Computer Modeling to Improve Flock-size Estimates

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Abstract

The National Audubon Society predicts 314 species of birds are inching closer to extinction because of climate change. It will be very important for biologists and bird watchers to estimate bird numbers accurately as bird populations are monitored. I chose to test traits, skills and characteristics that may affect bird counting accuracy. I used the Jack Hodges computer model/simulation *Wildlife Counts* to determine whether training improved estimating accuracy. I randomly selected biologists and bird watchers from a local list. Each participant was shown screens with an unknown number of birds, and was asked to estimate the flock size. In general participants made significant improvements after being trained using *Wildlife Counts*. Comparisons of groups (i.e. biologist vs. bird watcher, male vs. female, caffeine vs. no caffeine, artist vs. scientist) yielded no significant differences. Within each group, all members demonstrated a significant improvement in estimating flock size after training. I also used real bird photos and found there were significant differences between simulation and real bird photo estimates. This seems to indicate that there are other factors that may affect counting accuracy. One report said people tend to underestimate numbers in large flocks. My findings agree with that statement, even after training. In conclusion, there were no specific characteristics that affected the accuracy of flock size estimates, meaning that all individuals, regardless of background and traits, can count birds and improve through practice with the simulation. Training study participants using the *Wildlife Counts* program significantly improved their estimates of flock size. Similar training for anyone who monitors bird populations is recommended.

Introduction

According to the National Audubon Society (NAS), bird populations may be facing serious threats and declines due to global warming and climate change (Nijhuis, 2014). It will become very important for biologists and bird watchers to estimate bird numbers accurately.

When I read the NAS article, I realized how important it is to estimate bird numbers accurately and keep track of bird populations. I thought it would be a good idea to test traits, skills and characteristics in people that might affect bird counting accuracy. Some of those traits, skills and characteristics that I chose to test included biologist/bird watcher, male/female, use of caffeine within five hours/no caffeine within five hours and artist/scientist. I wanted to know if there were any differences between these groups.

I reviewed the proceedings of an International Symposium held in Asilomar, California called *Estimating Numbers of Terrestrial Birds* (Ralph, J.C. and M.J. Scott, 1980). I checked to see if any of the papers had used computer simulations to improve estimating accuracy and found that none did. This is probably because the paper is dated 1980 and computers were just starting to be used at that time. I did not find any other literature that referenced use of computer simulations to improve bird counting accuracy (other than the Jack Hodges, *Wildlife Counts* computer simulation, which I used in my experiment).

Within these same proceedings, Kepler and Scott (1980) described that variability can be reduced by training observers. I wanted to see if *Wildlife Counts* could improve estimation accuracy. A presentation by Harrington in 1999 stated that people counting birds tend to underestimate when large numbers of birds are viewed. I wanted to use my data to see if that principle held true.

Fig. 1. Example of Simulation Screen. Guess how many birds are there!

Methods and Materials

For this experiment, I designed four different tests using the Jack Hodges computer model/simulation *Wildlife Counts*. The model shows simulated images of birds while it knew the exact number of birds on the screen. For all tests the participants were told that the range of birds was 50-600. For my experiment, I used the "Swans on a Lake" simulation (Fig. 1). I was able to obtain 32 participants for this project, and their results were kept confidential.

For Test 1, the participants were asked to look at five screens, all with different numbers of birds in them, for a certain amount of time, and then write down their estimate after each screen was shown. This was considered the "pre-training" test, and was used to show how well the participants did without any training.

Test 2 was used as the training session. The participants were shown screens with 20, 50, 100, 300, and 500 birds in them, and were told the actual number. This helped the participants calibrate their eyes. Then, participants were shown five more screens of birds. They wrote down their estimates and then were shown the actual number of birds in the image immediately. This was used to let the participants know how well they were doing and what kind of changes they needed to make to increase their estimating accuracy.

Test 3 was the "after-training" test. The participants were again shown five computer screens, after which they would write down their estimate. We did not tell the participants that the numbers of birds were exactly the same in Test 1 and Test 3. This allowed me to see if there was improved accuracy after training because the actual numbers were held constant. Test 3 was used to determine if the participants' accuracy improved after training.

Test 4 was a series of three actual bird photographs. I used Corel Photo Paint Software to pre-count and modify bird numbers in the photos so that each photo matched the number of birds in one of the screens in Test 1 and Test 3. The participants would be shown the three photos, and then write down their guess. This test was used to show how accurately the participants could estimate real birds, after all the simulations. This allowed me to compare the photo bird number to a corresponding simulation number since they had the same number of birds.

