Sample Lab Report

[*Please note that all of the special formatting such as running heads with automatic page numbering, hanging indents, en- and em-dashes, small caps, and bold-face and Italic fonts can be produced by a word processing computer program such as MS Word. Consult your instructor for information on how to use a word processor to perform these formatting tasks for you. Unfortunately, there is no universally accepted format for journal-style papers. This student has used the format of* The Beloit Biologist*, which is where senior Biology and Biochemistry majors publish their senior papers. Your instructor, however, may ask you to follow another format such as that of a journal in a particular area of Biology.*]

Estimation of Cherry Tree (*Prunus*) Population Density at Chamberlin Spring by Quadrat and Point-Quarter Sampling

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[*Note that the title page includes a short, descriptive **title** (the shortest summary of the paper), the student's **name** and **institutionaladdress**. As this assignment is written in journal style, the title page does **not** include information about the course for which the paper has been submitted, or the date of submission. Note as well that everything is **double-spaced** and that the name of the genus for cherry trees is in italics (because it is Latin). Your instructor may ask you to submit other materials, such as a cover letter, as well.*]

Abstract. I estimated the population density of cherry trees (*Prunus* spp.) in the woods of Chamberlin Springs, Wisconsin using both a quadrat sampling method and a point-quarter sampling method. Averaging estimates from the trials, the point-quarter sampling method yielded an estimate of 0.75 cherry trees per 100 m 2. Averaging the results from the quadrat sampling technique, however, gave an estimate of 2.67 cherry trees per 100 m 2. The results are difficult to compare because there were more trials using the point-quarter sampling method than for the quadrats.

Key Words: Cherry Trees; Population Density; Quadrat Sampling; Point-quarter Sampling

[*The student includes an abstract, or* ***informative summary,*** *of the paper and a list of* ***key words****, which would help someone else to locate this paper in a data-base search. This abstract must "****stand alone****," meaning that it must be self-contained or understood without reading the entire paper, and it does not cite references. Note that the student uses the* ***active voice*** *in the Abstract and throughout the paper (e.g. "I estimated the population density" rather than "The population density was estimated"). Note also that the student has used a "****running head****," which includes the page number, on all pages except the title page. Finally, note that, because the student uses a scientific name of the species of plant, she places the name in Italics. If she had known the full scientific name, she would have capitalized the genus name but not the specific name (i.e. Arabidopsis thaliana). In this case, however, she did not know the specific name and she suspected that several species were included, so she used "Prunus* spp.*" (if she were to refer to a single, unknown species, she would have used "Prunus* sp.*"). Because* spp. *(or* sp.*) is not a Latin name, it was not italicized.*]

Introduction

The estimation of population size, density, and dispersion of a species is an important aspect of many ecological studies because these characteristics are important for the classification of range sites and conditions. Many techniques exist to estimate the density of plant or sessile animal populations, some involving plots, some plotless, each with some error. Two particularly popular methods are quadrat sampling and the plotless point-quarter sampling method (Campbell and Bomberger 1934; White 1983; Engeman et al. 1994).

In this study, the population density of cherry trees (*Prunus* spp.) is estimated using two different sampling methods: quadrat sampling and point-quarter sampling. Estimates from these two methods are compared for consistency and accuracy.

[*The first paragraph of the Introduction is very important. It "sets the stage" for the rest of the paper by introducing the topic and providing some background. The second paragraph narrows the focus of the paper to the particular topic at hand and provides more specific background information, which is also cited. It also provides a transition to the next section by indicating what the student intended to do in this study. Note that, to avoid plagiarism, the student has cited all information not her own, and that the citations are by* ***author and year*** *(e.g.Engeman et al. 1994) rather than end notes ("et al." means "and others"; it is used after the first author's name when there are three or more authors). Note as well that scientific papers* ***do not quote*** *sources (unless the exact wording is the point being made). Instead, the student reports information from sources in her own words and cites her sources as described above. Finally, note that there are no hyphens at the ends of lines and everything is double-spaced.*]

Methods and Materials

The study area used was the wood surrounding Chamberlin Springs. Located northwest of the Beloit city limits, the approximately 18-hectare area is typical of a relatively undisturbed mature forest in southern Wisconsin, although the surrounding area consists of agricultural fields (Cupps 1984). A number of tree species are present in the wood—elm (*Ulmus*), cherry (*Prunus*), oak (*Quercus*), hickory (*Carya*), and walnut (*Juglans*) were among the most predominant; there was also a substantial amount of undergrowth.

