eYield: Testing the Adoption and Outcomes of a Novel Online Growth and Yield Model

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DEDICATION

This document is dedicated to Dr. Richard Strange. Without his mentorship, none of this would have been possible. 1951-2020

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ABSTRACT

eYield is an online growth and yield platform designed to assist landowners and land managers in making the best choices for their properties. eYield aims to strike a balance between the necessary data to run growth and yield models while remaining accessible to its landowner userbase. The results of this paper point to an encouraging amount of user interest in computer-aided forestry tools, specifically in growth and yield models like eYield. The pre- and post-surveys of eYield from respondents suggest that there is a yearning for tools like eYield and that eYield is reasonably representative of the real world. These results point to the continuing march of technology through all sectors and the need for technological integration through most facets of life. Survey participants indicate that they are open and willing to accept new technology to address questions that are environmentally complex and highly variable associated with future forest growth.

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CHAPTER ONE
INTRODUCTION TO THE WOOD BASKET AND EYIELD

Introduction

Landowners and forestry professionals have long estimated forest products and timber values since the Biltmore stick was invented for quick and easy timber cruising in the 1890s. This opened the door for many people passingly familiar with forestry to conduct forest inventories with rates and accuracies never before seen. This, in turn, led to a more significant community focus around nature and more conscientious decision-making regarding forest planning and management. Tools like the Biltmore stick developed into the forestry tools that we use today, including diameter tapes, clinometers, and basal area factor prisms. These tools are designed for use in the field and are easy and efficient ways to collect forest information at scale. With the introduction of the computer and more abundant access to computational resources, the eYield team has set out to develop more tools for landowners and foresters to use these on-the-ground representations to make better decisions regarding their forestry practices in the future.

The American South has long been known as the "Wood Basket" of the world, which is a reasonable moniker considering the South alone has consistently produced more timber than any country since 1986 (Wear 2012). According to the USDA Forest Resource Facts and Historical Trends brochure

(Oswalt 2014), the South is comprised of the states of Texas, Oklahoma, Arkansas, Louisiana, Kentucky, Tennessee, Mississippi, Alabama, Georgia, Virginia, North and South Carolina, and Florida collectively. The South alone produced nearly 3 billion cubic feet of pulpwood in 2011, about 75% of the total production of the United States that year. The gap in production between the South and the North and West regions is not relegated to only pulpwood production. The South produced 2 billion cubic feet of lumber in 2011; this, however, was down from the high of nearly 3 billion cubic feet in the early 2000s.

With such a rich and vast resource, it is worth noting who owns this land. The general answer in the American South is private landowners. The South has the largest amount of privately-owned forest land in the US, at 147 million acres under private non-corporate ownership with another 65 million acres under private corporate ownership (Oswalt 2014). This is by far the largest amount of forest owned by private entities in the US, far exceeding both the North and West regions.

With this timber, having a management plan for each tract would be ideal. Unfortunately, that is far from the case. According to the US Forest Service National Woodland Owner Survey (Butler 2021), only 11% of family forest owners have a written management plan. This group of 11% owns about 24% of the family forest land. Additionally, 35% of those surveyed indicated that they planned to cut on their land for personal reasons, while another 17% indicated that they would cut for sale within the next five years. Consequently, landowners are harvesting with little to no long-term written plan in place. This does not

bode well if the South is to maintain its dominance as the wood basket of the world.

Soon decisions must be made about our Southern forests if we aim to maintain our dominance in the world markets. The American South has long been the outright leader in forest planting since the 1950s. Since then, the South has out planted the West and the North handily planting, at most, over 2.5 million acres of forests annually in the late 1980s. Since then, the South has planted between 1.3 million and just over 2 million acres per year (Oswalt 2014). Where these trees would be in their lifespans is important to understand; the age class of trees planted in the 1950s would be 70 years old, while the age class from the '80s would be 40. These are prime harvest years for both major types of roundwood, softwood and hardwood.

With these major harvest dates quickly approaching, landowners and advisors should be provided with the best tools possible in order to maintain the South's position as the largest wood producing region in the United States and the world. This is without the consideration that the South's industrial wood output is expected to increase by more than 50% from 1995 to 2040 (Prestemon and Abt 2002).

With that in mind, eYield was created. eYield is an online growth and yield platform aimed at professionals and advanced landowners to provide accessible growth and yield estimations such that the users would be able to make the most informed decisions to produce healthy and sustainable forests.

Current Knowledge

There have been previous attempts at building growth and yield systems similar to eYield. The notable example of this is WINYIELD which was developed in the 1980s to perform similar simulations to what the eYield program implements (Hepp 1982). WINYIELD, as it is written, has shortcomings. First, WINYIELD was originally created as a microcomputer-baser interactive FORTRAN program. The entire system would have to be rewritten for newer computational architecture for the program to run efficiently, or even at all, on modern hardware, which would allow for better utilization of newer computational features with some additional limitations. The notable limitation is the second issue with WINYIELD: it is a desktop-based computer program with access to local hardware features, such as the CPU. The user experience is complicated by tasking users with downloading and implementing executable files or .exe that may or may not be trusted by the Windows or Macintosh systems, causing an undue burden on both users and government-owned computers. Additionally, periodic updates would need to be implemented by users causing additional barriers to use and complicating rollout. Updating would be especially cumbersome in the earliest stages of eYield, in which changes, updates, hotfixes, and new simulations are rolled out more often. Additionally, depending upon the user's frequency of use, eYield may need to be updated each time the user intends to use the program. This would create additional barriers to the user experience and may become cumbersome to the end-user.

eYield, by contrast, is a web-based platform which inherently means that any needed update is pushed on the server-side and automatically enacted for all website users after a page refresh. This contrasts with locally installed programs in which each user is independently responsible for updating the software. Implementing updates solely at the server creates additional server load but is seen as a reasonable trade-off due to the convenience for end-users and the ease of pushing update rollouts. An additional benefit of website-based applications is their cross-platform nature. Cross-platform is a term used to describe a program that can be run on multiple operating systems while maintaining a single code base (Sun Microsystems 1999). The ease of updates from a single platform cannot be overstated. This benefit brings ease of management and a reduced workload on programming staff as there is no need to update a desktop, iOS, and Android app independent of one another.

eYield is designed for natural resource managers and small to medium-sized landowners to build a plan for their forest that makes sense both economically and in terms of land management principles. With eYield, building a land management plan is done through a battery of simulations that come together to give landowners and managers the best opportunity to manage their resources in a meaningful way.

The eYield platform is relatively unique in that it contains not only simulations for natural loblolly pine stands, which have various models due to their commercial viability and relatively standard growth patterns, but an upland oak-hickory model as well. The lack of available tools for hardwood estimation is

generally due to the complexities in modeling growth rates and timber quality (McTague, O'Loughlin et al. 2008). Compared to more common monoculture estimations, additional complexities can include varying age classes, forest structure, variable species makeup, past management or disturbance influences, differing site productivities, variable stand stocking and density, and dispersal within the forest. This makes eYield uniquely suited to the Southeast, particularly as upland hardwoods dominate in areas north of the Piedmont and Coastal Plains provinces. Upland hardwoods accounted for 39% of the forests in the southern United States in 2010 (Wear 2012).

Objectives

This study had two primary objectives. The first objective aims to disseminate information about eYield to the public and build interest in eYield as a tool that is available for planning. This was done by conducting online workshops with potential users. The goal was to introduce our model to the general forestry population and build a userbase to deliver further updates.

The second objective was to assess the workshop's impacts and observe which of the models, reports, and simulations users find the most useful. The resulting information would then be relayed to the eYield production team to better assess priorities for future updates. For this, surveys and personal interviews were conducted. These surveys and interviews revolved around a few main questions, those being; What financial and biological information are most

valuable to non-industrial private forest owners and forestry consultants, how do people view and process information with digital technology and models that are delivered via the web for the management of land, how do participants interact with a model designed to assist with financial and biological projections of proposed forest management options and outcomes, and finally, will the model further enhance the understanding and engagement of forest owners in the management of their land?

CHAPTER TWO
MATERIALS AND METHODS

Workshops

Due to the Covid-19 global pandemic, the investigators decided to forgo any in-person workshops with stakeholders. Instead, opting to conduct all workshops virtually through Zoom©, an online video conferencing software. Further discussion on this topic can be found in the Workshop Alterations subsection of this document. Five workshops were hosted between October 20th and November 18th, 2020. These workshops lasted less than two hours each. Within these virtual workshops, participants were guided through the eYield website, shown the features and abilities of the eYield program, and given an opportunity to input data and experiment with the system on their own. These virtual workshops were meant for the purposes of introducing the audience to the eYield platform, the simulations that the website is capable of, guiding them through the simulations and their options, and engaging the audience and encouraging their use of the system in their workflows.

