A WEB BASED GROWTH AND YIELD SYSTEMS FOR SOUTHEASTERN PINE AND HARDWOOD STANDS

Jacob R. Beard, Thomas G. Matney, Emily B. Schultz, Stephen C. Grado, and Charles O. Sabatia[1]

Abstract—Faced with the challenges of maintaining customer-specified objectives and meeting deadlines, forest land managers must integrate various mensurational information sources for developing management scenarios. Cost efficient measures are a consideration to save both time and money for a client. While inventory data collection is time and money intensive, data processing does not have to be costly. This paper presents an open access, non-fee website that will host several common growth and yield models. The growth and yield web-based system was developed by scientists at Mississippi State University. Software programs are also available in standalone versions with additional capabilities. Users may project future yields by either implementing combinations of thinning procedures based on a specified residual stand basal area, or projecting the stand to a desired age. Initial stand data and management options for growth and yield models are described in a downloadable user manual. Forest land managers should find this website to be a valuable tool for estimating the growth and yield needs of their clients. Other decision support utilities included on the website are TProfile©, TVolume©, and calculators for estimating required sample size, confidence limits and sampling error from stratified and unstratified random samples (Matney 1996a, Matney 1996b).

INTRODUCTION

The main goal of forest biometrics is to apply mathematical and statistical estimators and models for assisting land managers in decision support. The average reader of forest biometrics literature is often overwhelmed by the task of making sense of what is being presented to them. Everyone can recall the first time they looked at a profile equation article; it was obvious that one would either have to ask a lot of questions or study some higher mathematics texts. This, however, should not be the way that a typical reader should feel when presented with an exciting new method, or finding, regarding forest biometrics. It is uncommon to find published forest biometrics/mensurational literature that include digital access to the source code, or programs, to implement the proposed new procedure. While this is not always true, the availability of a centralized source for growth and yield models and other mensurational information is severely lacking. The website being developed at Mississippi State University (MSU) will allow users to select growth models applicable to their needs. This website repository for software is created with the forest manager in mind to promote the understanding and use of forest mensuration and models by concentrating the information into a central depository.

Availability of Growth and Yield Models

MSU and several other institutions have developed local/regional growth and yield models for important commercial species, stand origins, and regions. Both industry and research data have been analyzed in producing the models. MSU has been instrumental in the development of computer models for natural longleaf (*Pinus palustris* Mill.), plantation loblolly pine (*Pinus taeda* L.), plantation slash pine (*Pinus elliottii* Engelm.), and red oak-sweetgum bottomland forests (Farrar and Matney 1994, Matney and Farrar 1992, Matney and others 1987, Schultz and others 2010). Although these models are already available as standalone applications, current computer technologies permit dissemination of information in both web-based and standalone format. The initial website being implemented will include all of the MSU models and MSU's web-based and standalone implementation of the widely used PTAEDA model (Burkhart and others 2008). In addition, general biometrics applications, such as sample size estimators, and software such as TVolume© and TProfile©, will be made available (Matney 1996a, Matney 1996b). For ease of accessibility, online versions of models will be present with the option to download standalone versions. Some growth and yield models, particularly those of

[1]Graduate Research Assistant, Mississippi State University, Forest and Wildlife Research Center (FWRC), Mississippi State, MS. 39762; Professor, Mississippi State University, FWRC; Professor, Mississippi State University, FWRC; George L Switzer Professor of Forestry, Mississippi State University, FWRC; Assistant Professor, Mississippi State University, FWRC, respectively.

Citation for proceedings: Schweitzer, Callie J.; Clatterbuck, Wayne K.; Oswalt, Christopher M., eds. 2016. Proceedings of the 18th biennial southern silvicultural research conference. e–Gen. Tech. Rep. SRS–212. Asheville, NC: U.S. Department of Agriculture, Forest Service, Southern Research Station. 614 p.

the past, have authors who are no longer active in their respective institutions. These models would possibly need to have missing model components fitted to the original data, in order to permit the development of a stable computer model.