My fellow field researchers and I first estimated cherry density in the wood based on a point-quarter sampling method. One of my fellow researchers chose an initial sampling point in the wood; the line of a path on the edge of the wood was used as a parallel for one axis of the X-Y-coordinate system. From that point, the other researchers and I measured the distance from the sampling point to the nearest cherry tree (we did not discriminate by species) in each quadrant formed by the coordinate system. From that point, the same student chose a direction from the initial sampling point in which to head (continuing away from the original point so as not to overlap sampling areas) and the number of strides away from the original point to travel along that line (as randomly as possible). This procedure was repeated to yield a total of five point-quarter sampling points. I calculated density estimations for 100 m 2 based on these distance measurements and calculated the standard deviation for this method as well (Brower et al. 1998).

Moving back in the general direction of the initial point-quarter sampling point, my fellow researchers and I used a quadrat sampling method to estimate the density of cherry trees. As done before, the same field researcher chose a sampling point from which to measure. From this point, the other researchers and I set up and marked a 10 x 10 m square quadrat (100 m 2). We then walked the quadrat, counting all cherry trees encountered. The original researcher again chose the direction to travel and number of steps to take to reach another sampling point, where we set up another quadrat. A total of three quadrats were sampled. I calculated density as the mean number of individuals of the cherry tree genus per quadrat area and compared the estimations of the different quadrats sampled (Brower et al. 1998).

For both sampling methods, the minimum size of a cherry tree to be counted for the study was a 5 cm diameter at breast height (DBH); the tree also needed to be alive to be noted. Results of the density estimations of both methods were compared.

[*The Methods and Materials section describes procedures in* ***enough detail*** *for a reader to repeat this study. All units of measure are given in* ***metric units****. Note that the student uses the active voice when appropriate. She also uses the passive voice when she wishes to focus attention on materials or methods rather than on herself. She writes full sentences and uses the past tense because she is describing what she did. In this study, the student did not perform statistical analyses of her data, but if she had, she would have described the tests she used in this section as well.]*

Results

With the point-quarter sampling method, I found a range of cherry tree population densities when comparing sampling points (Table 1). The total density estimate, analyzing the data from all trials simultaneously, yielded a density of 0.75 cherry trees per 100 m 2. (Averaging the densities estimated for the five trials yielded an average density of 1.29 cherry trees per 100 m 2 (SD = 1.17).)

For the quadrat sampling method, we counted 5, 1, and 2 trees for the three trials. The average density from this method is 2.67 cherry trees per 100 m 2 over the three trials (SD = 2.08).

[*The student reports her results using* ***more than just tables and graphs****, but she does not repeat all information from the Tables in the text of the Results section. She also includes her* ***statistical results****, including means and standard deviations (SD). If she had used statistical inference tests, she would also have included test statistic values (e.g. t, F, or c 2 values), degrees of freedom (d.f.), and type-I probabilities (*P*), in the standard terminology of biology. Note that the word "significant" should be used only to indicate a statistically significant result of a statistical inference test. As this paper is a journal-style submission, the table is presented at the end of the paper (see below).*]

Discussion

The two different methods used yielded rather different estimates of cherry tree density in Chamberlin Woods. I did not run a statistical analysis on the two estimates because it would have had extremely low power (few trials were taken for either method) and the large standard deviations would not allow these two methods to be significantly different.

It is difficult to compare properly the accuracy of the two methods because of the low number of trials. Another confounding factor was the researchers' ability to properly identify a member of the cherry tree genus (*Prunus*). A number of trees may have been misclassified as cherry trees, causing an overestimation of density, or some cherry trees may have been overlooked, which would lead to an underestimation of tree density. On at least one occasion during the point-quarter sampling, the researchers in a particular quadrant were alerted to the fact that they had overlooked a cherry tree closer to the selected point. (As distance from the selected point increased, the area examined increased, and there was greater chance of overlooking a tree.) The difficulty in identifying cherry trees was likely only a problem during the point-quarter sampling, while researchers were gaining experience recognizing the genus. By the time we began data collection with the quadrat method, we had more practice; we also were able to collaborate in identifying and counting, as everyone walked the quadrat together. Another source of error was the randomness of the sampling. Although the researcher choosing directions and the number of paces attempted to do so at random, the use of a random number generator would have been more valid.