Surveys

The surveys were the primary quantitative barometer for the project. The surveys have been attached in the Appendix as pre-workshop survey and post-workshop survey. The questions presented on the surveys were created based on

the project objectives and various stakeholders' input. The surveys were also evaluated by several patrons of the eYield project. More discussion on the pre-workshop survey can be found in the Errors in Survey Language section of this document. Two surveys were prepared for delivery to participants with two main priorities in mind: personal autonomy and anonymity.

Personal Autonomy

Participants would not be required to answer any question beyond the agreement to participate in the survey. This was done in an effort to obtain the best quality answers and to allow the participants to opt-out of answering any questions where they did not have a strong opinion.

The transition from a paper-based survey, that would have been administered and retrieved during in-person workshops, to online, private, and personal surveys may have had additional effects on the participant's answers. Without the social pressure of seeing others filling in a survey, participants were free to opt-in or out of the survey at will, leading to a smaller sample size but the possibility of more genuine answers from those who chose to participate.

Survey Anonymity

Surveys were designed with the input and following the guidelines of the Institutional Review Board (IRB). Although these surveys did not fall under their purview the identities and responses of all those involved were protected. In an effort to fulfill that goal, at no point in the pre- or post-workshop surveys were the participants ever asked to give any personal information. The collection of

personal data, when required, was completed through participants answering in the affirmative that they would like to further participate in the project and that they understood the information that they were giving for the survey. If the participant indicated that they would like to participate further, they were given a link to a separate QuestionPro® survey to collect their name and email addresses. This was in an effort to completely decouple the names and contact information of the participant from their answer on the survey.

Survey Creation

Surveys were created on the QuestionPro® website. The surveys contained an assortment of question types, including open-ended responses, multiple-choice, ratings, and Likert-scale questions. The survey questions were formulated to address the objective listed in Chapter One. A copy of the pre- and post-workshop surveys can be found in the Appendix of this document.

The post-workshop survey is largely based on the pre-workshop survey to allow comparison of user's answers before and after the workshop to gauge the workshop's influence on the participants. The post-workshop survey also had additional questions directly asking users about their experience with eYield and their experience with the workshop. Examples of the types of questions asked would be, about the user's perception of the results from eYield, the ease of use of eYield, if they would use eYield in the future, if they had completed remote learning and computer training before, and how our workshop compared to their previous experience with online training.

Before the start of each workshop session, a link to the web survey was provided within the chat feature of Zoom. This link would allow users admittance to the survey and would bin each of the workshops individually. Users were given adequate time to complete the surveys before the workshop began. If a user arrived late, the moderator would resend the survey link and ask the new participant to complete the survey.

Before the formal dismissal of the workshop, a new link would be sent to users through Zoom's chat feature for the post-workshop survey. This survey was largely based on the pre-workshop survey with additional questions asking the participant's opinions on the workshop as a whole and how the workshop compared to other remote learnings they have completed in the past.

Personal Interviews

At the end of the post-workshop survey, each participant was asked if they would volunteer to participate further in the project in the form of another survey or as part of a focus group. Due to unforeseen circumstances outlined in the subsection, Survey and Focus Group Alterations and Possible Ramifications within Chapter Six of this document, the focus groups were altered to be personal interviews. These interviews intended to dig deeper than the surveys alone and allow the author to directly ask users for their feedback on the user interface and the user experience, otherwise known as UI/UX. Further, the personal interviewees were asked questions regarding their acceptability of online

workshops and their thoughts on the ease and information retention when delivered through online conference calls.

Survey Analysis

Pearson's Chi-Squared tests and Wilcoxon tests were used to compare the pre- and post-workshop survey responses. The Wilcoxon test was chosen due to the smaller sample size of our survey and the non-normal distribution of the sample results. All tests were completed within RStudio (RStudio 2021).

Additionally, through the use of Likert-scales in our questionnaires, Vaske's Potential for Conflict Index (PCI) is implemented to graphically represent where participants agree and disagree (Vaske 2008). This graphic is intended to show the similarities in participants' answers and is intended as a display of users' agreement with one another. This graphic operates by displaying the mean average of the group's answer on the Y-axis while the circle's diameter represents the cohesion within the group. A larger circle indicates dissonance, while a small circle represents cohesion within the group. The value of these circles ranges from 0 to 1. The PCI values for each of the responses can be found next to each circle. The PCI figures can be found in the Appendix of this document.

Likert-scale answers for the post-workshop survey participants were converted from words such as slightly useful and indifferent to numerals with -2 equating an answer that strongly disagrees, 0 indicating indifference, and 2 indicating a strong preference. The results after this transformation can be found

in Table 4.1. These responses are multiplied by their respective values. i.e. three -2 responses equate to the number 6. One should remain aware that neutral or indifferent responses would be multiplied by 0. The negative values would be multiplied by -1 in order to create a positive-sum. These values were then used within the following formula (Vaske 2008).

$$PCI = \left(1 - \left(\left(\frac{P1}{A1}\right) - \left(\frac{N1}{A1}\right)\right)\right) * \left(\frac{A1}{2 * A2}\right)$$

P1 – Sum of multiplied positive responses.

A1 – Sum of all responses after multiplication.

A2 – Sum of all responses before multiplication.

N1 – Sum of negative responses after multiplication.

Participation

Due to the impact of the Coronavirus, the eYield project struggled to maintain high participation rates. The workshops garnered about 55 participants throughout their run. These workshop participants translated into 28 pre-workshop survey participants. Although, not all participants answered all questions throughout all of the surveys. Following the workshops, 19 individuals participated in the post-workshop survey. At the end of the post-workshop survey, participants were asked if they would like to participate in the eYield project further. To that question, only five “yes” answers were recieved. Only two of the five individuals completed the personal interviews.

CHAPTER THREE

RESULTS AND DISCUSSION

The surveys that these quantitative results originated from are presented in the Appendix of this document as pre-workshop survey and post-workshop survey. Further results, charts, graphs, and figures are referenced in the list of tables and the list of figures presented on pages vii and viii of this document.

The pre- and post-workshops surveys were analogous to one another and asked participants similar, if not the same, questions before and after the workshop. This was in an attempt to understand if the workshops had any discernable effect on the answers the participants gave. The post-workshop survey added a total of eight new questions meant to gauge users continued interest in the eYield platform as well as their thoughts and opinions on the training.

Throughout both the pre- and post-workshop surveys, if respondents answered questions 7, 10, 11, and 12 with certain answers, they were directed to additional questions to further elaborate on their answers. In the case of question 7, if participants indicated they had completed remote learnings, they were directed to question 7a, which asked them about their personal opinions on remote learning as a training tool. For questions 10 and 11, on the post-workshop survey, if participants answered negatively, they were taken to a second question (questions 10a and 11a) which asked them for further elaboration in the form of a text box and a prompt asking them in what way did eYield did not line up to their

standards. If the participants answered in the affirmative for questions 10 and 11 that eYield did meet their standards, they were transitioned to the next question in the series, 11 and 12 in this case. For question 12, there were two options. The first option was an opt-in for further contact from the investigation team. If the participants answered that they would like to continue their participation, they were routed to a signup sheet. If they answered in the negative or failed to answer at all, they were routed to a text box and given a final opportunity to give feedback before the survey was concluded and a thank you message was displayed.

Survey

Questions 1 and 2

Following the first question, which asked for participant consent, the second question asked participants to read through a set of terms and definitions. These terms and definitions were the names of the simulations and their descriptions within the eYield platform. Participants were asked on the pre-workshop survey to indicate which terms they were currently familiar with after reading their descriptions. During the post-workshop survey, participants were asked this question again to determine if the participants showed growth before and after the workshop of terminology, and if they felt they were more familiar or less familiar with the terminology that eYield uses. The participants numerically increased their familiarity with the terminology on average by one term rising from the average participant being familiar with 3.48 terms in the pre-workshop

survey to 4.67 terms in the post-workshop survey. This resulted in a Chi-Squared p-value of .53, which is not significant. The relative increase numerically in familiarity may indicate a reinforcement of the term familiarity in the post-survey after the training is conducted rather than uncertainty perceived by respondents in the pre-survey.

Questions 3 and 4

Questions 3 and 4 asked participants, "To what extent do you find these items useful?" The items referenced were the financial simulations for question 3 and biological simulations for question 4. Participants were offered a Likert scale of which there were five options. The post-workshop survey results will be analyzed here; for more on the pre-workshop survey results for these questions, reference Errors in Survey Language in Chapter Six. Wilcoxon signed-rank test was chosen to analyze the Likert-scale results to observe if there is a difference in participants' opinions between individual simulation options and a difference between financial simulations and biological simulations. The results of the Wilcoxon test were that no significant p-values were assessed between any of the sampled simulations or between a combination of the financial or biological simulation. This result is likely the outcome of a small sample size without enough respondents to draw any clear conclusions.

The PCI test for this scenario is presented in figures 4.1.1 and 4.1.2 in the Appendix. The averages between the financial implications in 4.1.1. and the average of the biological simulations in 4.1.2. The biological simulations have a

slightly higher mean of .33 when compared to the mean financial simulations at .04. The comparison of these results is not significant, however. The average of the financial PCI values is .54, while the biological average is a similar .58. A similar probability for conflict value was observed between those who rated the biological simulations and the financial simulations.

