DEVELOPING A FRAMEWORK FOR AN INVENTORY OF THE BIODIVERSITY ON THE CONSERVE SCHOOL ACREAGE

A Project Report

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Abstract:

This project consists of the development of the framework for an inventory of the biodiversity on the Conserve School's 1200 acres of land. In an effort to further develop the curriculum in the Conserve School Semester Program's science classes, this project will develop the framework to perform an inventory of the various species of mostly terrestrial plants and animals that can be found on the school's property. Using methods translated from various literature sources, and from personal knowledge of the Conserve School faculty, the framework was developed collaboratively to meet Conserve School's needs. Methods for Point-Centered Quarter sampling and/or Random Pair sampling of forest ecology, line grid trapping for mammals, and observational sampling for mammals, birds, and other wildlife will be described so that it may implemented into the curriculum so that the students can be the scientists collecting the data should the Conserve School Faculty decide that it is something that they can use.

This project will also provide a database that can be added to by the students and faculty to facilitate an ongoing study that will monitor how the property changes over the years. Suggested methods to monitor change will be coupled with the use of the database and examples will be given so that students and faculty will know where to begin. The database itself is split up into six different categories to include: mammals, birds, trees, saplings and shrubs, herbs and fungi, and an "other" category that will be used to possibly include reptiles, amphibians, and some invertebrates.

Acknowledgements:

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Thanks to Beth for her ultimatum, as well as Ryan, Arke, Vanessa, Brenna, Kaylene, Katie, and Max for all the support and for being there for me when I needed you most.

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CHAPTER I. Introduction

A. STATEMENT OF PROBLEM

The goal for this project was to design an inventory of the biodiversity of Conserve School's property and implement it into the curriculum of the Conserve School semester program.

B. STATEMENT OF SUB-PROBLEMS

1. Develop a curriculum framework for Conserve School inventorying process.
2. Research resources to support the framework.
3. Create a database on the different types of plants and animals identified through field work done by students and will be carried on for several years.
4. Evaluate the inventorying process and adapt it to further aid with the needs of Conserve School.
5. Begin inventorying process as a pilot study with students.

C. HYPOTHESIS

There is no hypothesis for this project.

D. RATIONALE

Conserve School is lacking a section in its biology/environmental monitoring class with regards to knowledge and understanding of the species diversity on the property owned by the school. The importance of this project is: to give students at Conserve School an experience that they cannot get anywhere else relative to advanced forest ecology work at the High School level. Invasive species movement (if any) can be monitored and perhaps prevented in the future. It will hopefully give students a better appreciation for plants and animals and the environment that they share. It will teach ethical diversity sampling techniques that will leave the environment in the same condition it was in before the study was conducted.

E. THE LIMITATIONS

1. The study will be limited only to students who come to Conserve School's semester program.
2. The magnitude of the study is limited to the resources available with regards to sampling equipment.
3. The actual act of performing the inventory is limited by the weather and how long winter lasts considering that the two semesters of the program are vastly different from one another.
4. The longevity of this project is reliant on how long Conserve School and the Science teachers there want it to go.

F. DEFINITIONS

1. Conserve School: Conserve School is a Semester School for mainly High School juniors and seniors with an emphasis on inspiring environmental stewardship.
2. Invasive: A term used to describe species of organisms that migrate into an area and outcompete native species.
3. Inventory System: The systematic collection of specific data for the purpose of determining the species diversity in a given area and how many of each species there are in that area.
4. Population: A group of organisms of the same type (class, genus, species, etc.) living in a specific area.

G. ASSUMPTIONS

1. Conserve School will want this inventory to happen.
2. There are plants and animals that can be inventoried on Conserve School's property.
3. The science teachers at Conserve School have an extensive knowledge base of the local plants and animals and can help students to identify them in the field.
4. This inventory can be included in the environmental science curriculum at Conserve School.
5. The science teachers at Conserve School will agree to keep this inventory project going in the future.

CHAPTER II. Review of the Related Literature

The literature review will contain these areas: (1) why biodiversity is important and what other studies are being done that are similar to this one, (2) what is a curriculum framework, (3) methods on how to conduct a survey of mammals in a given area; what's needed, how to sample, etc., (4) methods on how to conduct a survey of plants in a given area, (5) methods on how to conduct a survey of birds in a given area, and (6) a list of written sources on the known plants and animals present in Northern Wisconsin.

THE IMPORTANCE OF BIODIVERSITY

Part of the inventory that will be done involves an ongoing discussion with the students on the importance of biodiversity and why we do studies like this to begin with. With regards to the importance of biodiversity, the Ecological Society of America has a short but valuable article outlining different reasons that the diversity of life should be maintained (Ecological Society of America, 1997). This can be used to fuel a series of discussions concerning the importance of the components of biodiversity. After looking at why it is important we can look at what other people are doing by looking at websites like the Beaver Creek Reserve and their section on citizen science (Friends of Beaver Creek Reserve and Eau Claire County, 2007). Ideas can be adapted from what they are doing with their citizens to this program for further development. For example, Beaver Creek Citizen Science Center performs a number of projects involving people of all ages including: stream monitoring, rusty crayfish monitoring, aquatic invasive monitoring, acoustic bat monitoring, frog and toad surveys, and aquatic plant surveys. They also do a project called Wisconsin Nature Mapping which is an online project that anyone in the state of Wisconsin can take part in. Participants can record observations of wildlife that they see on their website. (Applied Data Consultants, inc., 2011) The Urban Ecology Center (UEC) has a bird specialist, Tim Vargo, at the head of their citizen science projects, and they run a number of biodiversity related projects including: Herp surveys, migratory bird banding, tree surveys, soil surveys, and monarch butterfly marking. (Urban Ecology Center, 2011)

With what Beaver Creek and UEC are doing there is no reason that Conserve School cannot be doing something similar if not completely unique. The thing that sets Conserve School apart from Beaver Creek and UEC is that Conserve has students that are present for at least fifteen weeks instead of a handful of volunteers that cannot be depended on for consistent longitudinal work. Even though Conserve students are turned over each semester Conserve has the ability to do advanced work through continual training for biodiversity inventory work. Conserve School will be able to stand apart not only from other organizations that do citizen science but also from other semester schools because of this.

WHAT IS A CURRICULUM FRAMEWORK?

A curriculum framework can be either an incredibly extensive piece of an educational plan for subject matter, such as an entire outline for what should be taught in a field, such as science, throughout a student's entire education in a K-12 system. (California Department of Education, 2011) Or, a curriculum framework can specify "what is to be taught for each subject in the curriculum." (Pennsylvania Department of Education, 2011) Based off of these findings one can conclude that a curriculum framework can be as broad as being an outline for a student's entire educational journey, or it can be a specific piece of that puzzle. For example, a curriculum framework can be developed for a very specific part of a single classroom subject. In a biology classroom a framework can be developed to focus on cellular reproduction and how it relates to the human life cycle. For this project, a curriculum framework has been developed to be implemented into Conserve School's environmental science class as part of the ecology unit.

HOW TO CONDUCT A SURVEY OF MAMMALS

The main source for detailing how to conduct a mammal survey is a book released by the Wisconsin DNR. (Christoffel, Covell, Craven, & Ruff, 1999) It details a number of methods and these methods are used by professional researchers as well as private land owners. The book is specifically geared toward use by private land owners so it is entirely appropriate for use by Conserve School. Two published articles were also used to reinforce the methods used in the DNR book. The first article (Cole, 1993) details the set-up of a grid of live traps, the bait used, and the time frame of trapping nights. The second (Osbourne, Anderson, & Spurgeon, 2005) details the use of pitfall traps in a cross shape setup. Pitfalls and live traps can be set up along a grid (See Figure 1) using similar methods to how they were set in both articles. Trapping small mammals is an optional part of the study. Another way to gain an idea of what's out there is to use observational methods through the use of wildlife cameras, track and scat identification, as well as mammal sightings either with the naked eye or through binoculars, such as those performed in the study addressed in the Cole article and the DNR book. Scent posts can be set up to attract carnivorous mammals and this allows for a greater chance of identification through the use of cameras, tracks, etc. Chapter 4 will go into greater detail as to how to perform this inventory.