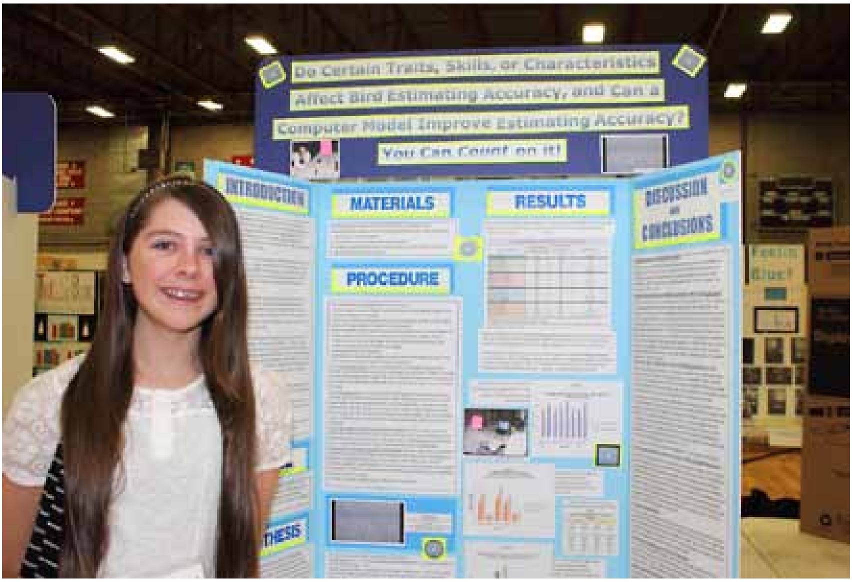
Results

There are two primary statistics used throughout this experiment. One is the average estimate for a group. For example, if 10 biologists write down their estimates, an average can be produced. If 10 bird-watchers provide estimates for that same screen, another average can be produced. This is comparing actual bird estimates that participants made, and is usually done within a single screen of a known number of birds. Averages therefore can be compared among groups or to actual numbers.

Another statistic I call the "absolute error" of an estimate. The plain and simple way to define absolute error is the number of birds, either above or below, that the participant guessed compared with the actual number of birds. Absolute error is used to determine the error for a participant across the five screens. For example, if a participant

Table 1: Summary of Group Analysis.

Summary of Group Analysis For Test 1 and Test 3			
Group/Comparison*	**Average Absolute Error for First Group Listed**	**Average Absolute Error for Second Group Listed**	**Significance****
All T1 vs. All T3	567	314	Extremely
Bio T1 vs. BW T1	510	606	Not
Bio T3 vs. BW T3	285	334	Not
Bio T1 vs Bio T3	510	285	Very
BW T1 vs. BW T3	606	334	Extremely
Male T1 vs. Female T1	529	597	Not
Male T3 vs. Female T3	269	350	Not
Male T1 vs. Male T3	529	269	Extremely
Female T1 vs. Female T3	597	350	Very
Caf T1 vs. Ncaf T1	507	621	Not
Caf T3 vs. Ncaf T3	318	311	Not
Caf T1 vs. Caf T3	507	318	Significant
Ncaf T1 vs. Ncaf T3	621	311	Extremely
Art T1 vs. Sci T1	659	526	Not
Art T3 vs. Sci T3	338	305	Not
Art T1 vs. Art T3	659	338	Very
Sci T1 vs. Sci T3	526	305	Extremely
*Abbreviations Include: Bio=Biologist; BW=Bird Watcher; Art=Artist; Sci=Scientist; Male=Male; Female=Female;T1=Test 1; Caf=People who had caffeine; Ncaf=had no caffeine; T3=Test 3			
** Categories include: not significant=<90% confidence; significant=90-98% confidence; very significant=98-99% confidence; extremely significant=>99% confidence			



The author presenting her poster, "Do Certain Traits, Skills, or Characteristics Affect Bird Estimating Accuracy, and Can a Computer Model Improve Estimating Accuracy? You Can Count on it!"

estimates that there are 250 birds on the screen when there are actually 412 birds, the absolute error (expressed as a positive number) would be the difference, in this case 162. Adding the absolute error for each of the five screens, you get the total absolute error for that person, which might be 470. If another person's total absolute error was 325, then that person's total error was lower. The total absolute error could be added together and averaged for each group. It should be noted that the Hodges simulation allows for the cancellation of errors. I chose not to allow cancellation of errors because it is like shooting two arrows at a bull's eye, hitting 10 inches high, and then 10 inches low. The two hits, high and low, should not make a bull's eye.

I used GraphPad, QuickCalcs 2014 to run my t-tests to compare means and determine significance. The analysis used both paired and unpaired samples.

Table 1 lists the summary of group analysis. It shows one group compared to another (example: male vs. female), and also one group compared to the same group (example: male Test 1 vs. male Test 3). It also shows the significance of the averages for each group.

Fig. 2 shows how each group improved after training, and the reduction in their errors.