Third-Party Growth and Yield Model Case Study

The implementation of PTAEDA 4.0 was a case study for determining the feasibility of creating a growth and yield model from publicly-available literature (Burkhart and others 2008). PTAEDA 4.0 was chosen because it is a well documented growth and yield model that has a standalone computer program. For clarification, the emulated model developed from this article will be hereafter described as "Gateway to PTAEDA," to distinguish it from the original computer model developed by Virginia Tech, PTAEDA 4.0 (Burkhart and others 2008). The results obtained from MSU's version of PTAEDA and the actual PTAEDA correspond very well.

MATERIALS AND METHODS

The case study version, Gateway to PTAEDA, employs a five step process of: 1) generate a Weibull diameter at breast height (DBH) distribution, 2) randomly assign trees to a tree-spacing lattice, 3) employ establishment management regimes, 4) grow to crown closure, and 5) process competitive growth models. PTAEDA 4.0 as established by Virginia Tech presents a stochastic process. Stochastic models provide a picture of the variability of yields that might occur. They are not ideal for practical use. In Gateway to PTAEDA, a constant random number and tree list of 3000+ trees are employed for the generation of the Weibull distribution to insure consistent answers identical to averaged stochastic trials by the user. Users may also elect to implement the stochastic model. Gateway to PTAEDA was programmed with C++ (ISO/IEC, 2014). As it is intended for both online and offline use, the solution was debugged in Microsoft Visual Studio 2010© prior to implementation (Microsoft 2010a).

The third step within the Gateway to PTAEDA process, 'employ establishment management regimes', involves a user choice between three different data entry scenarios. In the first scenario, the user provides existing conditions for a newly established, one to two year old loblolly plantation. The second scenario allows the user, who has an existing stand of loblolly pine, to enter a 'DBH'-'total height' tree list for the purpose of analysis. The third available scenario lets the user depict a hypothetical stand via stand totals. Based on the management stage of a user's property, this allows for a dynamic approach from which optimal management can be ascertained. Thinning models for Gateway to PTAEDA were taken from the MSU loblolly pine cooperative model. For the existing stand scenario, regional mean tree arithmetic and quadratic diameter prediction from the MSU loblolly pine cooperative model were used to generate the initial stand Weibull DBH distribution.

RESULTS

Gateway to PTAEDA as a standalone program provides the user with the three scenario windows at startup. Each window represents a separate growth scenario (described in the methods). Figure 1 displays the three scenario windows. The online version of Gateway to PTAEDA allows for the user to select a scenario and returns the appropriate HTML page for the selected scenario. In addition to the online reporting of results, users are able to download a Microsoft Excel© spreadsheet of the output (Microsoft 2010b). Figures 2 through 4 show user entry, online output, and the Microsoft Excel© output for the online Gateway to PTAEDA version (Microsoft 2010b).

DISCUSSION

Gateway to PTAEDA allows users to project future yields by implementing combinations of thinning procedures based on a specified residual stand basal area, and/or projecting a stand to a desired age. Growth scenario choice allows for management flexibility and provides a valuable tool for estimating growth and yield needs. This case study demonstrates the feasibility of literature adaption for growth and yield programming. The web-based version of Gateway to PTAEDA can be found at http://www.consultingforester.net/GrowthAndYield/PTAEDA.htm.

The growth and yield, and mensurational data web site being developed at MSU when completed will provide a central depository for forest biometric information support. MSU is committed to populating the website with MSU's biometrical store of information that it has developed over the past forty years. MSU will also select published models which have sufficient information to develop a web/standalone computer model that is stable. Anyone interested in contributing information for inclusion on the website that MSU is developing should contact MSU at jacob.beard@cfr.msstate.edu. Full decision support implementation of other growth and yield models will most likely not be possible because many of them do not have all of the required component equations. In some cases the missing equations can possibly be developed from the original source data or another similar data source.