HOW TO CONDUCT A SURVEY OF PLANTS

The data collectors will be performing either the Point-Centered Quarter (PCQ) or the Random Pair method of forest sampling. Several sources outline PCQ (May & Penfound, 1967) and Random Pair sampling (Anderson, Jones, & Swigart, 2006) and their benefits (Cottam & Curtis, 1956) with regards to ease of use, accuracy, and efficiency. Before moving out into the field a map is acquired of the site that is being sampled and a grid is drawn to represent the sample lines. Lines are placed ten meters apart and groups of samplers move in the same direction along as straight a line as possible. They stop every five to ten meters, depending on how large of a sample area the researcher wants, and place a point/stand at a single point. In the PCQ method they will then divide the local area into four quadrants and take a sample of the closest tree that is over ten centimeters in diameter in each quadrant. (See Figure 2) Data to be collected is species, diameter at breast height (approximately 5 feet) using DBH tape, and how far from the center point the tree is. This is performed once per quadrant per point.

The researcher can then decide whether or not to sample saplings or shrubs, as well as herbaceous plants on the understory. Understory is generally measured by picking a square meter of land and counting and naming the plants in that given square meter; assistance of the instructor may be needed in order to identify all of the plants present on the ground layer. This can be done once per point instead of in all four quadrants. Samplers move down their respective lines and take as many samples are necessary for the given site (generally five to ten is fine). The second method to try for sampling trees, which happens to be faster but less extensive, is the Random Pair sampling method (see Figure 3); the concept is the same, but instead of splitting a point up into quadrants the samplers stop at their point and measure the distance to the nearest tree that is over ten centimeters in diameter at breast height from the point, then measure the second closest tree for diameter and distance from the point. The same methods can be used for saplings or shrubs and herbaceous understory plants. Both of these methods will help give an idea on how dense a forest is and what the species diversity is for the site.

HOW TO CONDUCT A SURVEY OF BIRDS

The DNR's book on inventorying and managing wildlife also details inventories of birds. (Christoffel, Covell, Craven, & Ruff, 1999) Observational methods can be used on the data collection for birds in the area. Students can perform the National Audubon Society's Great Backyard Bird Count each semester. (National Audubon Society, Inc, 2011) The same observational methods can be put to use when students go out into the field at different sites and record what they see with regards to birds, as well as what they hear. If they do not know a bird by appearance or by call they can attempt to look it up using the internet or different birding books available in the Conserve School Library such as Peterson's Field Guide to Birds of Eastern and Central North America (Peterson, Peterson's Field Guide to Birds of Eastern and Central North America, 1934).

WRITTEN SOURCES OF KNOWN PLANTS AND ANIMALS IN NORTHERN WISCONSIN

A valuable web source of the plants of Wisconsin is the Robert W. Freckmann Herbarium out of UW – Stevens Point. (Freckmann, 2009) This site has extensive information on the plants of Wisconsin and is perfectly credible source of information that is easy to access for free by all on the World Wide Web. Conserve School also has plant identification guides that can be checked out from the library including Trees and Shrubs (Petrides, 1972), Ferns (Cobb, 1984), and Wildflowers (Peterson & McKenny, 1996). One book that will be very useful details a number of the species of mammals that live in the Great Lakes region, and it will be the primary source of literature for this study with regards to species identification (Kurta, 1995). Another book that can be used (Jackson, 1961) details the mammals of Wisconsin specifically. This will be useful for discerning migration patterns to see if mammals have moved into this area compared to what past research indicates because the book itself has distribution maps for all of the known species of mammals present in the state, including Vilas County, the county in which

Conserve School is located. The book Wisconsin Birds can be used as a reference for all of the birds that are in Wisconsin and even goes so far as to show when the birds are located in certain areas of the state and in what density. Because it was written in 1997 it will be difficult for it to be used as a comparative analysis tool to measure change as the window of time between now and then is relatively small, however it can give a little insight with regards to that particular topic. (Temple, Cary, & Rolley, 1997) All of these sources are quite advanced and will definitely provide a unique experience for any student who gets involved in the project.

SUMMARY OF LITERATURE SOURCES

The first source discusses the importance of biodiversity while the next couple of sources are studies that other organizations are doing in light of the importance of biodiversity. After that there are two examples of what a curriculum framework is from two different states. Following that is a source that details inventorying and monitoring techniques for birds, mammals, and herpetiles, as well as two more sources that detail mammal trapping and observational methods. After that there are sources that describe methods for inventorying trees. Next is a source describing observational methods for doing a bird count. Finally there are a number of sources for all of the known species of plants and animals in this region of the country/state including field guides, web sources for identification, and distribution maps of known species in different areas of the state.

CHAPTER III. Methodology

1. Inventory and Data Research Methodology

A. Mammal data will be collected through observational means and by using a grid of Sherman live traps (H.B. Sherman Traps, 2003-2005) and pitfall traps. The grid size is dependent on how many traps can be acquired, but a reasonable number of traps would be twenty. It would be four lines of five traps spaced ten meters apart in all directions to form a rectangular grid that is forty meters wide and fifty meters long. Traps would be marked with ribbons tied to nearby trees/shrubs to make them easier to find, and each trap would be numbered with two digits, one that represents the line and one that represents the trap number. For example, the third trap on the second line would be trap 2-3, that's line 2 – trap 3. Traps will be set out in the afternoon/evening and left over night, then checked in the early morning for specimens. Specimens will be documented as follows: Species, gender, weight, trap number, date caught, weather conditions (temperature, phase of the moon, was it clear or rain or snow?), and anything else that's notable (is the specimen still alive, is it a pregnant female, etc.). In addition to trapping, mammal signs (such as scat, tracks, rubbings and scraping on trees, etc.) will be identified and recorded. If available, a wildlife camera can be used to photograph any animals that are active at night.

B. Plant data will be collected as described in the "How to Conduct a Plant Survey" section of the Literature Review.

2. The Specific Projected Treatment of Each Sub-problem

A. DEVELOP A CURRICULUM FRAMEWORK FOR THE CONSERVE SCHOOL INVENTORYING PROCESS.

i. Determine the learner outcomes, academic standards, and assessment strategies that the inventory will work with

1. The researcher developed the learner outcomes, and consequently the academic standards, by addressing Conserve School's Schoolwide Learning Goals (which can be found in Appendix B). Those learning goals that are in *italics* are goals that specifically influenced the learner outcomes for this inventory. The learner outcomes are as follows – Students will be able to:

    a. Suggest what the dominant species of tree is for a site in a forest based off of abundance and average diameter at breast height.

    b. Inventory different animals using various scientific methods, especially through observation.

    c. Compile and organize data collected from the field into a common database, then analyze that data to determine the results of the study.

    d. Evaluate the data collection process to improve their methods.

2. Academic standards that these learner outcomes meet or work to help fulfill in the State of Wisconsin are as follows – as found at the WI DPI website (Sandrock, 2009):

    a. Science Inquiry Performance Standards: C.12.3 Evaluate* the data collected during an investigation*, critique the data-collection procedures and results, and suggest ways to make any needed improvements; C.12.4 During investigations*, choose the best data-collection procedures and materials available, use them competently, and calculate the degree of precision of the resulting data.

   b. Environmental Education standards: B.12.3 Evaluate the stability and sustainability of ecosystems in response to changes in environmental conditions; B.12.6 Predict population response to changes in environmental conditions; B.12.7 Evaluate the importance of biodiversity

3. Assessment of these learner objectives is entirely authentic as it is all a hands-on inquiry based project. (Pearson Education Inc., 2011) This was all done by Spring 2011.

ii. <u>Create a detailed methods narrative of how to perform the inventory</u>

1. The researcher compiled the methods for performing various inventories of plants and animals based off of information found in various articles stated in the literature review. Those methods were then synthesized and arranged in paragraph form and placed in Chapter Four. Chapter Four will discuss where to start with this project and what can be built up to with this inventory. This was done from the spring semester of 2010 through spring of 2011.

B. RESEARCH RESOURCES TO SUPPORT THE FRAMEWORK

i. <u>Discover various programs that are offered through other organizations that are similar to what Conserve School can do</u>

1. Through searching for organizations that offer Citizen Science projects the researcher came across the Beaver Creek Citizen Science Center in Eau

Claire, WI, as well as the Urban Ecology Center (UEC) in Milwaukee, WI. As discussed in Chapter Two, both centers offer a number of citizen science projects to the public that involve getting people of various ages involved in surveys of what species are present in local ecosystems. The researcher was unable to visit Beaver Creek, but did get a chance to visit UEC in January of 2011 to discuss some of the projects that Tim Vogel has going on there. He mentioned several inventories that they do and mentioned that if he had a consistent force of volunteers (like what Conserve School has with their students), that they could do quite a bit more work to add to their local and a national database (such as BirdSource/eBird). After seeing what these two organizations can do it is clear that Conserve School can easily do what they do and that it can be included in their science course.