Quadrat sampling is a basic and commonly used procedure for sampling various types of organisms and is robust over spatial patterns, but it can be labor intensive, especially when organisms are sparse or unevenly distributed. Plotless methods such as point-quarter sampling are sometimes used for plants, with the advantage of not having to demarcate sampling areas of a certain size or shape. The accuracy of this method, however, is sensitive to departures from a random distribution of individuals, especially when only small numbers of individuals are counted. A clumped population, as occur in many tree species, will give an underestimate of density. Quadrat methods, on the other hand, can handle nonrandom populations by increasing the number and size of plots sampled (Engeman et al. 1994; Brower et al. 1998). Another critique of the point-quarter sampling method is that estimation advantages may be out-weighed by the practical difficulties of dividing the plane around the sampling point into quadrants, deciding into which quadrant an individual belongs as part of the process for determining and measuring the closest individuals in that quadrant (Pollard 1971).

On the basis of the results of this study, I believe that the cherry tree population in Chamberlin Woods qualifies as an aggregated population. This would likely be due to seed dispersal, soil quality, and competition in various parts of the forest. The aggregation can be seen in the great variance in quadrat estimates and distances for the point-quarter sampling from one trial to another. Given the aggregation and potential sampling error, I believe that the quadrat sample was more accurate for the particular population studied. To estimate better the distribution of cherry trees, however, more quadrats should be sampled.

[*The Discussion begins with a* ***brief restatement of the pertinent findings****, but does not repeat the results in excess detail. More importantly, the student* ***examines the potential weaknesses of her study and relates her findings to the results of other studies****. As the student is discussing her own and others' results, she uses the* ***past tense*** *(use of the present tense would imply that the statement is forever true). The student also uses the discussion to suggest topics for further research. Note that the student has ended with a "****take-home message****," which provides a strong ending to this excellent report.*]

Acknowledgments

I would like to thank my peers, Angela Avilez, Joanna Cramer, Asuka Kitayama, Kristin Olson, Brooke Saepoo, and Jennifer Sperry, for their help in gathering data for this study. I would also like to thank Beloit College for providing the resources and funding for the study and Dr. Ken Yasukawa for guidance in classifying trees and performing the methods.

[*With their permission, the student acknowledges those who assisted with the project.*]

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[***All*** *sources cited in the text must be included in the References section.* ***Only*** *cited sources are included. References are listed in* ***alphabetical order*** *by authors' last names and all references must be* ***complete****, i.e. must include the names and initials of all authors, the year of publication, the full title, and the name of the journal, its volume and the page range. References typically use "****hanging indentation****," in which the first line is not indented but all subsequent lines are indented.* ***Web pages are typically not acceptable references****, although electronic journals are acceptable.*]

Table 1. Point-Quarter Sampling Estimation of Cherry Tree Density

	Sample					
	1	2	3	4	5	Overall
Quadrant 1	11.10	3.00	14.80	22.20	12.10	N/A
Quadrant 2	3.00	14.30	2.70	2.30	7.00	N/A
Quadrant 3	14.80	23.10	30.50	16.30	19.00	N/A
Quadrant 4	22.20	7.70	9.50	6.60	30.00	N/A
Paces to next sampling point	26.00	7.00	19.00	30.00	25.20	N/A
Average (m)	11.40	5.60	21.20	11.50	8.30	11.60
S.D. (m)	5.70	5.80	7.20	7.20	2.90	7.60
Mean area (m^2)	132.20	31.10	150.00	100.50	85.00	99.76
Density (per 100 m^2)	0.78	3.22	0.22	1.02	1.47	1.34

