Internal Rate of Return of Sugar Maple (*Acer saccharum*) in Wisconsin

Joel C. Kaminski, Nilesh Timilsina, and Michael C. Demchik[1]

Management of sugar maple (*Acer saccharum*) has the primary objective of growing trees that will produce high quality wood (Germain et al. 2015). As such, forest management often prioritizes the release of crop trees. However, in order to produce high value logs, there is an investment cost in the amount of time it takes for a tree to reach a desired size. Additionally, the collection of landowner goals, only some of which are economic, strongly impact management decisions. In species such as sugar maple, the length of time required to meet the basic specifications for sawlogs is sufficiently long to result in a rather low internal rates of return compared to many other species.

Dey et al. (2017) found that larger trees produced the highest value due to increase in volume and grades in the second and third logs. However, when age was taken into account, trees older than 100 years had a lower value than younger trees. This result implies that there is a certain point in a tree's life where its value begins to decline, regardless of its continued increase in volume. The purpose of this study is to estimate and analyze the internal rate of return for sugar maple over a 10-year period to determine how the tree's value (with all potential risks or changes in grade ignored) changes during that time.

The sites used for this study were eight northern hardwood stands in northern and central Wisconsin that were actively being logged during 2018. While composition varied between sites, sugar maple was generally one of the dominant species. Overall, these sites varied in quality and management history; however, it is likely that all had been subjected to a hard selection harvest one or more times in the past. A subset of data from a previous study (Kaminski et al. 2019) was also included. At each site, a maximum of 10 sugar maple trees were selected and measured before and after being cut and merchandized.

For each standing tree, the following data were collected:

- Diameter at breast height (d.b.h., to nearest 0.1 inch)
- Average width of the crown by measuring the width of the crown (to the nearest 1 foot) in two directions
- Height to the live crown
- Total height
- Standing tree grade for the best 12 feet of the lower 16 feet following Great Lakes Timber Professionals Association guidelines (GLTPA 2016)

After the standing trees were measured, the trees were cut and merchandized by the loggers using normal protocols to optimize recovery of high quality logs. The resulting logs were scaled and graded following the GLTPA grading guidelines into grades 1, 2, or 3. A log that fell below grading guidelines for either scaling diameter or quality was assigned a below-grade status (grade 4, henceforth).

[1] Graduate Student (JCK) and Professors of Forestry (NT and MCD), University of Wisconsin-Stevens Point, TNR Building, Stevens Point, WI 54481. MCD is corresponding author: to contact, call 715-346-3214 or email mdemchik@uwsp.edu.

Table 1.—Proportion of logs assigned to a specific grade for merchandized pieces (1-4) harvested from each tree

Grade	Log 1	Log 2	Log 3	Log 4
Grade 1	0.20 (n=15)	0.06 (n=4)	0.00 (n=0)	0.00 (n=0)
Grade 2	0.51 (n=38)	0.51 (n=34)	0.31 (n=15)	0.40 (n=6)
Grade 3	0.26 (n=19)	0.33 (n=22)	0.51 (n=25)	0.47 (n=7)
Grade 4	0.03 (n=2)	0.10 (n=7)	0.18 (n=9)	0.13 (n=2)

Table 2.—Calculated internal rate of return percentages for sugar maple logs over the past 10 years sorted by grade (1-4) and diameter size class, in inches

D.b.h.	Grade 1	Grade 2	Grade 3	Grade 4
≥13 (≥12.1 - 14)	14.6%	3.1%	4.4%	2.8%
15 (≥13.1 - 16)	7.8%	5.5%	2.2%	2.8%
17 (16.1 - 18)	x	3.1%	4.6%	3.1%
19 (18.1 - 20)	2.1%	3.3%	2.3%	2.6%
21 (20.1 - 22)	3.0%	2.9%	2.2%	x
23≤ (22.1 - 24)	2.5%	x	2.5%	x