C. CREATE A DATABASE ON THE DIFFERENT TYPES OF PLANTS AND ANIMALS IDENTIFIED THROUGH FIELD WORK PERFORMED BY STUDENTS THAT WILL BE CARRIED ON FOR SEVERAL YEARS.

i. <u>Create an easy to access and use electronic file that can be added to for future research</u>

1. Microsoft Excel was chosen for ease of use in the creation of the database simply because more people know how to use Excel compared to Microsoft Access, which is a more complicated program that can also be used for creating a database. The spreadsheet consists of six tabs, one for each type of inventory process depending on what is being inventoried. It was set up so that data can simply be transferred and plugged in from

field notes from data collection. Through various manipulations of the spreadsheets (such as data sorting based off of most present species or most diverse sites), students and their instructors can create charts and graphs, and other useful tools to analyze the collected data. For example, using the spreadsheet for Table 3.2, students can sort the data to determine what the most abundant species is, or they can sort it to determine what species had the largest average diameter. They can create visual representations of this comparative data in the form of a bar graph to better analyze the two factors of what makes a species dominant. This file is easy to copy for multiple inventory recordings and can be backed up in several locations so that data can be collected and added to for several years. It is located on the local Conserve School server "\\birch\Data\Curriculum\Science\BiodiversityInventoryDatabase-ByElliott". This was completed by the end of February, 2011.

D. EVALUATE THE INVENTORYING PROCESS AND ADAPT IT TO FURTHER AID WITH THE NEEDS OF CONSERVE SCHOOL.

i. <u>Communicate with Conserve School faculty about the inventory and how it can fit into the curriculum</u>

1. Through informal communication with the science teachers at Conserve School the researcher was able to evaluate what was possible and thus make suggestions in the description of the research methods for what will work best for the classes that they will be teaching. Ideas were taken into consideration and put forth into the project based off of the minor evaluations done. In depth evaluations were limited based off of time

constraints and the inability to perform a pilot study. What evaluations were able to be performed were done from late fall 2010 and spring 2011.

E. BEGIN INVENTORYING PROCESS AS A PILOT STUDY WITH STUDENTS.

i. Design the pilot study and implement it into the program

1. The pilot study was designed to be a quick inventory of an easy to access portion of the forest on Conserve School's property. It was originally going to be an inventory of the trees on the chosen site since that would be the easiest and most interactive yet most data intensive project to perform. However, due to time constraints the pilot was unable to be performed before this project was due for review so it was not implemented into the spring semester's curriculum. Had time not been an issue the pilot study would have included a series of small inventories performed on a site near the school's main academic building on a smaller scale than the full inventory that this project designed. A small grid would have been set up and students would have collected two to three points of data from that grid and made observations sporadically throughout the course of two weeks. One of the two science teachers would have been involved so that he would be able to get a grasp on the situation before implementing the inventory as a whole. This pilot was designed by March 2011.

CHAPTER IV. Results and Discussion of the Project

DEVELOP A CURRICULUM FRAMEWORK FOR THE CONSERVE SCHOOL INVENTORYING PROCESS

Please note that the methods outlined in this chapter are in reference to the sources addressed in Chapter II. This was done to remove clutter from the text to make it more readable.

Where to begin:

There are a number of ways that Conserve School would be able to go about performing this inventory. The best way is to start with baby steps going forward. The first time inventorying in the field would probably be a simple study of a site near the main academic building just off the shore of Little Donahue Lake. Because Conserve School has four blocks of class, four different inventory processes can be done consecutively so that all four groups are not collecting the same data. The first group can collect tree data, the second mammal data, third bird data, and fourth can do an overall sweep of the site. How this would work would be that the first group would move out, on a grid, at the site, and do a species diversity count at each of their points on the grid. They would not count individual trees, but instead they would count how many species of trees they can see from their point on the grid. After this is completed the data can be compiled and they can interpret the results in class. For mammals and birds, because these are not stationary things that can be counted like trees, students will still move on a grid and stop at each point to record species diversity like they would with trees, but as they walk their grid they would also count any animals or animal signs (scat, tracks, bird calls, etc.) and record those as they move. The final group will not record anything between the points on the grid but instead will record trees, shrubs, birds, mammals, or any other forms of life that they can see aside from understory plants on the forbs layer.

This activity can be a once per semester event that introduces the students to performing an inventory. The science teachers can then, depending on the success of the initial inventory, choose to continue at different locations throughout campus using the same methods, or they can increase the complexity of the activity for each group. The largest concern for how they make their choice is based upon time constraints of class days and the volume of material covered by the course (see Appendix B for the course syllabus). While there are days that do not have scheduled activities, several weeks could be used up doing nothing but inventorying, which is just unrealistic for the course. Instead it is recommended that at the most, four days be used for inventorying per semester unless, after evaluating how well the inventory works with the students, Conserve School decides that this is something they want to pursue further.

With four days available, four locations on campus can be inventoried per semester. In order to get the students to be able to participate in each inventory (plants, mammals, birds, etc.) four sites should be chosen and dedicated to individual block groups of students. Then, on the first day, all students can perform the trees, saplings and shrubs inventory on the first day. The second day, all students can perform a mammal inventory. Third, they can do birds, and on the fourth day they can perform the observational sweep as described above for the initial activity's fourth group.

Ideally, these four days would take place either in early fall of the first semester, before the leaves on the trees have dropped, and late spring of the second semester after the leaves have sprouted. Because conditions can be somewhat unpredictable in the spring it may just be best to perform the inventory at the most opportune time for the school since trees have been known to bud in mid- to late-May which is when classes are starting to come to a close. The benefit of snow would be that animal tracks would be easier to keep track of for the mammal inventory, and mammal tracking is already part of the course's curriculum as it is so one option would be to collect the data for the sake of the inventory while doing tracking in the winter. Fall may not have quite as much of an issue with regards to plants, but mammal tracking could be done later in the season after snow has fallen.

A note on the grids:

Each inventory description makes use of the same grid system. There is no reason to use different sites for each outing into the field. It is suggested that once a site is used for one inventory it is used for all other inventories. This will not only save time in planning but it will also provide an interesting overlay of data that will paint a wonderful picture of the entire ecosystem when comparing data sets. That is why it is important to number each chosen site and keep that number assigned to it clear. It will be left up to the one leading the inventory to discern where each site will lie on the map.

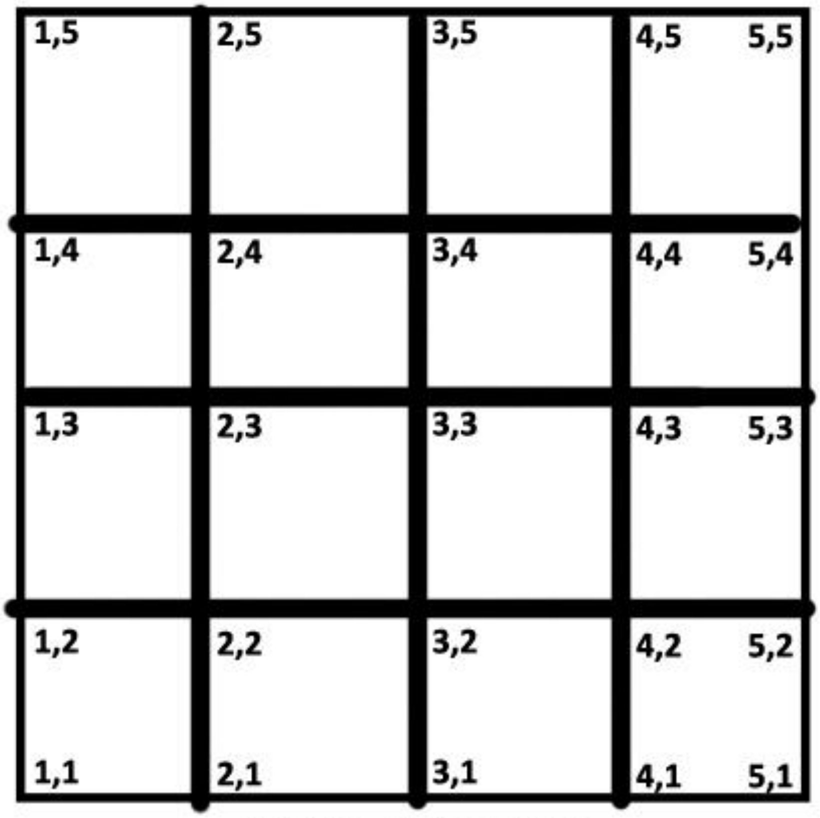

Figure 1 - Grid Example

Evaluating the Inventory

After each inventory is complete the instructor should perform two different evaluations: one of their own to determine if the students were accurate with their data collection, and one asking the students for feedback on ways that the inventory can be improved. Students should be asked these questions: How can each inventory be done more efficiently while still maintaining accuracy of data? Do you think that these methods accurately measure the species diversity of each site? If not, how can the methods be improved upon? Do you feel that this inventory helps you to better appreciate the outdoors and encourage you to be a better environmental steward?