Table 2: Test 3 vs. Test 4 Results.

Compare Simulated Screens to Real Bird Images: Average Estimates for All Participants Test 3 vs. Test 4		
Test 3 (76 birds) Average Estimate	Test 4 (76 birds) Average Estimate	Significance
78	76	Not significant
Test 3 (536 birds) Average Estimate	Test 4 (536 birds) Average Estimate	Significance
451	315	Extremely significant
Test 3 (132 birds) Average Estimate	Test 4 (132 birds) Average Estimate	Significance
118	143	Significant

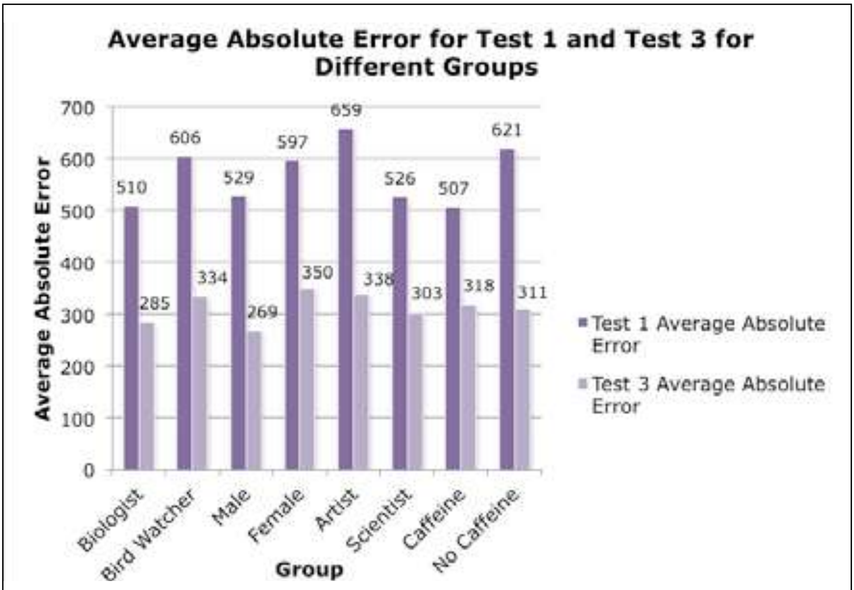


Fig. 2: How each group improved after training, and the reduction in their errors.

Table 2 shows the Test 3 vs. Test 4 results for each screen. Test 3 used simulated bird screens compared with Test 4, which used real bird photographs of the same number of birds.

Discussion and Conclusions

Did Traits, Skills or Other Characteristics Have an Effect on Bird

Estimating Accuracy? Table 1 shows the differences in one group vs. another. For example, were males more accurate than females? In all cases (biologist vs. bird watcher, male vs. female, caffeine vs. no caffeine, artist vs. scientist) there were no significant differences between any of the groups. This means that traits, skills and characteristics don't significantly affect counting accuracy. It also means that any person, regardless of characteristics, can potentially improve bird-counting accuracy through training.

How Did Accuracy Change From Simulation Screens to Real Life Bird Photographs? By testing the participants using real bird photographs compared to the simulation screens, I found out that when numbers are low, people are more accurate with estimating, as shown in Table 2. As numbers of birds in the photographs increased, there were significant differences between simulation screen estimates and real bird photo estimates. This may be due to the fact that there are more challenges when estimating real bird numbers. Difficulties such as background, types of birds, overlapping birds, and density may all affect bird estimating accuracy.

Over and Underestimation. Harrington (1999) said that people tend to underestimate numbers of birds in large flocks, and my findings are consistent with that statement. In Test 1, 85 percent of the estimates were lower than the actual number and in Test 3, 72 percent of the estimates were lower. I believe that the training had to do with the change in percentages.

Did the Jack Hodges Computer Simulation Wildlife Counts *Improve Bird Counting Accuracy*? Table 1, line one, shows the absolute errors for all of the participants in Test 1 and Test 3. As you can see the participants made extremely significant improvements after training (error was reduced). This data agrees with Kepler, et al. (1980) in that training reduced bird counting variability. Bird counters around the world should consider using the online or purchased editions of *Wildlife Counts* computer simulation model to improve their bird counting accuracy. The model is available at wildlifecounts.com.

Why Accurate Bird Estimating is Important. In the coming years, bird populations are expected to decline because of climate change. With all of these potential changes in bird populations, accurate bird estimates and population data will be very important to the future of these species. Using the Jack Hodges *Wildlife Counts* computer simulation, most participants' estimates improved. Although there were no specific characteristics that effected bird estimating accuracy, training participants with a computer model did improve accuracy, and that may be the future for keeping precious bird species accounted for and protected!

So how many birds did you guess were in Fig. 1? There were actually 360 birds!

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