Internal rate of return for each log was calculated by comparing the current value of merchandized logs to the value they would have had 10 years prior. In order to estimate the past volume for these logs, we used the growth measurement taken by measuring the rings over the past 10 years on each end and subtracting it from the radius. Then the volume of each individual log, both current and 10 years ago, was calculated using the assumption that the same merchandizing decisions would have been made 10 years ago and at the time of actual harvest. Delivered prices for each product class were determined by using values provided by the 2012 Timber Mart North price report – Wisconsin edition (Prentiss and Carlisle 2012) (the last year that delivered prices were estimated for this publication) and inflating the prices to meet current specifications (U.S. Inflation Calculator 2018). Estimated cut-and-haul costs (Gibeault and Coutu 2014) were adjusted for inflation and then subtracted from adjusted delivered values to determine stumpage price. Any physical damage or abnormality was assumed constant over this 10-year time frame, as there is no accurate method of determining what features the tree had at the time. This provides the assumption that logs from 10 years ago were assumed to have the same grade unless they failed to meet the specific size specifications. We were able to use the calculated volume and grade for the past and the present logs to determine the value for each. The internal rate of return (IRR) function in Microsoft Excel® was utilized to predict the percent return for each log.

An analysis of individual log pieces found that almost 80 percent of all grade 1 logs were in the first merchandized piece of a tree. The results show that quality tends to decline as you move up from the first merchandized piece (Table 1). The results for the IRR calculation (Table 2) indicated that there was value growth ($/MBF) when trees changed product class from a bolt to sawlog. Trees with grade 1 sawlogs had the most notable increase, with IRRs as high as 14 percent.

Lower grade trees were much less effective, with IRR values falling short of 5 percent when they improved to the next higher product class. The data demonstrated a significant decrease in IRR for each tree as its diameter increases, specifically for those with grade 1 potential. Change in IRR for trees with lower grades was less impactful than trees with grade 1 sawlogs. This seems to indicate that the value the tree accumulates each year begins to decrease once it reaches a specific size class.

Management decisions made to optimize a tree's financial return within a site are often determined by considering factors related to a tree's ability to accumulate value upon the next stand entry. Of course, financial return is only one of the collection of landowner goals; however, this does strongly impact management decisions. A common practice in Wisconsin is to grow trees, particularly those with potential for quality sawlogs, to larger sizes to maximize the potential of the tree. Once a log reaches a specific size class within a tree, its value drastically increases. Each log within the tree can increase to a higher product class once its small-end diameter reaches a specific size. This effectively means that the longer a tree is left growing on site, the higher the chance it has to produce more valuable products.

Our study found that from an economic perspective, the IRR for sugar maple logs has a tendency to decrease as its diameter increases (Table 2). This is particularly noticeable for grade 1 sawlogs, which show an IRR of around 14.6 percent at the 13-inch size class down to around 2.5 percent at the 23-inch size class. The data suggest that the potential for these logs will only decrease once they have reached highest value product class. Once a good quality tree has reached the point where it can no longer increase to a higher product class, it should no longer be considered for retention unless it is needed to meet other goals for the site (for example, maintenance of adequate basal area).

Dey et al. (2017) found that older trees can compensate for risk by increasing the value in the second and third logs in the tree. Because 40 percent of the tree's total value comes from the first log, the risk of letting the upper logs in the tree grow to grade 1 or veneer is even higher. However, during our study we found that certain trees that had a defective first log were selected as crop trees because of the potential value that could be obtained by the second and third logs before the next harvest. The value of the first log would likely not improve significantly, but if the second or third log could improve to grade 1 or veneer through time, then retention may be logical.

One assumption of this project is that log grades do not decline through time. Webster et al. (2009) has shown this to be inaccurate. We have intentionally not included risk through time within this model. We chose this approach because the composite risk associated with an individual tree is very difficult to determine and is partially dependent on each organization's goals and objectives, and these include financial risk (for example, value of the species in the marketplace may decline) and physical (for example, the tree may be damaged or die). While determining the value of risk is an important part of an organization's mission, it is outside the scope of this project.