Based off of student answers, and their own personal evaluation, the instructor can adjust the inventory to continually support the mission of the project and the mission of the school.

Making the inventory more complex:

Doing a species diversity count is fine for when the inventory is just starting out, but one of the learner goals for the school is that students are to take “a strong step forward on their educational path equal to or greater than the expected progression in their sending school.” Because of this, the challenge of this project can be increased and students can gain more advanced experience in performing an inventory process. Below there are details on how to perform advanced inventories of trees, saplings, shrubs, herbs, fungi, mammals, birds, and other forms of life. While doing more advanced techniques for all of these may be beyond the scope of a high school student’s education Conserve School can definitely facilitate at least the more advanced plant inventories that they likely would not get at their sending school, if not do more.

This is convenient because Conserve School recently hired professional foresters from Sylvania Forestry to survey the spring ephemerals, and using that data they were to determine what the overstory most likely consists of. With the methods that students can use for plants here they can double-check the spring ephemerals study and confirm things for themselves; something that Conserve School mentioned they would like to do with their students.

Before getting started with these methods a few pieces of equipment are suggested for each group: Diameter at Breast Height (DBH) tape for measuring the diameter of the tree; a compass so that they know that they are continuing on in the proper direction; measuring tape that will be used to measure the distance from the center point to the trees being counted in the survey; two meter sticks fastened together at the ends so that they form a ninety degree angle which will be used to measure one square meter of forest floor. While these items are suggested there are ways to make measurements without them. To replace the DBH tape all that is needed is a section of rope or twine that is long enough to go around the largest tree in the inventory, and a way to measure it. The measuring tape can be replaced with careful pacing and estimations (though this is not nearly as accurate). Finally, the square meter can be approximated or only one meter stick is necessary per group if two cannot be acquired and fastened together.

Advanced sampling – trees, saplings and shrubs, and herbs and fungi:

As described in Chapter Two, there are two ways to perform an inventory of trees: Point-Centered Quarter (PCQ) method or the Random Pair method of sampling. Random Pair sampling is faster and less extensive than PCQ, but as a result is less accurate. Depending on how much time can be allotted to this part of the inventory the instructor may want to use a mixture of both methods for different sites or to make the decision to only use one.

To start, pick the different sites where the grids will be placed for survey and, as with the mammal survey, split the students up into groups of two to four. Two can perform the survey but with three they can be more efficient. One student will be in charge of pacing out the grid and stand at the official point on the line, one will pick the trees that are to be sampled, make the measurements and report them so that the third person can make the recordings. Two students can split this work, but it would simply work better and would move faster with three. Both methods require the process of moving down the grid and stopping at each point. The difference between the two lies in how many trees are sampled.

PCQ method samples four trees whereas Random Pair sampling only measures two. In PCQ, once a point is reached the forest is split into for quadrats, using the gridline to split the forest into the first two, then another second line perpendicular to the line of travel. It does not matter which quadrat is sampled first, but for consistency's sake it is best to start and finish with the same one at each point. Students will measure the distance from the center point to the nearest tree in each quadrat. A tree is defined as being at least ten centimeters in diameter (or 31.4 cm in circumference) at breast height. Anything smaller is considered a sapling. From there they will identify the tree to species, and measure the diameter at breast height using DBH tape. If DBH tape is not available, a rope can be used to measure the circumference. To convert circumference to diameter divide the recorded number by pi. This is repeated three more times, once for each quadrat. If a tree is directly on the center point or in more than one quadrat, pick the quadrat that the bulk of the tree stands in then proceed to choose the next closest tree for each other quadrant. Figure 2 illustrates a single point on a PCQ grid. Each dot represents a tree, but only some trees are big enough to be sampled. In the upper left quadrant point 1 is the closest tree of the proper size. As long as the tree is large enough to be sampled it can be included.

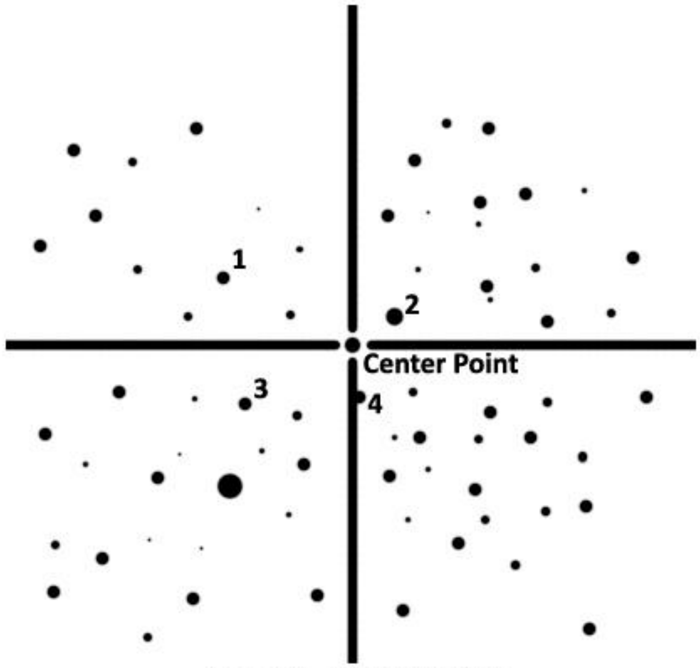

Figure 2 - PCQ Sampling

Random Pair sampling is done the same way, but instead of recording four trees students will pick the nearest tree to the center point and record the same measurements (distance to the tree, species, and size of the tree), then find the second nearest tree that is 180° from the from the first sampled tree and repeat the measurements. In other words, instead of splitting the point into four quadrats, you split it in to two halves. Find the nearest tree, then find its pair – the nearest tree in the other half of the sampling site. Both methods are used by researchers worldwide and are valid tools for a forest inventory, but again it is up to the person running the inventory to decide which best fits their needs. Figure 3 shows random pair sampling for the same exact site as what Figure 2 illustrates; the dashed line represents the division of the two sampling areas (180° from one another) with the nearest tree located in the second half and its pair in the first half. The two trees large enough to be included in the survey that are closest to the center point are marked.

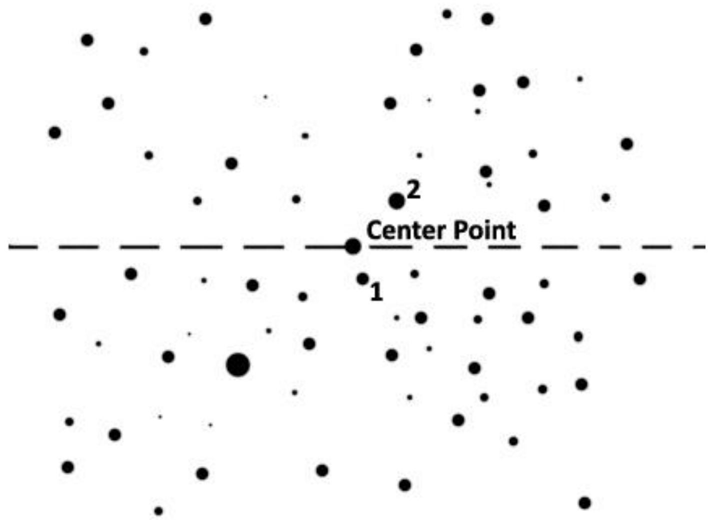

Figure 3 - Random Pair Sampling

While sampling trees, no matter the method, saplings and shrubs can be sampled simultaneously, along with herbs and fungi. Saplings and shrubs can be sampled via the same methods in Random Pair sampling except it is unnecessary to record the diameter of these plants. Simply noting their species and distance from the center point is all that is necessary for the purposes of this study. To sample herbs and fungi on the forest floor, measure one square meter at the center point (or as close as possible if a tree is located right at the center) and record all of the plants, fungi, mosses, or other non-animal organisms that are present in that space, preferably to species but sometimes genus is all that can be discerned without expert analysis. Once all the different species are accounted for, estimate the percentage of the square meter that is covered in living organic material.

All of these measurements and calculations are designed to paint a portrait of how dense the forest is. If it can be helped, only measure plants that are alive, but take note of seemingly dead plants as it will provide an idea of the health of the forest as well. Fungi can grow on the ground, but if it is growing on trees that are sampled it should also be recorded.