These results may indicate that moderators should likely be more clear about the separation between the financial simulations and the biological simulations in future workshops. This may lead to breaking the workshop into multiple, distinct sections to focus on the financial and biological simulations independent of one another. Originally, the workshops were led by combining all of the simulations to be run as one, potentially leading users to the incorrect conclusion that they need to provide more information to run their chosen simulation than is truly necessary, either excessive financial data for a biological simulation or vice versa.

Question 5

Question 5 asked participants how many years have they used computer and internet resources to assist in land management. Most participants, 82%, indicated that they had been using computational resources to assist in land management for six years or more in the pre-workshop survey. In the post-workshop survey, this value changed to 74%. This was likely resulted from a change in the number of users who completed the pre- to post-workshop survey.

This value may not be as impactful as indicated, however. Because the workshops were conducted online, it is possible that there may be implicit bias towards users who are more technologically savvy, as they may be more likely to participate in an online environment. It is possible that if the workshops were conducted in person, that this result may change.

The higher number of participants indicating prior use points to a minimal barrier to entry for new computational tools within the forestry industry. Most participants have been using computational resources for more than six years, likely indicating that their ability to use additional online tools, such as eYield, would cause relatively little inconvenience. This result is compounded by the increasing access and ever marching progress of innovation within the industry. With many natural sciences programs in United States universities continuing to integrate technology into their curriculum, this value is likely to increase over time.

Question 6

The following question asked participants about how they would prefer information be delivered to them, either digitally or on paper, and further asks participants about their personal feelings about technological integration. This question is differentiated from earlier questions about technology as it does not ask participants how they do their work but rather how they would like it to be done. The results showed that of the pre-workshop participants surveyed, 68% of participants indicated that they would like for their information to be presented

on computers, while 32% chose paper as their preferred medium. The post-workshop survey indicated similar results, with 74% choosing computers and only 26% choosing paper as their preferred medium. More than likely, the changes in percentage were not a result of the workshop but rather just a slight alteration in survey participation, with the post-workshop survey likely favoring those who would prefer to be around technology for longer periods of time or just simply that the post-workshop participants like computers more. Either way, the slight change is likely not the result of the workshop.

Further, almost all of the participants who indicated that their preferred medium was paper instead of computers also indicated that they had been using computers in their work for more than six years; 88% within the pre-workshop survey and 80% in the post-workshop survey. Although this is a small sample size, there is a clear indication that the overwhelming majority of 74% of those sampled indicating that their preferred medium is to have information presented to them digitally. This again bodes well for the further adoption of eYield as a platform and further computer-aided programs in the natural resources industry.

Question 7

Questions 7 and 7a asked users about their experience with computer-based training or remote learning, as well as how they ranked those experiences in relation to the workshop. Ninety-two percent of participants in the pre-workshop survey indicated that they had indeed completed at least one remote learning or computer-based training in the past. They rated those experiences as

relatively positive, with an average rating of 3.4 out of 5 stars. The participants were asked within the post-workshop survey to indicate, on a five-point scale, if the training they had just completed was better or worse than the training they had completed in the past. Most participants indicated that this training was about the same or somewhat better than trainings they had completed in the past resulting in an average score of 3.5.

This relatively minor change between pre- and post-workshop survey indicates that the eYield training was likely on par with previous training that the participants had completed. This result is considered positive, as it reflects that the eYield training was as good, if not better, than other online virtual trainings that participants had completed.

Question 8

Almost all of the participants that took the pre-workshop survey self-identified as forestry or land management professionals, a total of 96%, which was further confirmed in the post-workshop survey when 100% of the participants self-identified that they were forestry or land management professionals. This result indicated that although the target audience of eYield is small to medium landowners and forestry professionals, this training mostly reached forestry professionals and could be a further point of outreach into the future.

Questions 9 and 10

Questions 9, 10, and 10a are questions that were only asked on the post-workshop survey and evaluated user satisfaction of eYield. Question 9 asks users, "While using the eYield website interface, did you ever find the directions unclear?" The users responded with 68% of the responses answering no, they did not find the directions unclear. The remaining 32% of participants indicated that they, at some point, found the directions to be unclear.

Participants were not directly asked which portions of the eYield website were unclear, this was only assessed within the interviews. For more observations on this topic, refer to the interview subsection. The investigators thought that it might be confusing or difficult for the participants to directly point to a portion of the eYield website where they were confused during the workshop, possibly leading to further participant attrition during the post-workshop survey. Additionally, the participant's confusion, regardless of where that confusion comes from, is a key result from the question, not necessarily where that confusion occurred during the workshop.

Question 10 asked participants if they felt that the model's results mirrored real-world expectations. Seventy-four percent of survey participants indicated that the results did match what they would have expected in the real world, while 26% of users did not feel that the eYield results were similar to what they would expect in the real world. Participants who indicated that the results did not match their expectations of the real world were then asked to further elaborate on what portions of the results seemed incorrect in question 10a. A

participant indicated that they felt some of the error could be the result of "guessing at inputs." This is in reference to a portion of the workshop that attempted to elicit audience participation by having a member of the workshop lead the instructor through an example simulation, putting the workshop attendee on the spot, and giving the instructor variables that may or may not be reasonable. The purpose is to allow audience participation, and that is still achieved. Nonetheless, the instructor should still be aware of the implications of such a situation.

A further observation from a participant indicated that they felt the usability of eYield was limited by the inability to attribute market prices on a per species basis. They felt that this would limit the uses of the system in mixed-species applications, pointing toward a possible future expansion of eYield, which, instead of indicating the type of system beforehand i.e. natural loblolly pine or oak-hickory, that the systems be combined for a further wholistic approach attributing the specific growth curves on a species by species basis. An example might be a pine-oak cover type. Such an expansion, however, is outside of the current scope of the intended system.

Questions 11 and 12

Question 11 asked users, "With this tool freely available, would you use it in the future for growth and yield estimations?" Post-workshop survey participants responded overwhelmingly positively to this question indicating that 81% of participants would use this tool in the future. This result is likely the

largest takeaway from the survey analysis. There is an obvious yearning for a tool, such as eYield.

In the case that a participant answered no to question 11, they were directed to question 11a, which asked, “What features or changes would you like to see implemented before you would be willing to use eYield in the future as a growth and yield estimator?” One of the participants responded that eYield felt a bit sluggish or slow. This was a known issue that the eYield team has been attempting to address in various ways. The response is indicative of participants' feelings that they would like the tools on their system to work quickly. A sluggish product, even if good, may not be enough to influence users to continue using the tool.

Question 12 asked participants if they would like to continue participating in the study. This question presented the participants with two options, yes or no, with the default answer being no. In the case that a participant chose to no longer participate, they were directed to question 12a, which offered them a text box space in order to leave any further comments. After that, the survey ended, and they would receive a thank you message for completing the survey.

If a participant answered yes to further participating, question 12b provided them with a URL to an additional survey, the Contact Information Survey. This decoupled the participants ' answers from their contact information by sending the participants to an additional survey. Additionally, as QuestionPro® returns survey responses as an Excel document adding information such as the time of the survey and the IP address of the survey

participant, this information was immediately removed from the Excel sheet in order to obfuscate users from their survey responses further.

Survey Comments

If the participants chose an option that could be better addressed with an open-ended question, such as, “What portion of the reports did not line up with your expectations?” the participants were offered a chance to respond to those questions by writing in a text box. Usually, respondents only commented when a question was answered in a negative manner. The unedited responses that the investigators received to these questions are referenced in the Appendix.

In response to the question, “What portion of the reports did not line up with your expectations?” one respondent wrote, “Thought the expected revenue seemed pretty high, could be user error with guessing at inputs.” The reference to guessed inputs here is likely alluding to a portion of the workshop that attempted to solicit audience participation by having a participant from the workshop guide the instructor through an example hardwood stand simulation and provide values for the instructor to input into eYield. Some of the inputs for eYield, such as stand age, basal area, site index, timber values, and high and low diameter at breast height measurements for sawlog products and pulpwood, may have been outliers that would have been outliers provide non-normal or uncertain model outputs. This comment, although valued, is not necessarily representative of eYield’s outputs as a whole. The investigators would like to state that eYield, like

most programs, is a combination of multivariate equations and is only as good as the input values.

Another participant stated, in part, “The program has better application for large ownerships, with long ownership tenure, on public or industrial land, with even-aged and more homogeneous stands, and with pine. The average tenure of ownership is 11 years, so the application is questionable.” This response is valuable as it points to a broader question within the eYield project, “Who is this program for?” Although the stated answer from the eYield website is that the program is created for small to medium-sized landowners and land management professionals, this question asks, with the timeline of ownership, is eYield useful to small and medium-sized landowners. The investigators believe that the answer to this question is yes. Even with the average age of ownership, at some point, the land is likely to be harvested, and when that does occur, eYield could still be a useful tool in the planning and tax preparation phase.

