 Person Crew 4 Person Crew

Acreage
Average:81
Range: 5-300

Total Volume (ft^3)
Average: 26,615
Range:1,392-106,456

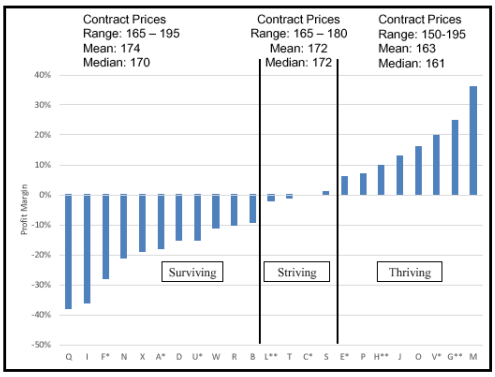
ft^3/Acre
Average: 393
Range: 71-920

Unit Cost $/$ft^3$
Average: $1.53
Range: .70-$2.64

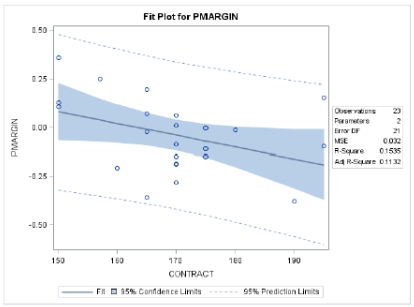
Number of Days on the Job
Average: 30
Range: 3-70

Contract Profit Margins

ID	Net Revenue	Net Profit	Profit Margin
	Surviving		
Q	$26,063	($9,809)	-38%
I	$21,620	($7,751)	-36%
F	$5,372	($1,504)	-28%
N	$26,495	($5,497)	-21%
X	$26,050	($4,912)	-19%
A	$13,260	($2,420)	-18%
D	$6,715	($995)	-15%
U	$37,100	($5,454)	-15%
W	$31,450	($3,408)	-11%
R	$130,899	($12,743)	-10%
B	$10,862	($953)	-9%
	Striving		
L	$31,262	($695)	-2%
T	$29,748	($344)	-1%
C	$23,128	($99)	0%
S	$39,423	$416	1%
	Thriving		
E	$14,493	$882	6%
P	$30,197	$2,145	7%
H	$34,926	$3,662	10%
J	$20,350	$2,636	13%
O	$111,517	$17,429	16%
V	$2,756	$543	20%
G	$99,522	$25,163	25%
M	$15,709	$5,689	36%



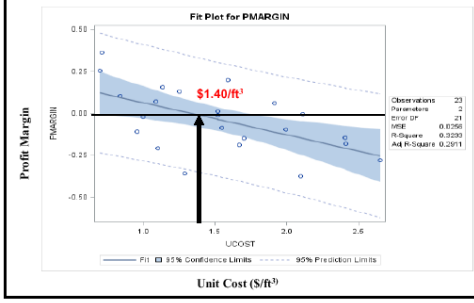
Contract Rate vs. Profit Margin



What it takes to "Thrive"

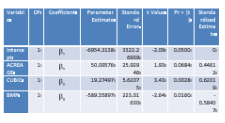
Name	Net Revenue	Net Profit	Profit Margin	Percent Contract Rate Increase to "Thrive"
		Surviving		
Q	$26,063	($9,809)	-38%	65
I	$21,620	($7,751)	-36%	90
F	$5,372	($1,504)	-28%	35
N	$26,495	($5,497)	-21%	40
X	$26,050	($4,912)	-19%	35
A	$13,260	($2,420)	-18%	25
D	$6,715	($995)	-15%	25
U	$37,100	($5,454)	-15%	25
W	$31,450	($3,408)	-11%	30
R	$130,899	($12,743)	-10%	20
B	$10,862	($953)	-9%	20
		Striving		
L	$31,262	($695)	-2%	10
T	$29,748	($344)	-1%	10
C	$23,128	($99)	0%	10

Unit Cost ($/ft³) vs Profit Margin



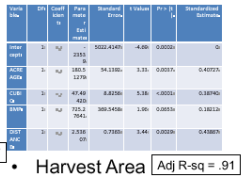
Regression: Other Significant Variables

Profit Margin



- Harvest Area Adj R-sq = .37
- Harvest Volume
- BMPs

Operating Expenses



- Harvest Area Adj R-sq = .91
- Harvest Volume
- Skid Distance
- BMPs

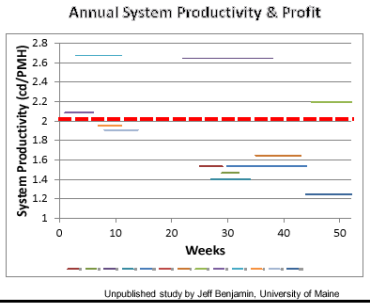
Discussion

- There can be a fine line between financial loss, equity erosion, and profitability.
- Germain et al. 2015 reported a modest increase in contract rate can move a job from surviving to thriving – **sometimes not**
- Important unit cost threshold: ≈ $1.40/ft³

Discussion

- Loggers need to be cognizant of potential marginal or unprofitable jobs – make informed decisions
- Loggers need to be aware of those factors that impact productivity and profitability
  - Harvest area
  - Harvest volume
  - Skidding distance
  - BMPs
- Foresters share in this responsibility.

Look at the Big Picture



Discussion: *Running on Equity*

- Contractors often cannot upgrade equipment
- Running old, often antiquated equipment
- Leads to downward spiral of productivity to "running on empty"

Discussion: Forest Resource

- Not in best interest of forest resource to have a logging force living on the edge.
- Loggers in "Surviving" mode are not in best position to be attentive to silvicultural implementation, residual damage and BMPs.

Take Home Message

Logging contract rates should reflect:

- Rising expectations on loggers
- High variability and lack of predictability across jobs
- Unique characteristics of those logging jobs

Loggers need to raise their level of business sophistication:

- Understand their costs
- Know factors impacting productivity and profitability
- Negotiate contract rates that allow them to thrive