To inventory mammals:

There are two ways that mammals can be inventoried. The first is to set up traps, either live traps or death traps, and the second is through observation; it is possible, and actually recommended, to do a hybrid of both. For trapping, live traps are recommended with regards to student interaction as the CDC will not allow students to handle the carcass of a dead animal. One thing to note is that there are special considerations that need to be made with regards to live trapping and the prevention of disease contraction and it may or may not want to be avoided by Conserve School because of that. However, even though this is the case, the framework for trapping will still be described regardless including the methods that should be taken to help prevent the spread of disease from animals to humans.

When preparing to trap small mammals the right equipment is needed as well as a good idea of where you will be trapping. For example, if you plan to trap in a bog it may not be the greatest idea to use a pitfall trap as it may fill up with water and drown any specimen that it may catch. Three different live traps can be used including pitfall traps, Tomahawk wire traps, and Sherman traps.

Pitfall traps are the most simple in nature and require the least amount of technology to set them. It is possible to use a simple coffee can as a pitfall trap by digging a hole in the ground, placing the can in the hole, then filling in the hole around the sides of the can to brace it in place. Make sure that the edge of the can is either level with or slightly below ground level so that the animal will simply fall in instead of finding the exposed edge and skirting around the opening. It is not necessary to place leaves or grass over the trap to camouflage it, though that can be done as long as they it is done sparingly. Remember, the only thing keeping a specimen in the pitfall trap is gravity, so if there is a stick or something that is placed over the opening that happens to fall into the trap with the animal, that animal may be able to use the stick to escape.

Tomahawk wire traps come in various sizes, (Tomahawk Live Trap Co., 2000) but for the purposes of this project the size of the trap should be approximately two feet long, ten inches tall and ten inches wide. This will allow the capture of slightly larger mammals than a pitfall or a Sherman trap. These are wire cage-like traps with a plate on the inside where bait is to be placed. The bait you choose will determine what kind of animal you capture. If you are looking to capture a small predatory mammal such as a weasel, use raw meat, however if you are looking to capture a squirrel or some other animal with a habit for herbivory, use various mixtures of oatmeal, peanut butter, raisins, grapes, etc. Place the bait on the plate, the animal goes in after it, steps on the plate, and the door snaps shut. A caution with regards to the use of Tomahawk traps; these do not keep smell inside them so the bait you use may attract larger animals such as bears, coyotes, or raccoons. It may be a good idea to set up a wildlife camera to watch these traps just in case, that way if a trap gets destroyed by a hungry black bear there will at least be some data to show for it. Be wary of skunks as well since they may be small enough to fit inside one of these traps. To avoid animals like this, check the size of the animal and purchase traps that are too small for it to get caught in.

Sherman Traps are much smaller but also come in various sizes. (H.B. Sherman Traps, 2003-2005) These are metal boxes that are usually less than a foot long and only a few inches tall and wide, designed for trapping small mammals such as mice, voles, and shrews. A similar system to the Tomahawk trap is used for capture with a plate inside attached to a spring loaded door that snaps shut once pressure is applied to the plate. The latch on these is more touchy since the target animals are quite light, so when setting them up be sure to carefully place them on the ground and watch your step around them otherwise they may be tripped accidentally leaving no chance for a successful trap. These traps are also quite fragile and will not withstand being stepped on. It is also somewhat common for traps to be ripped open by coyotes or other larger predators trying to get at the contents inside. The bait used for these should be a combination of oats, peanut butter, raisins, and maybe something with a little more sugar to attract a variety of small mammals.

When picking the area you will be trapping in, be sure that it is at least somewhat accessible to groups of people, but feel free to trap in otherwise difficult terrain. Thickets and bogs can be home to many interesting animals, but so can meadows and forest floors. When placing Sherman and pitfall traps, it is best to place them along tracks where animals my run on. Think like a small mammal trying to avoid predation from owls or other predators and place them near bushes or along fallen trees rather than simply plopping one down in the open. Tomahawk traps are similar but can be used at the bases of trees as well or along the edge of a water source.

Before checking traps that have been tripped it is important to have several items on hand including a notebook, pencil, and possibly a camera for data collection, a scale to measure the weight of a specimen, a ruler, rubber gloves that are thick enough to try to avoid puncture from a rodent's teeth, and possibly a mask to prevent aerosolized germs from entering the lungs. The mask is optional but recommended when working in a zone known for animals that carry diseases such as Hantavirus. Another set of items to have on hand would be a box of gallon sized plastic sealable (Ziploc works well) bags.

When approaching a trap that has been tripped it is best to keep quiet so as not to alarm the animal inside. For pitfall traps you simply need to clear away any debris that might have fallen over or in it and peer inside to check it. When you are done trapping with it cover the opening with something large and heavy, a rock works well, so that animals may not be trapped when you have no intention of returning for more than a day. This will prevent unnecessary death. It is best to remove the trap and fill in the hole when you are done trapping for the season. With Tomahawk traps you can almost immediately tell if the trap is tripped and there is something inside since it is a wire cage. If there is an animal inside, carefully approach quietly and without sudden movement to reduce stress on an already stressed out animal. Determine the species, or at least the genus, of the animal to determine what to do next. Always use caution when opening a trap, even if the animal is seemingly harmless like a squirrel. Live animals will bite, scratch, and excrete on you in order to defend themselves and try to escape. When one works with animals large enough to fit inside a Tomahawk trap it is best not to handle them at all unless under the supervision of someone with experience. Simply make whatever recordings are possible and release the animal carefully.

Sherman Traps are the hardest to tell if there is a specimen inside. These trip easily so they are often empty even if the door is shut. Despite this fact they are one of the best ways to trap small mammals live with low chances of mortality of the animal. Again, approach the trap quietly and pick it up carefully. Before opening it, give the trap a small shake from side to side to feel if there is anything inside other than the bait that was set. Usually one can feel the presence of a small mammal bumping against the side walls if there is something inside. Even if nothing is felt, the person checking the trap should turn so that their back is to the wind if wind is present *before* opening the trap. It is *very important* to do this so that any urine, feces, or other debris inside the trap does not come blowing out into a person’s face or clothes. This is one of the times where a mask may be a good idea. To visually check the trap, tilt the trap so that the door is up and the sealed end is down at least a forty five degree angle relative to flat ground with the intent of having the animal at the bottom of the trap. Use one finger to push the trap door open and peak inside, making sure not to inhale right as you open the door, and visually confirm if the trap is empty or not. If not, try to confirm what the animal might be inside. If it is something like a least weasel it may be best just to release it to avoid injury, but otherwise report what the animal might be and request a gallon sized plastic bag.

To remove the animal inside with the intent of handling it for data collection, place the plastic bag around the opening of the trap so that when the trap is opened there will be no escape for the animal. Press the door completely open from the outside of the plastic bag and try to coax the animal out with a gentle shake. If that does not work a more violent method can be used that does not necessarily hurt the animal but may startle someone watching: raise the trap up and forcefully shake it down toward the ground so that the animal inside is flung into the plastic bag. This is done because the animal is likely already stressed and hiding in the corner clinging to whatever it can cling to, and therefore it is important to remove it quickly so that data can be gathered and the animal can be returned to the wild. Move quickly and corner it in the corner of the bag by cinching the bag around it and removing options for it to go anywhere but to the corner, wrapping your index finger and thumb tight around the outside of the bag. From there, reach in and scruff the animal behind the neck, making sure to wear gloves, and pull it from the bag to allow it to breathe. Hold it firmly so that it does not fall but not too tight so that circulation or respiration is not cut off. Quickly gather your data on what it is: this might include taking a picture, weighing it, measuring the length of the tail or ears, and sex it by looking for external reproductive organs. When all of the data has been collected it is very important to return the specimen to the same place where it was trapped so that it can easily find its way back to a safe hiding spot that it is familiar with rather than removing it from its home range or placing it in another animal’s territory.

Snap traps (like a household mouse trap) can be used to collect specimens, but as discussed earlier it is not recommended for use with high school students and should be done sparingly, if at all, as it more often than not kills or at least injures the animal. To reduce impact on a population, snap traps should be used sparingly and only with the intent to collect tissue samples for research or to create a study skin for identification purposes.