ACKNOWLEDGMENTS

We greatly appreciate the help from Kretz Lumber Company, Tigerton Lumber, Steigerwalt Land Services, and Connor Forest Management for opening their active harvest sites for this study. A special thanks goes to the following foresters: Landin Brockman, Robert Connor, Al Koeppel, Joe Mattke, Tom Hittle, Ben Knaack, Dennis Fincher, and Gus Blemke. Thanks to the following loggers/hand cutters: Vernon Krolow, Ryan Weirzba, Pat Breaker, Jess Kettner, Jeff Mosher, Nick Fuhrman, Willard Harris, Jason Skierka, Darrel Javorek, Corey Zettler, Daniel Greenwald, Gus Blemke, Carl Baily, Jr., Carl Baily III, Todd Beckingham, Rusty Kettner, Gerald Reinhardt, Mike Schelling, Larry Mashak, and Taylor Koski. Lastly, we would thank the faculty and staff of University of Wisconsin-Stevens Point, College of Natural Resources, who aided us in this process. This project was funded by a McIntire-Stennis Cooperative research grant through the USDA National Institute of Food and Agriculture.

LITERATURE CITED

Dey, D.C.; Dwyer, J.; Wiedenbeck, J. 2017. **Relationship between tree value, diameter, and age in high-quality sugar maple (*Acer saccharum*) on the Menominee reservation, Wisconsin.** Journal of Forestry. 115(5): 397–405. https://doi.org/10.5849/jof.2016-026r1.

Germain, R.H.; Yanai, R.D.; Mishler, A.K.; Yang, Y.; Park, B.B. 2015. **Landscape and individual tree predictors of dark heart size in sugar maple.** Journal of Forestry. 113(1): 20–29. https://doi.org/10.5849/jof.14-004.

Gibeault, F.M.; Coutu, P.J. 2014. **Wood supply chain component costs analysis: a comparison of Wisconsin and U.S. regional costs.** Tomahawk, WI: Steigerwaldt Land Services. 40 p. [Report prepared for Great Lakes Timber Professionals Association and Wisconsin County Forests Association.] https://councilonforestry.wi.gov/Documents/PracticesStudy/ProjectReportFall2015.pdf (accessed Oct. 31, 2022).

Great Lakes Timber Professionals Association [GLTPA]. 2016. **Official grading rules for northern hardwood and softwood logs and tie cuts.** Rhinelander, WI: Great Lakes Timber Professionals Association.

Kaminski, J.; Demchik, M.; Timilsina, N. 2019. **Factors relating to dark heart of sugar maple in Wisconsin. Journal of Forestry.** 117(3): 256–266. https://doi.org/10.1093/jofore/fvz013.

Prentiss and Carlisle. 2011–2012. **Timber Mart North price report: Wisconsin edition**. Timber Mart North. 18(1): 1–9. https://www.prentissandcarlisle.com/.

U.S. Inflation Calculator. 2021. **U.S. inflation calculator.** San Antonio, TX: CoinNews Media Group. https://www.usinflationcalculator.com/ (accessed June 26, 2019).

Webster, C.E.; Reed, D.D.; Orr, B.D.; Schmierer, J.M.; Pickens, J.B. 2009. **Expected rates of value growth for individual sugar maple crop trees in the Great Lakes region.** Northern Journal of Applied Forestry. 26(4): 133–140. https://doi.org/10.1093/njaf/26.4.141.

CITATION: Kaminski, Joel C.; Timilsina, Nilesh; Demchik, Michael C. 2023. **Internal Rate of Return of Sugar Maple (*Acer saccharum*) in Wisconsin.** In: Kern, Christel C.; Dickinson, Yvette L., eds. Proceedings of the first biennial Northern Hardwood Conference 2021: Bridging science and management for the future. Gen. Tech. Rep. NRS-P-211. Madison, WI: U.S. Department of Agriculture, Forest Service, Northern Research Station: 179–182. https://doi.org/10.2737/NRS-GTR-P-211-paper37.