LITERATURE CITED

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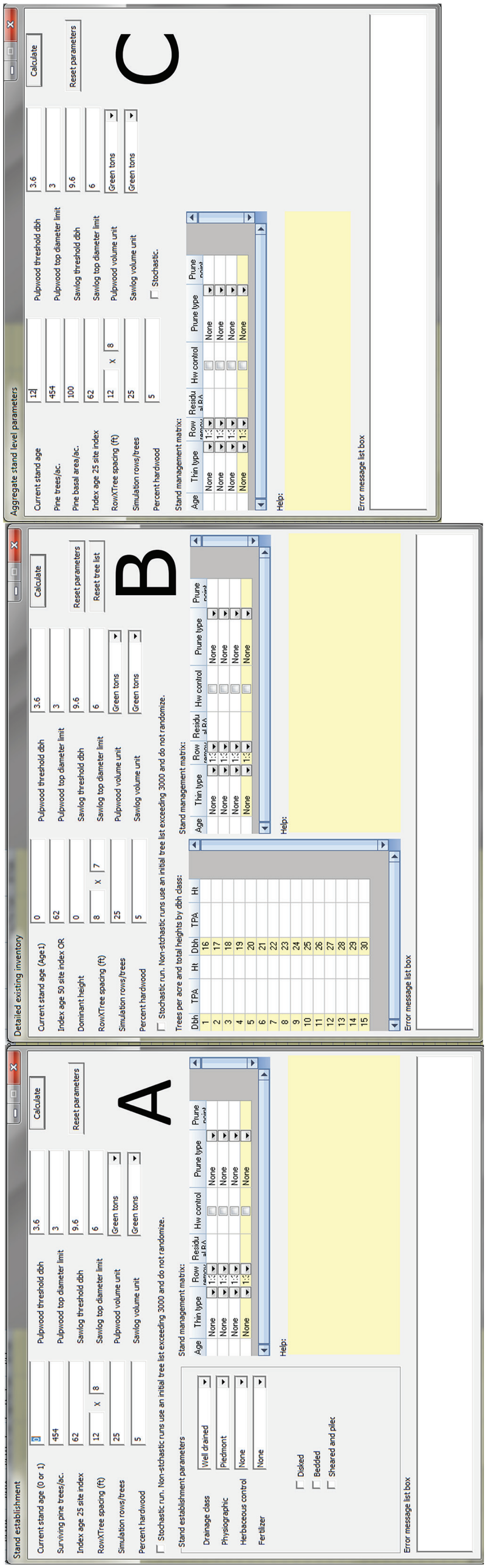
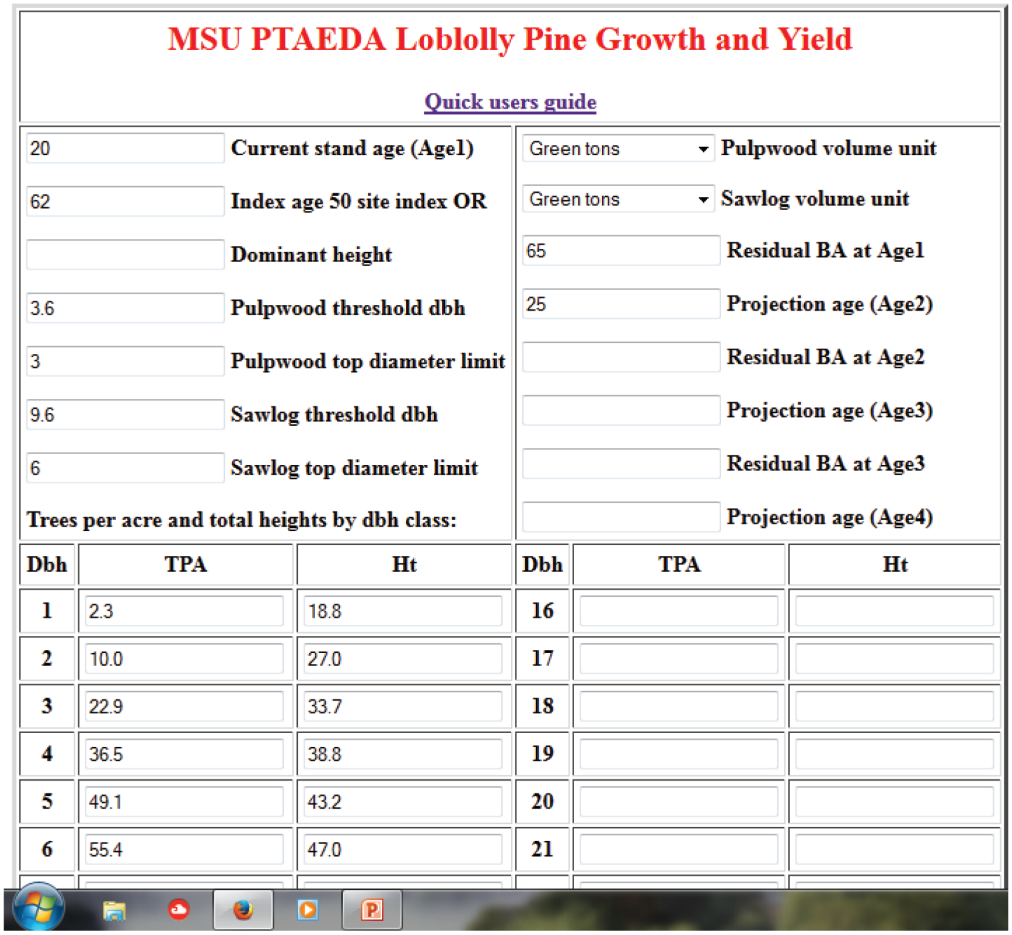