Traps should be set in the afternoon and checked in the early morning the next day. It is important not to leave traps in the field if the group is unable to check them after the first night! Leaving traps unattended will result in traps disappearing (carried off by wild animals or by people), or the death of captured animals due to starvation, drowning, hypothermia, or overheating. It's best to check traps right after sunrise to avoid overheating inside the Sherman traps (imagine sitting inside a metal box in direct sunlight), but also in case an animal is confined and cold and unable to move around to raise its body heat. If it rained expect things to be worse, it is not uncommon for animals to die after a night of rain in a trap. It is also best to not set traps during the day for similar reasons, so set them in the later afternoon either before dinner. Avoid negative results and check traps early then remove them or trip them so that they cannot capture an animal if you do not plan to check the next day.

Observational methods can also be used instead of going through all of the methods to live trap. It is much easier to go out and record what can be seen, however the data is not nearly as extensive as trapping since most mammals are nocturnal and quite elusive, not to mention that working with live animals is much more exciting and memorable for anyone involved. To collect data via observation, go out into the field and simply write down or photograph what can be observed. Actually observing a mammal is best, but finding mammal signs such as scat, tracks, fur, or rubbings/claw marks on tree bark can also lead to valuable data. Setting up wildlife cameras near game trails, water sources, bedding grounds, dens, or perhaps near a carcass or other food source can also provide good data. It is suggested to use these observational methods alongside live trapping so that a better picture of the ecosystem can be painted and recorded.

The Christoffel book describes each of these methods, but also details a way to increase the chance of success of observational methods for carnivores with the use of scent posts. To create a scent post a plaster scented disc, available from the USDA Pocatello Supply Depot (208-236-6920), should be placed somewhere on or near the grid. Only one is needed per grid and scent posts should actually not be within 300 meters of each other. The scent post station should be approximately one meter in diameter. All rocks and vegetation should be removed from the station and sifted soil can be placed on the ground. This is to allow for good imprints of mammal tracks. Wildlife cameras can be set up so that the animal that visits the scent post can also be photographed. Rubber or latex gloves should be worn when handling the scented disc and researchers should take care not to leave other scents behind when setting this up. Rotten eggs or meat can be used instead of scented discs to attract these carnivores.

All methods should be used on a grid. Determine where on the property each site is to be located with the use of topographical maps and determine how the grid will be set up once at that location in the field. Grids should be at least four points wide by five points long for a total of twenty points per site. This can be modified to be bigger depending on how many students are involved in the survey, but twenty points are quite manageable for a group of ten or twelve students. Points on a grid should be ten meters apart but that number can be adjusted depending on the terrain; it does not need to be exact. For observation, simply stop at a point and make the necessary recordings. Points on a grid should be marked and labeled with flagging tape on site. The point name would be a series of three numbers, the first number would be the site number as there will be more than one site, second will be the line number, and third will be the point number. For example, the fifth trap on line three at site two will be trap “2, 3, 5.”

For all methods of data collection for mammals, it is important to record specific details. The time of day when going out into the field should be recorded, along with weather conditions, temperature, date, and phase of the moon. Mammal activity is known to change with the moon and to get a better feel of when to trap or observe it is good to try at different times of the month and figure out which phase is best, and that still may not be a clear cut answer.

For the actual process of data collection, students should be broken up into groups of two or three depending on the size of the class. A class of ten will have five even groups of two, a class of fifteen will have five groups of three, and so on, and these groups will each take a line on the grid and record data on four or five points on their line. The lines will run parallel to one another and therefore each group will need a compass so that they are all traveling in the same direction. In a perfect world all twenty points will be ten meters apart on all sides save for the edges of the grid, realistically with the terrain, however, the points tend to be more sporadically placed simply due to terrain differences, differences in compass reading, and what method is used to determine how to measure ten meters. There should be at least one field identification guide available for students when in the field so that data collection can be more accurate.

To inventory birds:

As with every other inventory process described in this framework, this can be done on a grid similar to that of the mammal inventory. Observational methods are the most simple for performing a bird inventory. Unlike with the mammal inventory not only can what is seen be recorded, but bird calls can also be used for identification and proof of presence. It is difficult to get a good number of how many birds are present based strictly off of bird calls, so when recording the presence of a bird based off of its call it should be noted that it was not observed visually. When making observations at each point on the grid it is best to record any and all observations right away. If a student does not know what a bird is they should either photograph it or make a good description of key characteristics including but not limited to: approximate size of the bird using comparisons to other more common birds such as the robin, chickadee, blue jay, etc., the coloration of the bird's breast, wings, tail, and/or feet, and how they move whether they fly quickly from tree to tree, hop on the ground, or if they tend to move in groups or alone. Record the location and other data the same way that was done for mammals listing the site, line, and point numbers, weather conditions, and time of day.

There is one other way to inventory birds that is a bit more hands-on, however without the supervision and training from an experienced professional it may not be possible to do so. Birds can be caught with the use of mist nets the same way bats can, but without the proper knowledge and experience the risk of injuring the bird. While it is not recommended to do this it is included here as an option should Conserve School wish to seek proper training to perform such a thing.

As a way to tie in their observations into a national bird count, students can take part in the National Audubon Society's Great Backyard Bird Count (GBBC). The instructions for the GBBC are as follows:

"Count birds at any location for at LEAST 15 minutes—or more if you wish. Later you'll be asked to record the amount of time you spent watching.

- Write down only the highest number of each species you see together at any one time to avoid counting the same birds more than once. For example, if you see 8 cardinals as you start your count period, then later you see 12, and later still you see 3, you'll only report 12--the highest number you saw together at once. Please do not add the numbers together.
- You'll submit your data on a new checklist for each day you participate in the count. It's OK if you count at the same location each day—submit a new list for each day.
- You'll submit a new checklist for each new location. You can submit more than one checklist on a given day if you count at more than one site." (BirdSource, 2011)

To get started, they also offer a checklist of the common birds in any local region. By visiting their checklist website (BirdSource, 2011) the zip code of the area can be input and the checklist will be generated for students to use. It even has a link for most birds on the checklist to help with identification. The GBBC is good not only for the purpose of this project, but also to give students the idea that they are adding to something bigger such as a national checklist instead of just the local database. Students can also add to a database set up by Cornell University, eBird, for another extensive way to add to a national database. (Audubon and Cornell Lab of Ornithology, 2011) This is an addition to the same database (BirdSource) as the GBBC only it can be added to at any time of year instead of the one specific time set aside for the GBBC.

To inventory other forms of life:

Our world is full of life that often goes unaccounted for or is overlooked. The "other" category is designed as a catch-all for these different categories of life. All of these can be recorded on a grid as with everything else that this framework has set up. Most other animals are simply to be recorded through observational means. Reptiles and amphibians can easily be observed if a careful eye is used. Record these observations whenever they are made.

Salamanders can be inventoried using methods from the Christoffel book by placing 12 X 12 inch boards of untreated wood on the ground approximately 150 feet from the edge of a forest (in an open field). These can be checked on mornings after a night where the temperature was not below freezing and at least 24 hours after rain or mist. Each coverboard should have a pair placed approximately half a meter apart to prevent territoriality between individuals. This can be done on a grid like everything else. When placing a coverboard remove all the leaf litter from the area where it will be in contact with the ground so that it lays flat on bare soil. Other animals may use the coverboard for shelter as well so be sure to identify and inventory them as best as possible. This is best done in early spring or late fall when temperatures at night are above freezing.

Fish can be inventoried in lakes and streams in the shallows where they can be observed, through catch and release fishing, or by using electrical shock to bring fish around a boat to the surface for surveying. Aquatic plants can also be recorded while performing this part of the study, as can any observed mammals, reptiles, and amphibians. Aquatic environments are full of all kinds of life, and the lakes of Conserve School's property are a valued resource, so they should not be overlooked despite the large area of land that is present and needs to be sampled.

Insects are quite abundant in all environments and can easily be accounted for through observational means or through the use of D-nets in water if desired. It is a monumental task to try and inventory all of them as their diversity is quite high and they are often difficult to key out to species. It will be up to the one running the inventory to decide whether or not to count insects in the study. This applies toward microscopic organisms as well, but it is certainly possible to gather samples from each point or at least each site.

RESEARCH RESOURCES TO SUPPORT THE FRAMEWORK

As stated in Chapter 2, there are a number of organizations that perform citizen science projects that have to do with wildlife and plant surveys and two major players in citizen science in the state of Wisconsin are Beaver Creek Citizen Science Center and the Urban Ecology Center. These two organizations do a number of monitoring surveys that add to either statewide or national databases and are valued by the DNR for the work that they do. This work can certainly be done by Conserve School, and with the resources that Conserve has at its disposal in the form of students to perform research, land, and financial ability there is no reason that Conserve School cannot be a valued organization in the scientific community as well as being a leader in the private school community for performing this kind of research.