Near the end of the post-workshop survey, respondents were asked the question, “With this tool freely available, would you use it in the future for growth and yield estimation in the future?” If a respondent chose “No” as their answer, they were further prompted to answer the question, “What features or changes would you like to see implemented before you would be willing to use eYield in the future as a growth and yield estimator?” In response to this question, one of the participants offered, “It seems the program is likely more accurate with weight volume estimates than with board feet. The simulated example used a partial harvest yet indicated 82 hardwood trees per acre. Harvesting 82

hardwood trees per acre, in most stands, would be virtually a clearcut. Most partial harvests with hardwoods will be removing 15-20 trees per acre. Given the very large size of the decurrent shaped hardwood crowns, even 20 trees per acre would be heavy in a partial cut. It just seems that pine silviculture reasoning was attempted to be used with hardwood stands." This critique likely stems from the initial workshop simulation example in which an upland oak-hickory simulation of a 25-year-old stand with a basal area of 130 sq. ft. and a site index at 50 years of 85 for upland hardwoods was to be reduced to a basal area of 90 sq. ft. at a stand age of 30 with a final cut at stand age 60. Although the investigators were unable to replicate the 82 trees per acre value that the comment referenced, the feedback, nonetheless, is valuable information as it demonstrates a sentiment from this particular user that eYield is not clear enough in its differentiation between hardwood and softwood growth models. Respondent misconceptions are easily construed as negative reactions leading users to the conclusion that may not necessarily be the case, in this example, softwood plantation growth and yield estimation techniques are used for hardwood growth and yield simulations.

Another respondent suggested that more popups should be added to the eYield system that would further guide users through their experience. They wrote, "add explanations /information option above each field, for example harvest type: partial - low?, even? high? not sure what these terms mean, operational definitions will avail." For this instance, although this information might have been available to the user by hovering over the information bubbles that were explained to users within the workshop, their point is rather that eYield

needs to be clear about the information it needs and should make it clear to users how the options and features of eYield could change the outcomes.

Personal Interviews

If participants indicated that they would further participate in our study, they were asked to participate in an interview. Participants were asked open-ended questions within these interviews that would allow them more time and space to answer questions. The interviews focused on user's thoughts and perceptions of the models, the workshops, and future developments for eYield. The full transcribed interviews are available in the Appendix.

Interviewees indicated that they thought they believe they would have gotten more out of the workshops had they been in person. They also sounded empathetic to the restrictions that were put in place due to the ongoing Coronavirus pandemic and seemed to understand the position that the investigation team was put in. An interviewee indicated that a possible way to better the workshops would be to have participants bring in data to run in eYield. They would be familiar with the data they are inputting into eYield instead of a sample set of data provided by the instructor. They also note that this might be difficult without first understanding eYield and the variables that the simulations require to run in the first place. This may be an opportunity to explore an expansion of the eYield training into basic and advanced eYield training, possibly paired with field training.

A consensus among the interviewees was the appeal of the simple interface and the minimal amount of information that eYield requires. They indicated that the UI seemed intuitive and relatively accessible for new users. They also stated that they appreciate the balance that eYield has struck between the necessary data and inputs to run the chosen models while also not requiring extraneous or cumbersome data. This should be kept in mind if eYield decides to use different models in the future. It would be best to keep in mind that users value the simplicity of the inputs, as is. If other models are considered, they should use similarly simple, accessible, and commonly used metrics to maintain that balance. Interviewees indicated that they understand and appreciate the simplicity of eYield. When asked to rate eYield on a scale of 1-10 for ease of use and knowledge required to operate, they indicated that eYield is a 3 or 4, with 1 being minimal experience in land ownership 10 being an expert on the topic.

Participants were asked for their opinions on the question, “If I was a brand new user, I wouldn’t like X.” The intent of this question was to gauge user's satisfaction with eYield and to understand which portions, if any, they would change to allow the system to work for them in their workflows. Participant 2 offered, “I remember there being some sort of steps when you’re setting your site parameters that required a particular order… I thought that might have been a little tricky to a user who has not attended one of the workshops.” This feedback is pertinent to eYield’s design and UI/UX. It would be pertinent to the eYield designers that they create a system in which new users find the system inviting

and logical with minimal ability for users to become lost or frustrated with the system.

Within the interviews, participants were given the question, “Would you like to see further integration with applications like ArcGIS or Web Soil Survey?” The interviewees seemed to have a positive outlook on such expansions by indicating that they would be inclined to further expansions and that “If you guys can find a way to integrate geospatial data into that… that would be great!” This points to a conclusion that eYield as a stand-alone tool seems useful, but further integration should be a route the eYield team may consider in the future.

As described in the Participation section of this document, the investigators struggled with participant attrition throughout the length of the project. The loss of nearly one-third of participants from pre- to post-workshop surveys was disheartening and unexpected to the investigators. The lukewarm response and struggles with attendance for the personal interviews were disappointing. However, the investigation team stands by their survey design, with autonomy being a key factor, as they believe it provided the most genuine answers.

CHAPTER FIVE
CONCLUSIONS AND RECOMMENDATIONS

Conclusion

Although no hard conclusion may be drawn, due to the small sample size, the results of the anecdotal evidence of user responses and interviews would indicate that participants were open to hearing about eYield and seem eager to try new tools that might advance their work at large. Most of the participants indicate that they would indeed use the eYield system again and that in their opinions, the results seem reasonably well suited to the real world, although this has yet to be proven empirically. The continued success of the eYield platform lies in the proselytizing of eYield to all who could benefit from it, including landowners, forestry professionals, and students. The combination of biological and financial simulations that eYield can perform could lead to a successful future for the program, and this document should encourage its development further paired with outreach.

Recommendations for the Continued Improvement of eYield

With more participants, workshops, and therefore survey takers, more information might lead to greater trends in the data. To achieve this goal, two routes are available. The first would be to create a new tab of the website to

introduce users to the eYield platform. The tab would merge components from the FAQ and the glossary into a video format. The video would be a succinct recording of the workshops already presented and additional information based on the FAQ, glossary, and responses from workshop participants. During the video, the user would be presented with the option to participate in a pre- and post-workshop survey, similar to the ones found in the Appendix. The users would not be forced to participate in these surveys to view the embedded video. This solution would provide ongoing data and feedback to the development team to provide their users with the most fitting simulations for their continued workflows.

In addition, a guided experience of eYield may be useful to some with a recommended example, or a walkthrough of the eYield system may alleviate some of the confusion that some participants reported after the workshop. This system could walk a user through each of the simulations and the various options contained in each. This would differentiate itself from a video guide in two distinct ways. First, the tactile nature of a walkthrough may aid in the users being more comfortable with the system as they would have already completed the simulation once instead of only seeing someone else finish it. Second, a video guide would need to be edited and published each time a new feature is added or changed, causing an additional burden. Although a walkthrough would need added textboxes or possible animation changes, these should be within a reasonable purview of the eYield team.

Another recommendation is that eYield implement a simple email signup for a newsletter allowing the ongoing development of eYield to be relayed to the end-users in cases of updates to current simulations and the addition of new simulations and scenarios. The eYield platform is already equipped to handle first name, last name, and email, as seen in the Contact tab of the eYield website.

Participants, at times, found the directions unclear in eYield. Although the lack of clarity was noted in the post-workshop survey, with 32% of participants finding the directions to be vague at some point, where the unclear areas lie is uncertain. Within one personal interview, participant 2 noted that inputting of certain parameters might have been unclear, although it is difficult to know with certainty which parameters they were individually speaking about. This is only the statement of one individual, however. Without a further understanding of which portions of the system are unclear to users, it is difficult with certainty to suggest changes. Additional efforts should be committed to understanding which portions of eYield are unclear or pose difficulty to the end-user. A further usability study is suggested in order to understand what may pose a problem and to address these errors.

Although 74% of the post-workshop survey participants indicated that they thought the model results were similar to what they could expect in the real world, this has yet to be proven empirically. An additional study into the accuracy of the eYield models and the publication of those results within the site, and a margin of error on the reports would be a sensible due diligence measure.

Within the interviews, participants seemed enticed by the assertion that geographical information may be integrated into the system. With the ever-increasing knowledge and depth of geographical information freely available, a logical conclusion is that eYield should consider its integration as well. Possible outlets may include the USGS Web Soil Survey, QGIS, or ESRI product integration with field integration such that a user could use the location of their choosing or from their device, resulting in a host of soil and atmospheric information that could be used to enhance the models, reduce error, or lead to the integration of newer models that consider these variables.

To aid in the continued user acquisition of eYield, the eYield team should continue to reach out to area foresters in the intended use markets with a particular focus on the higher organizational levels of administration. EYield adoption from the top of the organization down would be an efficient rollout as it would likely be able to cut through some possible bureaucracy that could be present with the acquisition of new tools.

A white paper should be written to provide a brief history of eYield's past and an easily digestible explanation of each simulation, its intended use cases, the limitations of the simulation, and the equations that make up those simulations. This may go toward building goodwill with the user base and providing further documentation to eYield's use in the academic field.