Figure 1—(A) Established stand input scenario screen; (B) Tree list input scenario screen; (C) Hypothetical stand input scenario screen.

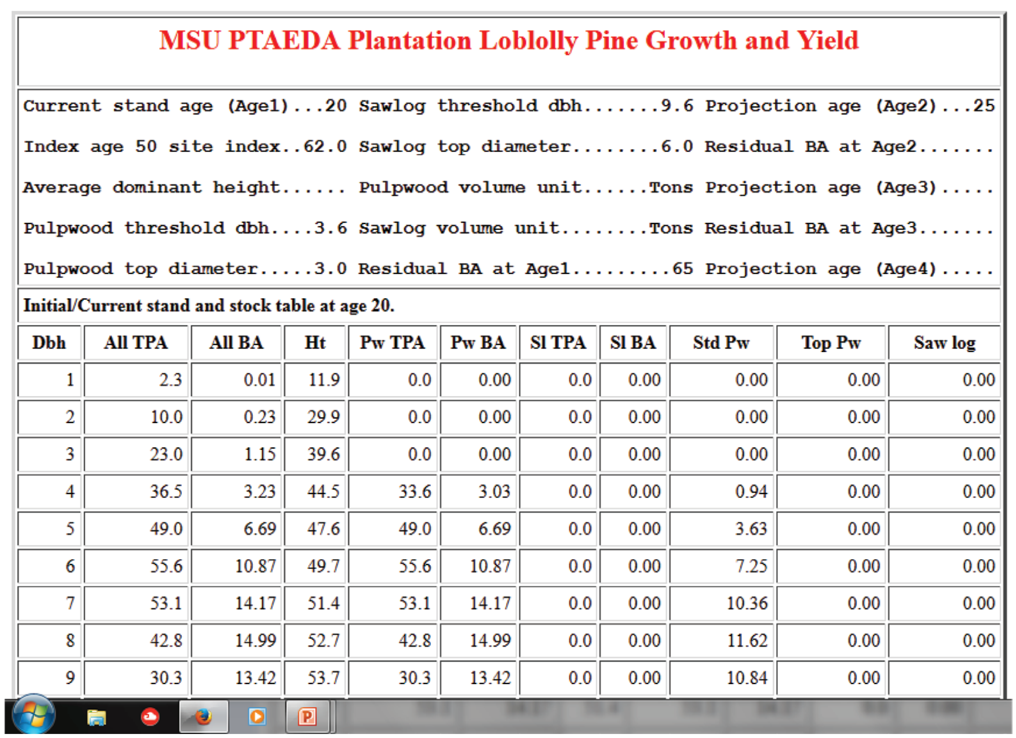

MSU PTAEDA Loblolly Pine Growth and Yield

Quick users guide

20	Current stand age (Age1)	Green tons	Pulpwood volume unit
62	Index age 50 site index OR	Green tons	Sawlog volume unit
	Dominant height	65	Residual BA at Age1
3.6	Pulpwood threshold dbh	25	Projection age (Age2)
3	Pulpwood top diameter limit		Residual BA at Age2
9.6	Sawlog threshold dbh		Projection age (Age3)
6	Sawlog top diameter limit		Residual BA at Age3
Trees per acre and total heights by dbh class:			Projection age (Age4)