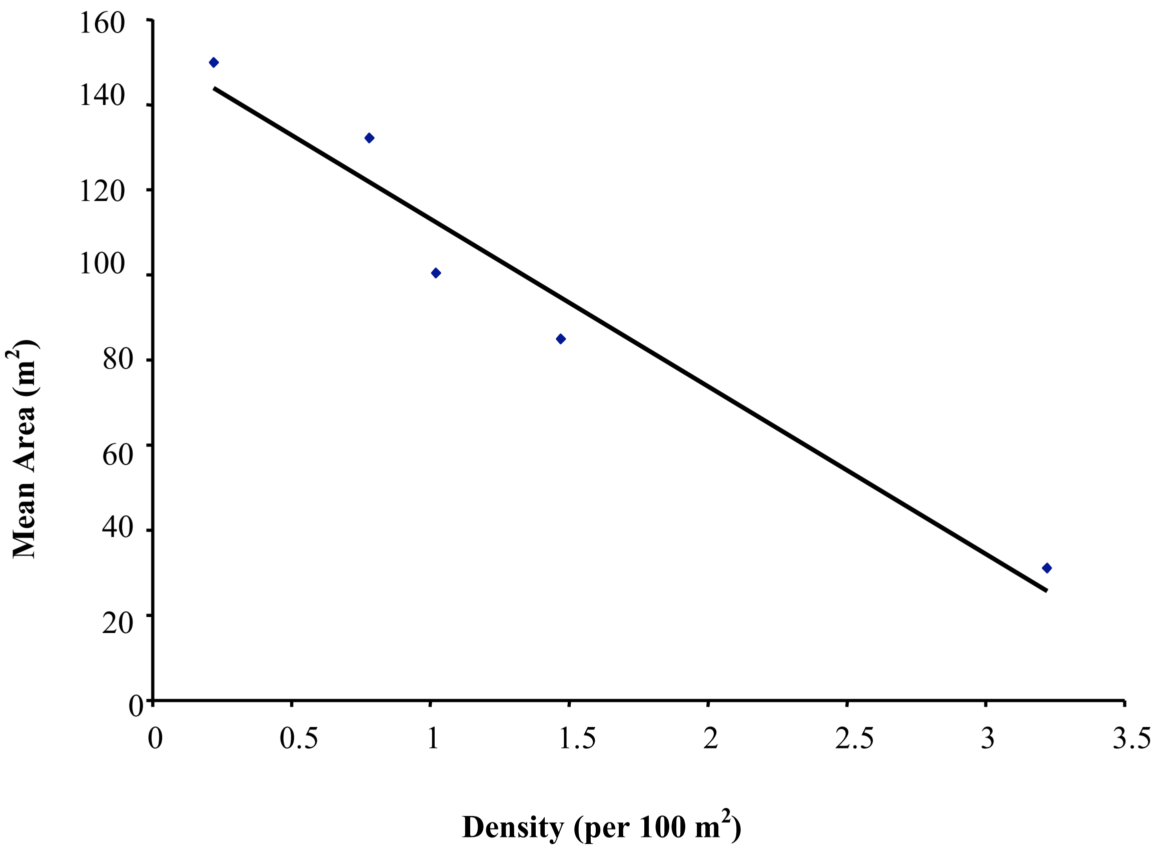
[All tables **must be cited** in the text. Each table is numbered consecutively **in the order in which it was cited in the text and each is listed on its own page**. Each table also includes a descriptive title and other information that allows it to "stand alone." Footnotes, which explain tabular material, are allowed. "Stub lines" above headings allow the reader to easily see the way the information is organized. Tables are **also double spaced** (**nothing** is single spaced) with columns aligned. **Only horizontal lines are allowed**; there are not vertical lines. The student might also present other results in a figure (i.e. as a graph). In many cases, figures are better ways to compare results than tables. If the student had used a figure, however, he/she would not also present the same data in a table (use one or the other, but not both.]

Figure Legends

Fig. 1. Germination success of seeds of the *gal-3* mutant of *A. thaliana* in response to treatment with GA 3 in light or darkness. Means with SE bars are shown.

[*If the student used a figure rather than a table, she would need to add a* ***Figure Legends*** *page on which the legend of the figure would be listed. The figure itself would then follow on its own page. As with the corresponding table, the figure must "stand alone." It would probably be better not to have the x-axis go up to 125%, as more than 100% success is not possible, but leaving some room at the top of the graph makes it easier to see the error bars on the 0.5mol L - 1 means.*]

Figure 1. Mean Area vs. Density (per 100 m^2)



[All figures **must be cited** in the text. Each figure is numbered consecutively **in the order in which it was cited in the text and each is listed on its own page**. Each figure also includes a descriptive title and other information that allows it to "stand alone." Each figure should be centered without borders, gridlines, and a gray background. Figures should only be called figures. "Graph" or "Chart" is unacceptable.]