Finally, for the continued growth of eYield, a targeted multi-prong approach to user acquisition is suggested. This may include further workshops, monthly update emails, and conference attendances in order to proselytize about

eYield, the simulations, and their use within the industry as a whole. A combination of outreach mediums and obtaining key industry professionals as eYield users will further eYield's immediate future. EYield may consider an alternative route targeting collegiate-aged forestry professionals within their coursework for long-term success and adoption. This would familiarize them with the eYield platform before encountering the broader industry and may present eYield with a prosperous future. Further, eYield efforts should also be allocated to additional landowner outreach and landowner user acquisition.

Objectives Revisited

The objectives stated objectives of this thesis were to first, disseminate information about eYield to small and medium landowners as well as forestry professionals. As stated in the survey section, nearly all of the respondents indicated that they consider themselves forestry professionals. Although workshop participants did indeed provide pertinent information, there still lies the opportunity to reach out to landowners and inform them of eYields existence and abilities. This could prove to be a fruitful avenue for user acquisition, although much of the long-term success of eYield still lies with forestry professionals.

Additionally, the eYield project set out to provide guidance on a suite of objectives, including which information users found valuable, how people perceive models on the computer, and if the models will further the

understanding and engagement of forest owners in the management of their land. To understand which financial and biological information users found the most valuable, look towards the PCI data from the Surveys section. Unfortunately, we were unable to draw a firm conclusion as to which simulations users found the most valuable. With further survey responses, more trends in this data may become clear.

To answer, "how do people view and process information with digital technology and models that are delivered via the web for the management of land," one might consider the responses from the surveys indicating that most participants would prefer their information presented to them digitally. Also, considering almost all users had greater than six years of experience utilizing computer resources to manage land, one may conclude that those surveyed found no difficulty with information being delivered to them digitally. It is also worth considering that with the ubiquitous nature of technology and its introduction at a younger and younger age, future foresters would have similarly minimal trouble viewing and processing data presented to them digitally.

Another objective was to understand how participants interact with a model designed to assist with financial and biological projections of proposed forest management options and outcomes. To this end,surveys were utilized in which participants were asked about their experience with eYield, if they ever found the directions unclear, and if they thought the outcomes represented the real world. The conclusion was that most of those surveyed thought their experience with the eYield workshop was on par with those they had experienced

before. Additionally, a majority of those surveyed found the eYield directions to be clear but could be improved upon. Finally, most agreed that the outcomes presented by eYield were in line with what they would expect to find in the real world.

Finally, the investigators attempted to answer, “will the model further enhance the understanding and engagement of forest owners in the management of their land.” With the lack of landowners involved in our workshops, it would be difficult to speculate on the outcome of this question. However, if landowners were similar to forestry professionals who answered that 81% of them would use eYield in the future, it would be reasonable to assume that at least some landowners would find value in eYield’s simulations and might increase their understanding and engagement on their land. This is in combination with the anecdotal opinions of the two interviewees who stated that the knowledge barrier to use eYield is relatively low.

From the results of this project and accompanying surveys, eYield has a bright future if the user base continues to grow and a significant focus is placed around user acquisition and feature development to suit the target audience.

CHAPTER SIX CHALLENGES AND ERRORS

Alterations Due to Coronavirus

The Coronavirus pandemic caused numerous issues with the completion of the project. The surveys were conducted online instead of in-person, and the workshops were similarly transitioned into online video conference calls. This greatly affected the project as more information and Covid guidelines were ever-evolving. Some of the changes and their ultimate effects are listed in this section including, changes to the workshops, changes to the survey, and changes to the originally planned focus groups.

Workshop Alterations

Workshops were significantly altered based on the Centers for Disease Control and Prevention (CDC) recommendations. Originally, the project plan was to organize educational hands-on workshops in Tennessee along with additional locations in Kentucky and Georgia. During these workshops lunches would be provided and instruction and examples would be given to lead participants through the eYield website and answer questions about its use. With the Coronavirus, that was no longer possible without large-scale venue changes to adequately social distance participants. Because of this, the project was transitioned to a digital workshop hosted on Zoom®.

There may have been certain participant attrition with the alteration, and some bias may be intrinsic based on those who were familiar with technology and

were comfortable attending a meeting in an online setting. However, there may have also been larger attendance due to attending the session from anywhere in the nation and avoiding unnecessary work absences due to driving to and from the workshop. Based on the participants' responses outlined in the interview and comments section of this document and the conditions presented from the pandemic, the correct course of action was taken under these extraordinary circumsances.

Survey and Focus Group Alterations and Possible Ramifications

Anonymity was prioritized within the survey responses in order to comply with best practices from IRB. This provided survey takers with the ability to answer questions without the social pressures from the investigators knowing their names. Additionally, because of the online nature of the workshops and surveys, participants were free to opt-in or out of the survey without the knowledge of others around them. This would not have been possible if we provided paper surveys during an in-person workshop. Although this procedure likely lead to more participants opting-out of taking the survey, the answers were likely of higher quality. Additionally, due to the anonymity of the survey participants in both the pre- and post-workshop surveys, it is impossible to follow a single participant through both surveys. Further, this anonymity limited the ability to follow up with participants after the workshops. Unless a participant opted in to participate further, they were not contacted further. This was a conscious decision made by the investigation team when creating the surveys.

Although a greater sample size of participants opting in to be contacted further, was preferred, the individual's right to privacy and anonymity outweighed the possible information that might have been gleaned from them.

Errors

Errors in Survey Language

Surveys for the workshops were prepared within QuestionPro® online survey creation software. When the surveys were being designed, there was discussion among the stakeholders about the language to be used in the Likert-scale questions. Inadvertently the pre-workshop survey was created without a negative response. Even with stakeholder reviews beforehand, this error was not caught, as illustrated within the pre-workshop survey entry in the Appendix. Unfortunately, this survey was used for all of the pre-workshop responses. This oversight resulted in the lack of a baseline for comparison with post-workshop responses. Survey designers should be cautioned that even with the best intent, surveys should be reviewed thoroughly to keep them as error-free as possible.

Interview Alterations

Within the post-workshop survey, survey participants were given the ability to choose if they would like to further participate in ongoing project. If participants chose to further participate, they were directed to a separate QuesionPro® survey named Contact Information Survey. A copy of this survey is

referenced in the Appendix as well. Within the Contact Information Survey, participants were asked to provide their name and an email address. The separate survey was thereby decoupled from the original survey to protect the anonymity of the answers provided.

A lukewarm response was recieved from users who would like to participate in our study further. Of the 19 participants who answered at least one question on the post-workshop survey, five answered that they would like to participate further and provided their names and email addresses. The group of individuals were asked to complete an online poll through the service Doodle®. to schedule a Zoom® meeting time that would work for all of the participants. When that day and date were designated, a follow-up email was sent to the group of participants with a date, time, and a hyperlink to access the meeting. The day before the meeting, a second email was sent to participants to remind them of the date and time.

On the day of the meeting, one of the five participants attended the meeting. Although disappointing that only one individual participated, the prepared follow-up questions were answered via Zoom. Following this meeting, a date was re-scheduled with the other four individuals who indicicated that they would participate with a follow-up session. Only one of those four participants attended and answered the same prepared questions. The transcripts for both of these interviews are in the Appendix. Although a group dynamic of a focus group was preferred, the personal interviews provided sufficient qualitative data for the project to continue forward under the circumstances encountered.

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APPENDIX

Presented Tables and Figures

Table 4.1. Tabular Post-Workshop Responses.

This table shows the tabular post-workshop survey responses of each respondent on a Likert-scale. The number 2 representing the response as very useful, 0 being indifferent, and -2 being very useless

Cashflow by transaction	Cashflow by year	Financial profitability	Market Conversion	Growth and Harvest	Woodflow Summary
2	2	2	2	2	2
2	2	2	2	2	2
1	2	2	1	2	2
1	1	2	1	2	2
1	1	1	1	2	2
1	1	1	1	2	1
1	1	1	1	1	1
1	1	1	0	1	1
0	0	0	0	1	1
0	0	0	0	1	1
0	0	-1	0	1	1
-1	0	-1	0	0	0
-1	-1	-1	-1	-1	-1
-1	-1	-2	-1	-2	-1
-1	-1	-2	-1	-2	-2
-2	-1	-2	-1	-2	-2
-2	-2	-2	-2	-2	-2
-2	-2	-2	-2	-2	-2