Dbh	TPA	Ht	Dbh	TPA	Ht
1	2.3	18.8	16		
2	10.0	27.0	17		
3	22.9	33.7	18		
4	36.5	38.8	19		
5	49.1	43.2	20		
6	55.4	47.0	21		

Figure 2—Online Gateway to PTAEDA user entry page.


MSU PTAEDA Plantation Loblolly Pine Growth and Yield

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Current stand age (Age1)...20 Sawlog threshold dbh.......9.6 Projection age (Age2)...25
Index age 50 site index..62.0 Sawlog top diameter........6.0 Residual BA at Age2.......
Average dominant height...... Pulpwood volume unit.....Tons Projection age (Age3).....
Pulpwood threshold dbh....3.6 Sawlog volume unit........Tons Residual BA at Age3.......
Pulpwood top diameter.....3.0 Residual BA at Age1.........65 Projection age (Age4).....
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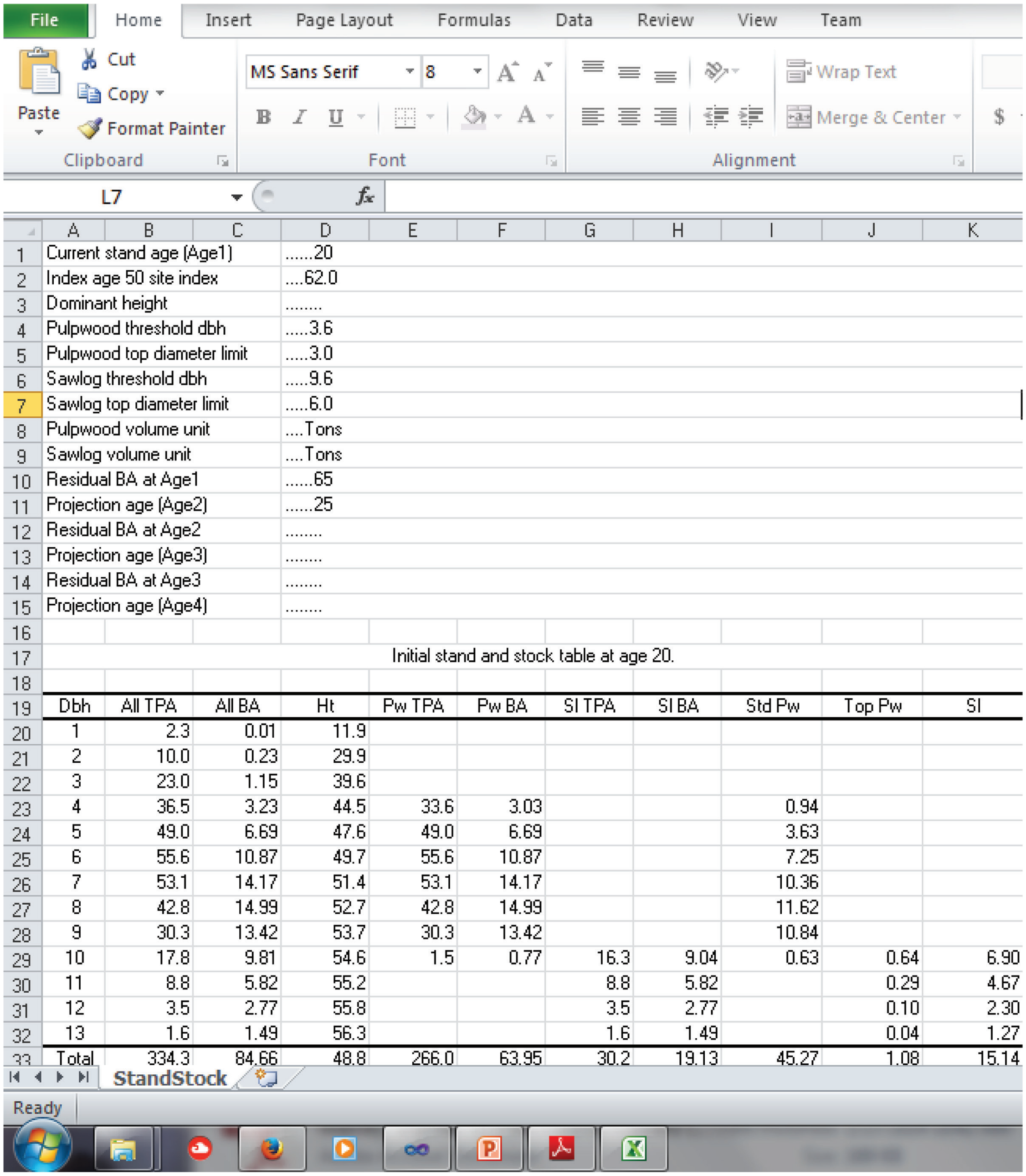
Initial/Current stand and stock table at age 20.