CREATE A DATABASE ON THE DIFFERENT TYPES OF PLANTS AND ANIMALS IDENTIFIED THROUGH FIELD WORK PERFORMED BY STUDENTS THAT WILL BE CARRIED ON FOR SEVERAL YEARS

The database that will be used to record and store all data collected from the field was created using Microsoft Excel. Appendix A gives examples of the database, but the actual database itself is much larger and can be expanded upon indefinitely, and has been left blank for future additions. The first section, on mammals, lists most of the mammals present in Northern Wisconsin as well as some that have been extirpated from the region but were present in the past (such as the wolverine) or have been rumored to pass through from time to time (such as the moose). It is arranged in alphabetical order of genus, but only one category is set up for each genus even though there are possibly more than one species present in the region for each genus.

The examples of each section of the database have been shortened in order to fit on a single page; they are merely a sample of the entire database. For table 1 - mammals, there are three species that have data points recorded. *Lepus a.* was recorded at two different locations, with three individuals spotted. The in the gender column the data is recorded simply as “unc.” This is because these animals were not caught in a trap and could not be sexed and there was no tell-tale sign of their genders, and thus are unconfirmed. The next animal with recorded data, *Microtus*, was caught in a trap at two different locations. The “F” and “M” recorded in the gender column stand for Female and Male, respectively. The third set of recorded data, *Odocoileus v.,* was observed four times at two different locations. The first location had three organisms present have been listed as unconfirmed with regards of their gender, but are assumed to be female because they did not have antlers, hence the listing “Unc(F)”. The second sighting was a single male that had antlers so even though it was not trapped there was still a way to confirm the animal’s gender. This can be repeated for any other animal that has any sort of obvious sexual dimorphism whether it is coloration, antlers or horns, size, or otherwise. This can be applied toward birds and organisms in the “Other” category as well.

Table 2 is a sample of the bird database. There is an extensive list of birds available in the book referred to in Chapter 2. Table 2 lists all birds in that book with the genus beginning with the letter A, and then random birds that are known to exist in Northern Wisconsin from the letter B through H, but the full database follows all the way through T. This is designed to be added to and subtracted from.

Table 3.1 is different from the first two tables in that it lists every point for every site. Unlike with animals where there may not necessarily be recorded data for every point at every site, there will be data recorded at every point for plants and thus the table is different. The example table provides data for the first two points of a Random Pair sampling. If the leader of the inventory decides to use PCQ method they will have to add two more sets of columns for the extra data. For demonstration purposes *Abies balsamea* was added to this example twice, specifically for use in Table 3.2, where it shows the example for average diameter as well as abundance. Table 3.2 also provides a list of common species of trees in this region of Wisconsin, but it may not include all species of tree.

Table 4 is essentially the same as Table 3.1 with the exception of the record of diameter. Table 5 is very similar to the other two except it has a column for percent coverage. It only has two columns for the species that are present, but there is a chance that there will be a large number of species present in the data so more will likely be added. And finally, Table 6 is the catch all for the “Other” category and is therefore the least developed. It will be up to the leader of the inventory to develop this further.

This database is set up in one single file with six tabs, one for each category, but it does not discern the timeframe for which the inventory has taken place. To create a new database for a new year or a second survey of the same sites, it would be easiest to copy the file and fill it in with the new data, and then save it under a new file name that describes the reason for the new data set (i.e. a new year or semester of surveys). As it is up to the faculty at Conserve School to carry out the ongoing study it is up to them to create future databases that meet their own needs. This can be done to monitor change over time. If the same grids are used repeatedly the data can be analyzed to see what was the same and what had changed whether or not it was the presence of a different kind of animal, whether trees have grown, or if new trees have grown to become the dominant species on a site.

EVALUATE THE INVENTORYING PROCESS AND ADAPT IT TO FURTHER AID WITH THE NEEDS OF CONSERVE SCHOOL

Over the course of the design of this inventory framework, the researcher had several informal interactions with the science teachers at Conserve School. In those interactions ideas were pitched to the teachers about what could be done and what would be beyond the scope of their own curriculum for their classes with regards to the inventory process. Through consistent communication and brief explanations of what it is that this project is describing it was decided that the science class could easily pick and choose what parts of this inventory they would use if not simply take the entire idea and apply it to their classes as a whole. With the database provided the teachers will be able to work with what they have here, along with their own personal knowledge, and they will be able to build upon the database as the semesters pass. It will be left up to them to do with this as they desire and to adapt it to meet the needs of their courses strictly due to the fact that the nature of the semester program at Conserve School is one that is new and consistently changing from semester to semester.

BEGIN INVENTORYING PROCESS AS A PILOT STUDY WITH STUDENTS

Unfortunately the pilot study was not able to be implemented in the spring 2011 semester. The framework and the database were not developed enough before the syllabus for the course was submitted in order to work the pilot study in to the Environmental Science course. As seen in the syllabus (Appendix B), there were no open slots of time to perform the inventory early enough in the semester for results to be published as a part of this project. Had there been time available in early April running the pilot might have been possible. The pilot would have involved a brief study as outlined in the “where to begin” section at the start of this chapter.

CHAPTER V: Conclusions and Recommendations

The framework for the inventory has been laid out in Chapter Four. It is simple enough to start out with and can be elevated into a more complex study that will provide not only a better experience for the students that participate but also improve the knowledge of the level of biodiversity there is on Conserve School's 1200 acres. Many people might ask "why should we care about the biodiversity?" There are several reasons why a study like this should be done. Beaver Creek and the Urban Ecology Center both understand that by knowing what we share our world with we can become better stewards of the land, water, and air. Conserve School's mission is to inspire environmental stewardship, and it is imperative to know what they are being stewards of, especially with regards to the land that they use to inspire such actions.

Through this inventory Conserve School will be able to monitor the health of the property that it looks after; invasive species movement can be tracked, forest management plans can be devised, and students can be connected to the local ecosystem and can also contribute to both statewide (Nature Mapping through Beaver Creek) and national databases to provide a more broad perspective on the matter. If performed once per semester, this inventory will build upon the local database that has been created and with a good record of hard data Conserve will be able to monitor change as the world around it grows older and is affected by climate change and other extrinsic forces. If the study finds the health of the ecosystems to be failing through minimal biodiversity or strong invasive species movement, action can be taken to try and improve the situation. If the ecosystems turn out to be healthy then Conserve School can be viewed as a model community for environmental stewardship.

It is recommended that the Great Backyard Bird Count is performed each year, and that it should be performed a second time (as it only officially is performed once) in the fall so that everyone who attends Conserve will have a chance to participate. Data that is collected can still be added to BirdSource via eBird to provide the sense of a national accomplishment. It is also recommended to perform the advanced plant inventory even though it and the mammal inventories may seem a bit too advanced. The mammal trapping is a unique idea that few others do, but may be a bit too complicated for Conserve School; it is not recommended per se, but it is there as an option. The purpose of performing these is to broaden the horizons for these young people and to give them an experience that they cannot get at their sending schools, so that is important to keep in mind when performing the inventory. It will also give them an edge in college if they choose to go on in an ecologically based field.

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APPENDIX A

Database Examples

Mammals, Birds, Trees, Saplings and Shrubs, Herbs and Fungi, and Other.

The database was created as a spreadsheet in Microsoft Excel. The digital version has been provided to the faculty at Conserve School in a more extensive blank form.