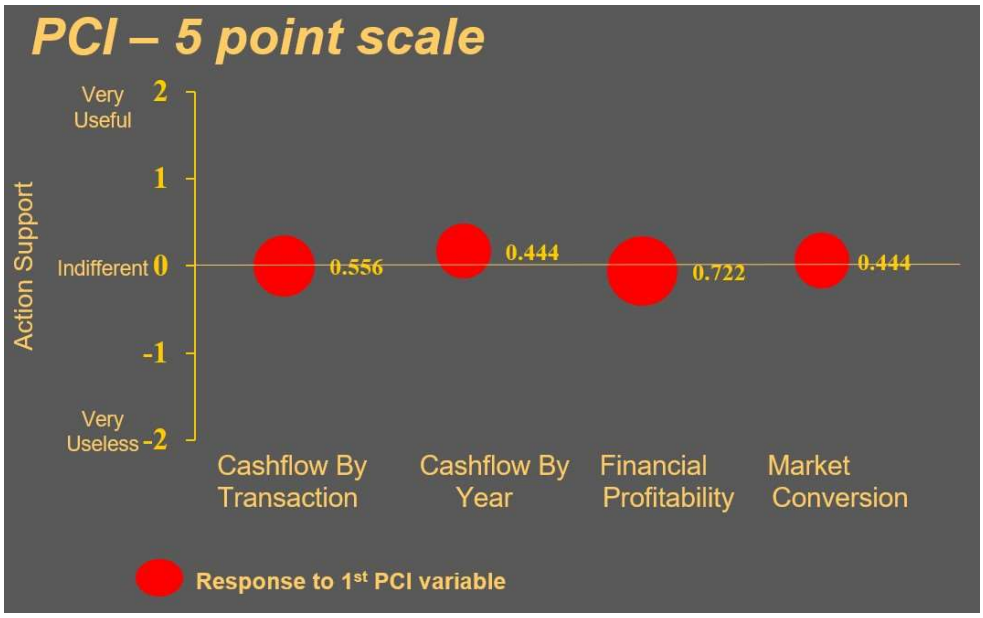


Figure 4.1.1 Post-Workshop Potential for Conflict Index.

Graphical representation of the post-workshop survey participants PCI for the financially focused simulation reports.

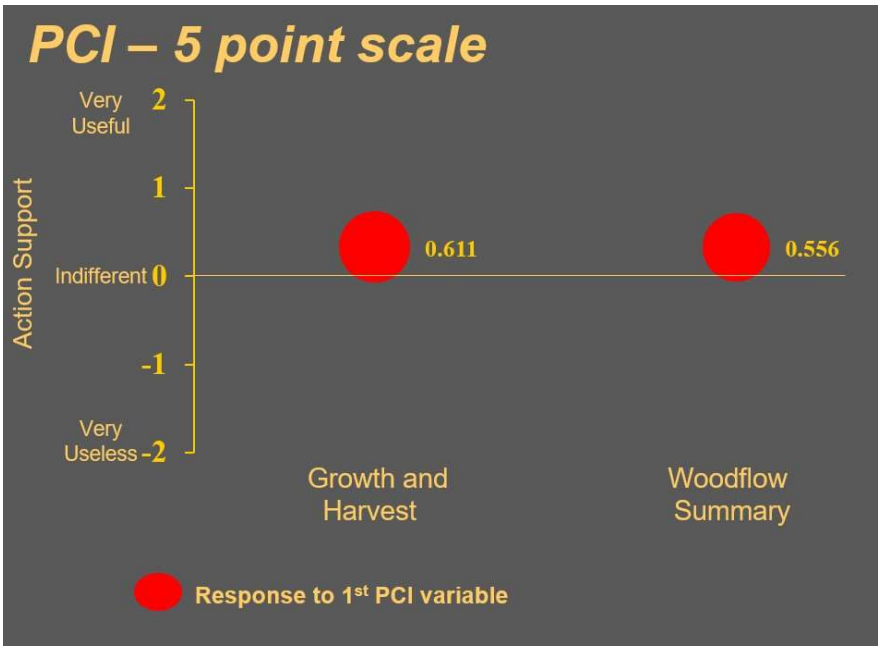


Figure 4.1.2 Post-Workshop Potential for Conflict Index.

Graphical representation of the post-workshop survey participants PCI for the biologically focused simulation reports.

Pre-Workshop Survey

You have been given the link to this survey as a result of your participation in The University of Tennessee's eYield workshop. This project is in tandem with The University of Georgia in order to build a tool to assist small-to-medium-sized landowners to better understand their forests. This survey is the device we are using to gain valuable user feedback about the tool itself, how users feel about the tool, and how users may use the tool. This survey is completely anonymous and poses no risk to you as a survey taker. The survey is short and will likely take less than 5 minutes to answer all of the questions. If you could assist us in answering a few short questions, we would truly appreciate it. While there is no direct benefit to you from participating in this study, your answers will assist us in providing the best tools that we can to small-and-medium-sized landowners as well as forestry professionals. If you have any questions about this study, please feel free to contact Tim Kane at tkane3@utk.edu.

Question 1: Completing this survey constitutes consent to participate in this completely anonymous survey. Do you agree to participate in this survey?

1. Yes
2. No

Question 2: Provided is a short description of each of the reports in eYield. Please

use these short descriptions to inform your choices below.

Cashflow by transaction - Type, amount, and taxes associated with each income (revenue) and expense transaction.

Cashflow by year - Aggregate before-and-after-tax revenues and expenses.

Financial profitability - Measures of the financial plan including cost-benefit, net worth, and rate of return.

Market conversion - Product dimensions and applicable prices at the time of harvest including stand harvest statistics, wood volumes and weights, and product prices.

Bark Beetle - Hazard rating report for southern pine beetle.

Growth and harvest - Pre- and post-harvest stand statistics.

Woodflow summary - Standing and harvested stand statistics and marketable wood volumes.

Of the terms listed above, please select all of the terms you were familiar with before this survey.

1. Cashflow by transaction
2. Cashflow by year
3. Financial profitability
4. Market conversion
5. Bark Beetle
6. Growth and harvest
7. Woodflow Summary

Question 3: To what extent do you find these items useful?

	Very useful	Slightly useful	Indifferent	Slightly useful	Very useful
Cashflow by transaction	❑	❑	❑	❑	❑
Cashflow by year	❑	❑	❑	❑	❑
Financial profitability	❑	❑	❑	❑	❑
Market Conversion	❑	❑	❑	❑	❑

Question 4: To what extent do you find these items useful?

	Very useful	Slightly useful	Indifferent	Slightly useful	Very useful
Bark Beetle	❑	❑	❑	❑	❑
Growth and Harvest	❑	❑	❑	❑	❑
Woodflow Summary	❑	❑	❑	❑	❑

Question 5: How many years have you used computer and internet resources to assist in land management?

1. None
2. less than 1 year
3. 2 -3 years
4. 3 - 5 years
5. 6 or more years

Question 6: Given the option, would you rather have information presented to you digitally on a computer, or on paper?

1. Computers
2. Paper

Question 7: Have you ever completed remote learning or computerized trainings before?

1. Yes
2. No

Question 7a: Based on your previous experiences with online learning, please rank your previous experiences out of 5 stars. 1 star being the worst way to learn, 5 stars being the best way to learn

	1	2	3	4	5
Online learning	❑	❑	❑	❑	❑

Question 8: Do you consider yourself a forestry or land management professional?

1. Yes
2. No

Post-Workshop Survey

You have been given the link to this survey as a result of your participation in The University of Tennessee's eYield online workshop. This project is in tandem with The University of Georgia in order to build a tool to assist small-to-medium-sized landowners to better understand their forests. This survey is the device we are using to gain valuable user feedback about the tool itself, how users feel about the tool, and how users may use the tool. This survey, unlike the previous survey, will ask you at the end to participate further in our study. This may include the use of focus groups and an additional survey in about 2 months. If you chose to participate further, we will contact you through an email address you provide to us. Your survey will remain completely anonymous and we appreciate your participation. This study poses no risk to you as a survey taker. The survey is short and will likely take less than 5 minutes to answer all of the questions. If you could assist us in answering a few short questions, we would truly appreciate it. While there is no direct benefit to you from participating in this study, your answers will assist us in providing the best tools that we can to small-and-medium-sized landowners as well as forestry professionals. If you have any questions about this study, please feel free to contact Tim Kane at

tkane3@utk.edu.

Question 1: Completing this survey constitutes consent to participate in this completely anonymous survey. Do you agree to participate in this survey?

1. Yes
2. No

Provided is a short description of each of the reports in eYield. Please use these short descriptions to inform your choices below.

Cashflow by transaction - Type, amount, and taxes associated with each income (revenue) and expense transaction.

Cashflow by year - Aggregate before-and-after-tax revenues and expenses.

Financial profitability - Measures of the financial plan including cost-benefit, net worth, and rate of return.

Market conversion - Product dimensions and applicable prices at the time of harvest including stand harvest statistics, wood volumes and weights, and product prices.

Bark Beetle - Hazard rating report for southern pine beetle.

Growth and harvest - Pre- and post-harvest stand statistics.

Woodflow summary - Standing and harvested stand statistics and marketable wood volumes.

Question 2: Of the terms listed above, please select all of the terms you are

currently familiar with following the eYield workshop.

1. Cashflow by transaction
2. Cashflow by year
3. Financial profitability
4. Market conversion
5. Bark Beetle
6. Growth and harvest
7. Woodflow Summary

Question 3: To what extent do you find these items useful?