Dbh	All TPA	All BA	Ht	Pw TPA	Pw BA	Sl TPA	Sl BA	Std Pw	Top Pw	Saw log
1	2.3	0.01	11.9	0.0	0.00	0.0	0.00	0.00	0.00	0.00
2	10.0	0.23	29.9	0.0	0.00	0.0	0.00	0.00	0.00	0.00
3	23.0	1.15	39.6	0.0	0.00	0.0	0.00	0.00	0.00	0.00
4	36.5	3.23	44.5	33.6	3.03	0.0	0.00	0.94	0.00	0.00
5	49.0	6.69	47.6	49.0	6.69	0.0	0.00	3.63	0.00	0.00
6	55.6	10.87	49.7	55.6	10.87	0.0	0.00	7.25	0.00	0.00
7	53.1	14.17	51.4	53.1	14.17	0.0	0.00	10.36	0.00	0.00
8	42.8	14.99	52.7	42.8	14.99	0.0	0.00	11.62	0.00	0.00
9	30.3	13.42	53.7	30.3	13.42	0.0	0.00	10.84	0.00	0.00

Figure 3—Online Gateway to PTAEDA output example pa



Current stand age (Age1)	20
Index age 50 site index	....62.0
Dominant height	....
Pulpwood threshold dbh	.....3.6
Pulpwood top diameter limit	.....3.0
Sawlog threshold dbh	.....9.6
Sawlog top diameter limit	.....6.0
Pulpwood volume unit	....Tons
Sawlog volume unit	....Tons
Residual BA at Age1	65
Projection age (Age2)	25
Residual BA at Age2	....
Projection age (Age3)	....
Residual BA at Age3	....
Projection age (Age4)	....

Initial stand and stock table at age 20.

Dbh	All TPA	All BA	Ht	Pw TPA	Pw BA	Sl TPA	Sl BA	Std Pw	Top Pw	Sl
1	2.3	0.01	11.9							
2	10.0	0.23	29.9							
3	23.0	1.15	39.6							
4	36.5	3.23	44.5	33.6	3.03			0.94		
5	49.0	6.69	47.6	49.0	6.69			3.63		
6	55.6	10.87	49.7	55.6	10.87			7.25		
7	53.1	14.17	51.4	53.1	14.17			10.36		
8	42.8	14.99	52.7	42.8	14.99			11.62		
9	30.3	13.42	53.7	30.3	13.42			10.84		
10	17.8	9.81	54.6	1.5	0.77	16.3	9.04	0.63	0.64	6.90
11	8.8	5.82	55.2			8.8	5.82		0.29	4.67
12	3.5	2.77	55.8			3.5	2.77		0.10	2.30
13	1.6	1.49	56.3			1.6	1.49		0.04	1.27
Total	334.3	84.66	48.8	266.0	63.95	30.2	19.13	45.27	1.08	15.14

Figure 4—Downloaded Microsoft Excel© output from online output example page.

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