Species Name	# Observed	Location	Gender	# Observed	Location	Gender
Moose						
Bison						
Short-tailed Shrew						
Canines						
Cougar						
Flying Squirrel						
Wolverine						
Snowshoe Hare	2	1,3,5	Unc	1	3,1,4	Unc
Northern River Otter						
Lynx/Bobcat						
Groundhog						
Fisher/marten						
Striped Skunk						
Voles	1	2,2,4	F	1	6,1,3	M
House Mouse						
Weasels						
Bats						
Woodland Jumping Mouse						
Whitetail Deer	3	4,2,2	Unc(F)	1	8,4,1	M
Muskrat						
Deermice						

Table 1 – Mammals

Latin Name	Common Name	**# Observed**	**Location**	**Gender**
Accipiter spp.	Goshawks			
Actitis m.	Spotted Sandpiper			
Aegolius a.	Saw-whet Owl			
Agelaius p.	Red-winged blackbird			
Aix s.	Wood Duck			
Ammodramus spp.	Sparrows			
Anas spp.	Dabbling Ducks			
Anthus s.	Sprague's Pipit			
Archilochus c.	Ruby-throated humming bird			
Ardea spp.	Egrets			
Aremaria i.	Ruddy Turnstone			
Asio spp.	Eared Owls			
Aythya spp.	Diving Ducks			
Bonasa u.	Roughed Grouse			
Branta c.	Canada Goose			
Bucephala a.	Bufflehead			
Buteo j.	Red-tailed Hawk			
Cardinalis c.	Northern Cardinal			
Carduelis t.	American Goldfinch			
Catharus spp.	Thrushes			
Ceryle a.	Belted Kingfisher			
Corvus spp.	Crows			
Cyanocitta c.	Blue Jay			
Dryocopus p.	Pileated Woodpecker			
Gallinago g.	Common Snipe			
Gavia i.	Loon			
Haliaeetus l.	Bald Eagle			

Table 2 - Birds

Location	Species 1	Diameter (cm)	Distance (m)	Species 2	Diameter	Distance
1,1,1	*Abies balsamea*	23.6	1.3	*Acer saccharam*	40.6	4.2
1,1,2	*Betula papyrifera*	16.9	2.6	*Abies balsamea*	11.5	2.9
1,1,3						
1,1,4						
1,1,5						
1,2,1						
1,2,2						
1,2,3						
1,2,4						
1,2,5						
1,3,1						
1,3,2						
1,3,3						
1,3,4						
1,3,5						
1,4,1						
1,4,2						
1,4,3						
1,4,4						
1,4,5						
2,1,1						
2,1,2						
2,1,3						
2,1,4						
2,1,5						
2,2,1						
2,2,2						
2,2,3						
2,2,4						
2,2,5						
2,3,1						
2,3,2						
2,3,3						
2,3,4						
2,3,5						
2,4,1						
2,4,2						

Table 3.1 – Trees

Species name	Common name	Average Diameter (cm)	Abundance
Abies balsamea	Balsam Fir	17.55	2
Acer rubrum	Red Maple		
Acer saccharum	Sugar Maple	40.60	1
Betula alleghaniensis	Yellow Birch		
Betula papyrifera	Paper Birch	16.90	1
Carpinus caroliniana	American Hornbeam		
Fraxinus americana	White Ash		
Fraxinus nigra	Black Ash		
Fraxinus pennsylvanica	Green Ash		
Larix laricina	Tamarack		
Ostrya virginiana	Ironwood		
Picea glauca	White Spruce		
Picea mariana	Black Spruce		
Pinus banksiana	Jack Pine		
Pinus resinosa	Red Pine		
Pinus strobus	White Pine		
Populus grandidentata	Big Tooth Aspen		
Populus tremuloides	Quaking Aspen		
Prunus pennsylvanica	Pin Cherry		
Prunus serotina	Black Cherry		
Prunus virginiana	Choke Cherry		
Quercus rubra	Red Oak		
Thuja occidentalis	Northern White Cedar		
Tilia americana	Basswood		
Tsuga canadensis	Eastern Hemlock		

Table 3.2 – Average Diameter and Abundance of trees

Location	Species 1	Distance (m)	Species 2	Distance (m)
1,1,1				
1,1,2				
1,1,3				
1,1,4				
1,1,5				
1,2,1				
1,2,2				
1,2,3				
1,2,4				
1,2,5				
1,3,1				
1,3,2				
1,3,3				
1,3,4				
1,3,5				
1,4,1				
1,4,2				
1,4,3				
1,4,4				
1,4,5				

Table 4 – Saplings and Shrubs

Location	% Coverage	Species 1	Species 2
1,1,1			
1,1,2			
1,1,3			
1,1,4			
1,1,5			
1,2,1			
1,2,2			
1,2,3			
1,2,4			
1,2,5			
1,3,1			
1,3,2			
1,3,3			
1,3,4			
1,3,5			
1,4,1			
1,4,2			
1,4,3			
1,4,4			
1,4,5			

Table 5 – Herbs and Fungi

Location	**Species**	**Gender**	**Quantity**
1,1,1			
1,1,2			
1,1,3			
1,1,4			
1,1,5			
1,2,1			
1,2,2			
1,2,3			
1,2,4			
1,2,5			
1,3,1			
1,3,2			
1,3,3			
1,3,4			
1,3,5			
1,4,1			
1,4,2			
1,4,3			
1,4,4			
1,4,5			

Table 6 – Other

APPENDIX B

Conserve School’s Schoolwide Learning Goals and Environmental Science Syllabus

Schoolwide Learning Goals

After completing a semester at Conserve School, a student:

Appreciates and experiences the wonder of nature; values fundamental, life-long connections with nature; and expresses those connections in creative ways.

Comprehends the complex meanings of sustainability and stewardship and uses these principles as guideposts for their personal and professional life.

Will have taken a strong step forward on their educational path equal to or greater than the expected progression in their sending school.

Demonstrates the skills necessary to feel comfortable and confident in the outdoors, both alone and with others.

Understands and critically evaluates the complexities of environmental issues, including their ethical dimensions, and advocates effectively for what they believe is just.

Develops and sustains personal and professional connections across distances and differences.

Understands educational and professional opportunities related to the environment and how to pursue them.

Frequently takes time for outdoor play and reflection.

Demonstrates improved skills in the principles and practices of teamwork and leadership.

Demonstrates a commitment and responsibility to community and is inspired to value and take part in service to others.

Demonstrates the inquiry-based, observational and reflective skills necessary to the development of an on-going sense of place.

Displays an understanding of the connections across disciplines and the value of an interdisciplinary worldview.

Understands the crucial influence of cultural beliefs and practices on the environment and appreciates the importance of examining traditional Western perspectives on the natural world and the alternatives to them.

Has a hopeful and realistic outlook, including a personal vision for a better future.

Understands the ecology, history and cultures of the Northwoods from the local to the global levels.

Demonstrates deep knowledge of and affection for Lowenwood, the 1200 acres on which Conserve School is located.

Understands James R. Lowenstine's love of Lowenwood, a love that moved him to make a remarkable and enduring gift that would engender that same love in young people and inspire them to be stewards of the natural world.

Environmental Science Syllabus by Robert Eady and Andrew Milbauer

Week 1, 1/31 – 2/4
M/T – PRETEST. Conservation, Stewardship, preservation (Robert
W--History (Andy) and GIS (Robert)
R/F -- Ecology and Succession (Andy)

Week 2 2/7 – 2/11
M/T Snow shoe, animal tracking
W Trophic Cascades (Robert)
R/F Predator Prey adaptations and interactions, evolution (Andy)

Week 3 2/14 – 2/16
M/T Phenology, Brids, Introduce blog, (Robert)…John Bates?
W Peshtigo Fire, and history of forestry (Andy)
R/F Winter Festival

Week 4 2/21 – 2/25
M/T GPS, GIS
W Forest Management, Wildlife, Bird habitat (Andy)
R all students to science Kelly on GIS and fire models
F Field instruction

Week 5 2/28 – 3/4
M/T Introduce project week
W Project
R/F Project

Week 6 3/7 – 3/10
M/T Energy (Robert)
W/R Mining, Rice Crispy Lab (Andy)
F WINTER SKILLS

Week 7 3/14 – 3/18
M/T Local Mining Issues and Energy
W Start Seeds (Andy) Alternative Energy (Robert)
R/F Projects and Batteries (Robert, Andy at NSTA)

Week 8 3/21 – 3/24
M/T Quarter assessment and project work
W/R Introduce Horticulture, soils, Porosity and Permeability Lab (Andy)
F FAMILY WEEKEND

Week 9 3/28 – 4/1
M/T Monarch Project (Robert), Mark recapture lab (Andy)
W Dust Bowl (Andy), Taxonomy (Robert)
R/F Project Day and Seedling Transplanting

Week 10 4/4 – 4/8
M/T GIS (Robert)
W/R Food, Diet, and Heirloom Crops (Andy)
F WINTER SKILLS

Week 11 4/11 – 4/15
M/T Alternative Agriculture (Robert)
W History of the Apple (Andy) ____________________(Robert)
R/F Project and Seedling Maintenance

Week 12 4/18 – 4/22
M/T Introduction to water cycle, well logging, visit wells (Robert)
W Groundwater Simulator, Groundwater flow (Andy)
R Earth Day
F Spring Break

Week 13 5/2 – 5/6 Limnology
M/T Aquatic Invertebrate sampling (Andy)
W
R/F

Week 14 5/9 – 5/13 Limnology
M/T
W Plant Apple Trees for stewardship day
R/F

Week 15
M/T
W Final
R/F

Final month ideas
Adventure Mine Trip
Aquatic Invertebrate sampling
Compare Forest recovery with and without deer
GLEON and GIS