	Very useless	Slightly useless	Indifferent	Slightly useful	Very useful
Cashflow by transaction	❑	❑	❑	❑	❑
Cashflow by year	❑	❑	❑	❑	❑
Financial profitability	❑	❑	❑	❑	❑
Market Conversion	❑	❑	❑	❑	❑

Question 4: To what extent do you find these items useful?

	Very useless	Slightly useless	Indifferent	Slightly useful	Very useful
Bark Beetle	❑	❑	❑	❑	❑
Growth and Harvest	❑	❑	❑	❑	❑
Woodflow Summary	❑	❑	❑	❑	❑

Question 5: How many years have you used computer and internet resources to assist in land management?

1. None
2. less than 1 year
3. 2 -3 years
4. 3 - 5 years
5. 6 or more years

Question 6: Given the option, would you rather have information presented to you digitally on a computer, or on paper?

1. Computers
2. Paper

Question 7: Have you ever completed remote learning or computerized trainings before?

1. Yes
2. No

Question 7a: Compared to other online learning programs that you have participated in previously, how would rate the quality of the online learning workshop today?

	Far Worse	Somewhat Worse	About the Same	Somewhat Better	Far Better
I thought it was…	❑	❑	❑	❑	❑

Question 8: Do you consider yourself a forestry or land management professional?

1. Yes
2. No

Question 9: While using the eYield website interface, did you ever find the directions unclear?

1. Yes
2. No

Question 10: In your opinion, do the model results seem similar to what you would expect in the real world?

1. Yes
2. No

Question 10a: What portions of the reports did not line up with your expectations?



Question 11: With this tool freely available, would you use it in the future for growth and yield estimation?

1. Yes
2. No

Question 11a: What features or changes would you like to see implemented before

you would be willing to use eYield in the future as a growth and yield estimator?

Question 12: Would you like to further participate in our eYield study?

By answering Yes your survey will remain completely anonymous and you are agreeing to give the investigators your name and email address for further contact and study participation

By answering No your survey will remain completely anonymous and you will not be asked to participate in the study any further.

1. Yes
2. No

Question 12a: The space below is provided for you to express any further thoughts or opinions you have about eYield, or the workshop. If you have no comments, please click the Next button to end the survey.

Question 12b: Please click on this link to fill in your contact information.

https://utk.questionpro.com/*Link removed*

Contact Information Survey

First Name

Last Name

Email Address

Unedited Participant Text Responses

Question 10a: What portions of the reports did not line up with your expectations?

Participant 1: Thought the expected revenue seemed pretty high, could be user error with guessing at inputs.

Participant 2: The inability to put market prices in by species greatly limits the financial forecasting for mixed stands.

Participant 3: The program has better application for large ownerships, with long ownership tenure, on public or industrial land, with even-aged and more homogeneous stands, and with pine. The average tenure of ownership is 11 years so the application is questionable. How does depletion allowance of the timber tax basis calculate into the taxes and profitability

Question 11a: What features or changes would you like to see implemented before you would be willing to use eYield in the future as a growth and yield estimator?

Participant 1: Seems like a great tool. It is a little slow and was hard to get it to go to the pricing tab. I could not get it to pull up.

Participant 2: It seems the program is likely more accurate with weight volume estimates than with board feet. The simulated example used a partial harvest yet indicated 82 hardwood trees per acre. Harvesting 82 hardwood trees per acre, in most stands, would be virtually a clearcut. Most partial harvests with hardwoods will be removing 15-20 trees per acre. Given the very large size of the decurrent shaped hardwood crowns, even 20 trees per acre would be heavy in a partial cut. It just seems that pine silviculture reasoning was attempted to be used with hardwood stands.

Question 12a: The space below is provided for you to express any further thoughts or opinions you have about eYield, or the workshop. If you have no comments, please click the Next button to end the survey.

Participant 1: Tennessee Division of Forestry Area Foresters are not allowed to provide volume or value estimates to landowners, due to liability concerns and because these items are considered to be the domain of consulting foresters, and TDF does not want to complete with private industry. With that in mind, while this model is useful for 99.9% of the forestry industry, it may not be useful to TDF Area Foresters since we can't provide the results to landowners

Participant 2: Thanks for letting us know it's out there.

Participant 3: Suggestions: add explanations /information option above each field, for example harvest type: partial - low?, even? high? not sure what these terms mean, operational definitions will avail. percent interest?: a pulldown for a region with historical averages, or links to data, data would be helpful. How can eyield be applied to encourage TSI on younger stands? I'd like to be able to show forest landowners the potential economic benefit of TSI, for example the benefits of a crop tree release in a stand that is pre-commercial, for example, small pole size...the best time for crop tree release.

Participant 4: The moderator did a very fine job. The training had good flow and the program is easy enough to understand. Hardwood yield models have never interested me. There are far too many variables with hardwoods to produce

reliable results, including: many species, all growing at different rates, with wildly different ($) values depending on species/form/grade, with site indices that change multiple times as the aspect and slope vary. Early commercial thinning rarely occurs due to poor hardwood pulpwood markets and difficulty in thinning hardwood stands on rough terrain. Finally, true 'oak-hickory' stands rarely exist. Most hardwood stands, except on very poor sites, have 6-10 primary species, each with near equal representation. The model is interesting, but I would not feel comfortable summarizing the projected results with most small landowners. It is likely a better fit with pine.

Interview Transcript One

Interviewer: Thank you for being with us today. What we are trying to do today is to dive into the eYield program and the user values that surround it. In this time we are going to ask you questions and give you a longer, more appropriate format for you to voice your opinions on it.

A brief overview of what we're going to talk about today is we are trying to dive into your experience with eYield and what you think about it, how you perceive the program and if you would use it.

The first question is, have you used eYield since the workshops at all?

Participant 1: I have not.

Interviewer: Is there any reason for that?

Participant 1: The biggest reason is that I haven't had an opportunity to go out and do a whole lot of it because I was on fire duty out west.

Interviewer: So you haven't had any use cases for it?

Participant 1: That's right.

Interviewer: What were your overall thoughts on the workshop itself? How it was delivered.

Participant 1: I think it was informative and it could be a really essential tool. It's just a matter of putting it into production and trying it out.

Interviewer: Did you have any thoughts on the Zoom portion of the workshop? Would you have preferred that it would have been face-to-face? Would you have gotten more out of it if it were face-to-face?

Participant 1: Definitely. I'm a face-to-face learner. I focus more when I'm talking to someone face-to-face and they're actually there.

Interviewer: That's just fine. Do you think there could have been something done differently within the zoom workshop that could have given you a better experience?

Participant 1: A little more hands-on interaction. I guess that's a lot of the difference between online and face-to-face is that you can do hands-on. I know we had an opportunity to play with it, but a lot of the time when you're playing with something you don't know if you're doing it right or messing it up especially with an online group it's harder to say, "Hey how do you do this?"

Interviewer: Do you think if we gave each user more time to voice their separate opinion that, that would have improved things for you?

Participant 1: I would make sure that everyone has eYield loaded on their computer and make sure they can do it. Give them a test scenario and see if they can run that scenario. I know you did that to some degree. I don't know that everyone was doing it.

Interviewer: If you were in charge of the workshops, was there one thing that you would have changed about it?

Participant 1: Not that I can remember. It seemed like it flowed pretty well.

Interviewer: Within eYield there are a bunch of simulation reports. Those are the reports that come out at the end of eYield. Those reports are; Cashflow by Transaction, Cashflow by Year, Financial Profitability, Market Conversion, Bark Beetle, Growth and Harvest, and woodflow summary. Are there any of these that you find necessary or unnecessary?

Participant 1: On the advising side I would use the growth and harvest a lot more to show somebody, “Hey this is what you have got, this is what it could potentially be… in 30-years.”

Interviewer: Are there any of them that you find unnecessary? That you would have no use for?

Participant 1: I don’t really understand the Bark Beetle one. I don’t know how essential that would be.

Interviewer: Within the eYield website, the navigation of the website is usually large buttons that you can tactilely press that indicate something, additionally, it is divided into colors. All of these inputs and interactions come together to build the user interface or UI. Are there any parts of the website design that you found cumbersome or that you did not particularly enjoy, or that you would change?

Participant 1: I haven't played with it enough to find any quirks in it. But of what I've used of it, I thought it was pretty self-explanatory as far as the workflow of it.

Interviewer: Was there any point in using eYield where you felt you didn't like 'this thing' whether that was the selection of menus or dropdowns or anything like that? Where you felt, "If I as a brand new user I wouldn't like X."

Participant 1: Not that I recall.

Interviewer: The User Experience is how you as the user interpret all of the design that is put into the website. Are there points in the website that you like?

Participant 1: I like that is used simple inputs and you could see it without having to go through a whole lot of calculations. You can get almost instantaneous results, that may not be 100% accurate. But, it doesn't have to be 100% accurate, this is just an estimate. So, I like the ease of use of it.

- The interviewer's internet connection was briefly terminated for approximately 3 minutes. The participant continued to talk to Dr. Clatterbuck who was sitting in on the interview until the connection was re-established. The following is a summary of the question asked in that intermission.

Interviewer: Would there be other cover types or scenarios that would be beneficial to add to eYield?

Participant 1: Early successional from a changing land use possibly old-field succession and a mixed pine-hardwood scenario

Interviewer: On a scale of 1-10 with 1 being very easy, someone with minimal experience in land ownership and 10 being an expert in the topic, where do you think that the questions that are asked in eYield lie? Essentially, how much experience do you need to operate the website?

Participant 1: Other than the identification of trees and tree species, that would probably be the biggest thing that you need to know. I would probably give it a 4. It's pretty simple once you know your trees it's pretty easy.

Interviewer: Was there any point with the use of Zoom or eYield that has left a bad taste in your mouth or that you didn't like or that you wished were different if you were running the meetings?

Participant 1: I would love to just enter a tiny bit of information and get exact numbers. That would be great. If you figure that out, you just let me know. (This statement was presented as a joke.)

Interviewer: If you had to redesign the website, is there anything that you would change about it?

Participant 1: Being able to do multiple types of sites would increase the usability of it.

Interviewer: Are there any other comments that you would like to share with us?

Participant 1: No. I'm looking forward to trying it out and working with landowners to do stuff. With what I do, it doesn't have to be exact. I just need a ballpark and this, will give me that.

Interviewer: At any point did any of the results not line up with your expectations of what maybe they should have been?

Participant 1: No, they all seemed pretty accurate. I might add in the different regions, soiltypes, but that adds complexity. For simple use, I think it works great.

Interviewer: Would you like to see more integration with further applications like integration with ArcGIS or Web Soil Survey? Where it is less based on the number you input and more based on the geography of where it is placed.

Participant 1: I'm about ArcProed out. The state is switching over to ArcPro. If it were ArcMap, I would say possibly. But I think it's good as a stand-alone. But it could be integrated.

Interview Transcript Two

Interviewer: Thank you for being with us today. What we are trying to do today is to dive into the eYield program and the user values that surround it. In this time we are going to ask you questions and give you a longer, more appropriate format for you to voice your opinions on it.

A brief overview of what we're going to talk about today is we are trying to dive into your experience with eYield and what you think about it, how you perceive the program and if you would use it.

The first question is, have you used eYield since the workshops at all?

Participant 2: Not since the workshop.

Interviewer: Okay, is there any particular reason for that?

Participant 2: Workload right now. I've got a considerable amount of work on my plate.

Interviewer: Okay, do you have any use cases for a program like eYield?

Participant 2: Certainly. It would be like, our land owner assistance foresters or state forest foresters using that to better inform their forest management recommendations or compartment plans as it pertains to the state forest system

Interviewer: Alright, what were your overall thoughts on the workshop itself and how it was delivered?

Participant 2: I thought the workshop went really well, I thought you provided everybody with some good test data parameters and some good walkthroughs and what results they should expect to see and how to interpret those results. I think it was a good workshop.

Interviewer: Did you have any thoughts on the Zoom portion of the workshop? Would you have preferred it to be face to face, or would you have gotten more out of it had it been face to face?

Participant 2: Well, I think with all meetings people get more out of it face-to-face. There's more opportunities for one-on-one discussions and the like. But in today's world, Zoom is the best thing we got going.

Interviewer: Do you think there could have been something that was done differently in the Zoom workshops that would have given you a better experience or maybe an experience closer to what you would have gotten in a face-to-face environment.

Participant 2: Not that I know how to do. No recommendations there.

Interviewer: If you were in charge of the workshops, was there one thing that you would have changed about it? That you would say, “Hey, next time, he’s what I would have done instead.”

Participant 2: Tough to say, I don’t know how much participation you would get if you asked folks to come prepared with their own data sets to upload in there. But without having at least the first iteration of the workshop, to familiarize them with eYield, I don’t think that would have been doable. So, I’m going to say no, at least on the initial workshop, that’s the way it should have been done is how you did it.

Interviewer: Within eYield there are a bunch of simulation reports. Those are the reports that come out at the end of eYield. Those reports are; Cashflow by Transaction, Cashflow by Year, Financial Profitability, Market Conversion, Bark Beetle, Growth and Harvest, and Woodflow summary. Are there any of these that you find necessary or unnecessary?

Participant 2: To my knowledge, the bark beetle thing wasn't fully developed yet. Seems like it's coming out of left field there in regards to the other reporting functions. But otherwise, I think all of those reports are useful.

Interviewer: Within the eYield website, the navigation of the website is usually large buttons that you can tactilely press that indicate something, additionally, it is divided into colors. All of these inputs and interactions come together to build the user interface or UI. Are there any parts of the website design that you found cumbersome or that you did not particularly enjoy, or that you would change?

Participant 2: No, I think it was all pretty intuitive.

Interviewer: Was there any point in using eYield where you felt you didn't like 'this thing' whether that was the selection of menus or dropdowns or anything like that? Where you felt, "If I as a brand new user I wouldn't like X."

Participant 2: I'm trying to recall my pervious use during the webinar, I remember there being some sort of steps when you're setting your site parameters that required a particular order to how you did that, if I'm remembering correctly, I may be misremembering that. I thought that might have been a little tricky to a user who had not attended one of the workshops.

Interviewer: The User Experience is how you as the user interpret all of the design that is put into the website. Are there points in the website that you like?

Participant 2: I liked the simple interface. Seemed to be able to easily focus your attention to what your desired outputs were and where to put in your data. I though that was all very straight forward. It didn't clutter you down with extraneous information.

Interviewer: Would there be other cover types or scenarios that would be beneficial to add to eYield beyond the hardwood and the pine model?

Participant 2: Does it differentiate between upland hardwood systems and bottomland hardwood systems?

Interviewer: It is designed for upland right now.

Participant 2: Possibly a bottomland cover type. As far as scenarios go, no. I think it covered most of the bases.

Interviewer: On a scale of 1-10 with 1 being very easy, someone with minimal experience in land ownership and 10 being an expert in the topic, where do you think that the questions that are asked in eYield lie? Essentially, how much experience do you need to operate the website?

Participant 2: I think I remember there being imbedded descriptions in the inputs. So I think that really limited the amount of experience required to be able to use that from the get go. So on a scale of 1-10, I would say, maybe a 3. So someone with the general knowledge of land ownership who knows some of the tax and financial implications, thereof would be able to use that.

Interviewer: Was there any point with the use of Zoom or eYield that has left a bad taste in your mouth or that you didn't like or that you wished were different if you were running the meetings?

Participant 2: No, eYield did not upset me.

Interviewer: If you had to redesign the website, is there anything that you would change about it?

Participant 2: One thing, this probably isn't where the question is going but, I would like the ability to optimize based on desired output. If you want to optimize financial output by year at the end of whatever harvest cycle you want. Then based on what inputs you've provided, it would be able to provide you kind of a best case scenario. That would be handy. Rather than having to run multiple iterations to see if I deferred this by a couple of years it would be better or worse. Then trying to find that middle point. That's the only thing.

Interviewer: Are there any other comments about the design or the user experience that you would like to share with us?

Participant 2: No. Good work! I don't dwell too much in the tech world of designing user interfaces so it seemed A+ to me.

Interviewer: At any point did any of the results not line up with your expectations of what maybe they should have been?

Participant 2: No. The results seemed pretty standard.

Interviewer: Would you like to see more integration with further applications like integration with ArcGIS or Web Soil Survey? Where it is less based on the number you input and more based on the geography of where it is placed.

Participant 2: I think absolutely. If you guys can find a way to integrate geospatial data into that whether it would be a separate report based on no inputs and no management considerations and just based on biotic and abiotic conditions that would be great! Or to further refine that confidence interval around those estimates by having that type of data associated, that would be really handy.

Vita

Tim Kane was born in Katy, Texas, then moved to Tennessee when he was a toddler. He resided in Karns, Tennessee for the majority of his life. He attended the University of Tennessee, Knoxville in the fall of 2013, bringing in course credits from Pellissippi Community College to bolster his transferal. While completing his undergraduate degree, he met and befriended many influential people who would prove to be pivotal to his further success in life. A non-exhaustive list of those people is presented in the acknowledgments. While attending the University, Tim completed Dr. Wayne Clatterbuck's Silviculture course. Dr. Clatterbuck would go on to become Tim's mentor and advisor in graduate school.

After completing his undergraduate degree, Tim returned to working as a journeyman carpenter while looking for work within the wildlife and mapping industries. That came when Tim accepted a position as an administratively determined Geographic Information Systems Trainee with the National Park Service. He worked one fire in the 2017 season, the Helena Fork fire in Whiskeytown, CA. Following the 2017 fire season, Tim accepted a job working as a GIS Analyst at Apple in Santa Clara, CA. Tim spent a year in this position until returning to Knoxville to work with Dr. Clatterbuck on the eYield project.